PART B

Proposal Front Page

Proposal Full Title: **INNOVATIVE SYSTEMS FOR EARTHQUAKE RESISTANT MASONRY ENCLOSURES IN RC BUILDINGS**

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Construction, masonry infill walls, masonry veneer walls, seismic behaviour

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Project summary

The project aims at developing innovative systems for masonry enclosures, used to create façades, envelopes and partitions of reinforced concrete framed buildings, to derive sound concepts for their analysis, and to develop reliable, simple and efficient methods for their design in the everyday engineering practice.

Masonry enclosure systems contribute significantly, yet non to a measurable degree, to the performance of buildings, in terms of healthy indoor environment, temperature, noise, moisture, fire, durability. However, they have been considered for long time as non-load-bearing, non-structural elements. In reality, they do play a structural role in the overall seismic behaviour of buildings . It has been recognized that such role can be positive, provided that their arrangement in-plan and in-elevation is adequate (not to create irregularities) and that their effect on the building response is adequately taken into account in the design phase. On the other hand, enclosure walls need to be checked against excessive damage and potential out-of-plane collapse. Under this respect, as proven by recent earthquakes, if they are not properly detailed to accommodate seismic loads and correctly designed, they represent a significant hazard and can result in extensive economic losses as well as in a source of danger for human lives. Hence, it is necessary to reconsider the structural role of enclosures, in order to establish reliable analysis and design procedures and to provide background for an update of current structural codes. The research focus is not only on the effect of masonry partitions and enclosures on the structural system, for which already numerous studies and some code provisions already exist (although still to be improved), but mainly on the damage to partitions and enclosures themselves and on the criteria to limit such damage, for which a lack of knowledge and technological solutions is felt.

The adopted approach starts from material and technology development. Technical and economic feasibility of the envisaged construction systems will be demonstrated by performing parallel experimental and theoretical studies, and will be validated by prototypes construction. Experimental and numerical characterization will be aimed at deriving structural requirements of masonry infill walls, as well as tools and methods for their assessment.

In summary, the research, being aimed at the development of design procedures and innovative enclosure systems, for technological progress and code updating, will offer innovative solutions to scientific and industrial problems which have a broad-spectrum impact. The experience of SME associations involved in the project, with the aid of different agents in the process, will ensure that the needs of large communities of SMEs are met. Hence, the final project results will benefit a larger group of enterprises and end-users across Europe, effectively replying to the competitive threat of the market.

1. Scientific and/or technological excellence, relevant to the topics/activities addressed by the call

1.1 Sound concept and quality of objectives

1.1.1 Motivation and approach

The use of masonry infill walls and, to a certain extent, veneer walls, especially in reinforced concrete (rc) framed structures, is widespread in many countries. This practice derives from the natural evolution of the traditional building technique, which was based on masonry walls. The exceptionally rapid growth in the use of rc elements for creating the bearing structure, transformed the latter into a "wire frame" of negligible volume, mass and stiffness, when compared to traditional masonry walls. The resulting deficits in all the other performances that buildings must provide (separation between internal and external environment; location of pipes, other installations, and windows; thermal and acoustic insulation; moisture control; etc.), were compensated by using the material that can naturally offer them, i.e. masonry, for enclosures.

Indeed, lightened masonry units are able to provide an almost continuous range of density and thus of humidity and thermal performance, including transpiration. Masonry can be constructed to maximize these benefits by reducing to a minimum the mortar joints or by using mortars with suitable characteristics (e.g. lightweight). Masonry units can be also used to cover the rc elements, minimizing the effect of thermal bridges and lower porosity of concrete [Ref. 2]. With these solutions, enclosure walls provide a continuous, homogeneous surface. They prevent unpleasant micro-environmental phenomena, which cause problems of comfort, aesthetics, and durability, to occur. Hence, the total cost of the building (initial cost plus maintenance) is reduced [Ref. 1].

However, the widespread use of non-load bearing masonry enclosures in rc frames was accompanied by a series of drawbacks, including problems related to poor construction and/or poor detailing, excessive settlement or cracking of the non-structural elements. With reference to structural problems, it has to be underlined that they have only recently started calling additional attention, and still no suitable solutions, acceptable under all possible points of view (compliance with code required performance, safety, economy, aesthetics, durability, adequacy of design procedures, etc.), have been investigated and proposed. This fact is particularly pronounced when the so-called non-structural elements are subjected to actions that force them to behave structurally, as in the case of earthquakes, strong winds, etc (see Fig. 1 and Fig. 2).

Fig. 1: Examples of in-plane and out-of-plane seismic damage to clay unit masonry infill walls

Fig. 2: Examples of in-plane and out-of-plane seismic damage to clay brick masonry veneers

The 1971 San Fernando earthquake (Mw = 6.6) is considered a milestone in the development of modern earthquake engineering, as it occurred at the centre of the largest concentration of strong-motion recording instruments in the United States Cooperative Network, provided an unpreceded amount of data [Ref. 87], and gave impetus for revising building codes and improving seismic resistant design specifications for bridges and buildings [Ref. 111]. It has been reported that one third of the reconstruction costs in the fault area were related to enclosure walls, and almost 90% of framed building far from the fault suffered damage to non-structural elements [Ref. 24]. The remarkable progress of seismic codes that has been achieved since then mainly concerned the structural portions of the buildings. Today, design provisions for ductility and proper detailing can ensure that framed buildings behaves properly under earthquakes. Notwithstanding, the shortcomings of masonry enclosures when subjected to seismic loads as well as their significant economic impacts are not yet solved, as modern earthquakes confirm. The Loma Prieta (1989) and Northridge (1994) are good examples of the economic costs associated to non-structural damage (30 million USD dollars), even in buildings that were not structurally affected [Ref. 132]. In Lefkada (Greece, 2003, Mw = 6.2) only one reinforced concrete building collapsed, while the majority of rc buildings behaved in a satisfactory way. Damage was limited to local failures of structural and non-structural components, mainly related to cracking of infill walls made of clay units (diagonal shear cracks, out-of-plane collapses, etc), and reported injuries were mostly related to free-falling roof and infill wall clay tiles [Ref. 89].
The 2009 earthquake in L'Aquila (Italy, Mw = 6.3) produced around 300 casualties and more than 1500 injuries. The highest number of casualties (around 200) was concentrated in the town of L'Aquila, with dominant damage type causing fatalities equally subdivided between masonry houses collapse and poorly designed/built rc frame failure and infill walls failure [Ref. 65]. Indeed, during the L'Aquila earthquake, rc building structures behaved, on average, fairly well, despite the severe ground shaking. However, widespread extensive damage to masonry infill and internal partition walls was detected, and caused the highest losses in rc buildings [Ref. 66].

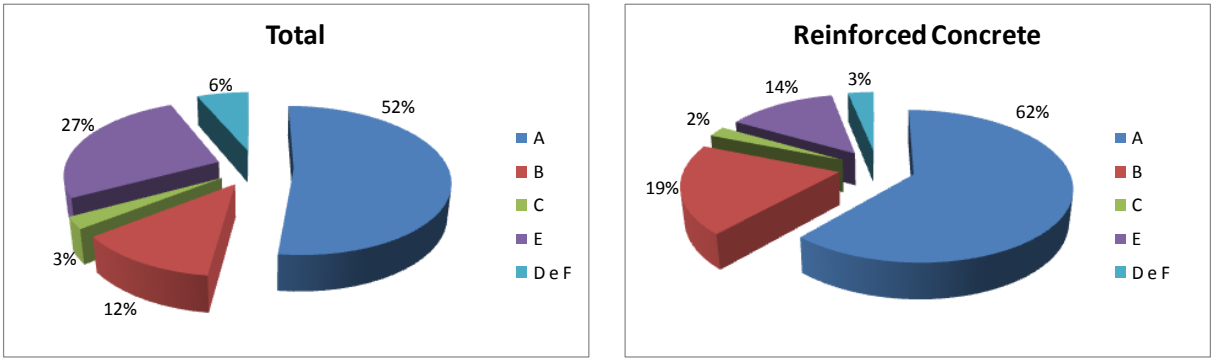


Fig. 3: Results of inspection on 73521 buildings after L'Aquila 06/04/2009 earthquake [Ref. 103]

Detailed economic analyses have been carried out during the post-earthquake reconstruction to evaluate the cost of repair, including repair works on clay unit infill walls, equipment and interior finishing. Concerning rc buildings with moderate to high non-structural damage, that were 21% of the inspected rc buildings (classified B and C, on a scale ranging from A to E according to the increase of damage extent, see Fig. 3), a cost equal to about 318 €/m^2 has been estimated. For buildings having high non-structural damage and structural damage (classified E, 14% of the inspected rc buildings), the cost increases to about 400 €/m^2 [Ref. 103, Ref. 122]. In economic terms, it is evident that the impact of enclosure walls repair, even in a severe earthquake, can be more relevant than the cost related to purely structural interventions [Ref. 8]. For a complete analysis, in addition to the costs in terms of personal injury/death and property damage, also costs related to loss of building function should be taken into account [Ref. 24, Ref. 4].
The 2011 earthquake in Van (Turkey, Mw=7.1) once again demonstrated the highly variable nature of the seismic damage to infill walls in rc frame buildings. In some cases (Fig. 4a, b, c), the infill walls contributed significantly to strength and hence helped in the survival of the building. In some other situations (Fig. 4d), masonry infills detached from the structure and/or collapsed due to a combination of in- and out-of-plane demand. This type of non-structural damage can be extremely

dangerous for occupants, emphasising the importance of masonry infills in rc buildings and calling for the development of new systems for their improved performance.

Fig. 4: Damage to infills in 2011 Van Earthquake: a) in-plane damage, b) damage inside building in a, c) moderate damage, d) heavy combined damage

Fig. 5: Masonry infill and veneer damage: Emilia, Italy, 2012

Also in the recent (May 2012) earthquake in Emilia (Italy, Mw=6.0), examples of in-plane and combined in-plane and out-of-plane masonry infill and veneer damage have been reported (Fig. 5) [Ref. 97]. Problems related to the performance of masonry infill and veneer types and construction techniques, typically adopted in Italy and other seismic prone European countries, could be identified, even in newly constructed buildings [Ref. 57, Ref. 97].

A number of earlier studies also report of very high costs related to non-structural elements. The FEMA guidelines [Ref. 24], estimate the structural interventions for commercial buildings to approximately 20-25% of the original construction cost, while the other elements account for the remaining 75-80%. An older statistical study carried out by Insurance companies [Ref. 126] refers similar costs (up to 80% of the total value of the building) for repair and reconstruction of non-structural elements after earthquakes. Recent studies confirm those values [Ref. 122], and report even higher values for special building types, such as hospitals [Ref. 36]. Another major aspect to be underlined is that non-load bearing masonry walls exhibit frequently inadequate performance under serviceability states, being responsible for 25% of the damage in buildings [Ref. 43; Ref. 37]. One of the recently reported causes of damage is the short support of the external walls on concrete slabs, particularly for slender enclosures [Ref. 100], leading to severe cracking or even collapse [Ref. 56]. Commonly, no detailing of the masonry infills is provided in the design, and the workmanship is often poor [Ref. 95, Ref. 46, Ref. 134].

In this context, most of the codes have recognized that also non-structural elements need to be designed for earthquake actions, in relation to different performance levels. However, sound design procedures still do not exist. **The European structural codes for design of reinforced concrete** [Eurocode 2, Ref. 17] **and masonry buildings** [Eurocode 6, Ref. 18] **do not specify details, performance requirements, or compliance criteria for the safe use of masonry enclosures, nor for the behaviour at serviceability and ultimate limit states.**

In the current design practice in Europe, referring to the design of new buildings, rc frame structures subjected to seismic loads are usually examined using linear elastic structural models on which equivalent static or multimodal dynamic response spectrum analyses are performed. The design of infilled rc structures is usually performed on bare frame elastic structural models; where

the masonry infill panels are considered in terms of masses and vertical loads only. In this context, the safety verification of rc frames at the ultimate limit state, according to Eurocode 8 [Ref. 19], has to be accomplished in terms of resistance to seismic action effects for both structural and non-structural elements. In particular, for non-structural elements like interior and exterior walls, partitions and facades that might, in case of failure, cause risk for human life or affect the main structure of the building or services of critical facilities, the verification of resistance for the design seismic action is foreseen and a simplified procedure is proposed for the evaluation of the horizontal seismic force acting on the non-structural element in the out-of-plane direction. Nevertheless, in Eurocode 8 no recommendation for the calculation of the corresponding resistance of the building enclosures is provided. Moreover, according to Eurocode 8 – Part 1, the damage limitation requirements for buildings with non-structural elements are considered satisfied when the induced inter-storey drifts do not exceed certain limits in each storey of the building, defined only as a function of the "ductility" of the infills and on the connection with the surrounding structure, without any reference to the type of masonry enclosure and to the dimensions and amount of infills. Hence, the further development of presently existing code requirements for seismic design of infilled rc structures, as well as the introduction of practical solutions which allow the compliance with the code, in order to achieve satisfactory levels of damage limitation and life safety, is of primary interest and presents one of the important objectives of this research.
Furthermore, the empirical solutions proposed by the code are not accompanied by rationales for design, applicable to the various types of masonry enclosures, and not even rules for the use of connectors in composite systems such as masonry veneers are given. This unclear environment discourages the possible clients of the industrial sector and causes, inevitably, a market loss in the short term. **The absence of clear performance requirements and design methods, and the lack of some practical (even if theoretically stated into the code) measures, can hinder in the long term the further development of masonry construction systems for enclosure walls and, even worst, could turn out to be ineffective, causing a greater damage to the industrial sector.** In other cases, e.g. in steel framed constructions, where structural (steel) and non-structural (masonry) elements have even more pronounced differences, the above mentioned problems appeared immediately and more evidently, and quickly brought to the abandon of masonry and to the set-up and use of solutions based on light materials and components (infill panels made of combined metals, composites and insulation materials), causing a significant market shrinkage for masonry solutions [Ref. 58, Ref. 59, Ref. 60].

1.1.2 Project objectives

In the given context, and according to the Research for SME-AGs objectives as stated in the Work Programme, the main aim of the project is to address **common technological problems faced by SMEs**, indirectly **supported by their Associations**, related to the implementation of **masonry enclosures in seismic areas** and **pre-normative research issues**, through **the development of new products (i.e., material components), technologies (combining material components and construction techniques) and design procedures.** Specific problems related to various constructive solutions need to be considered, in particular, (i) enclosures included in the frame, rigidly attached (rigid infill), (ii) enclosure included in the frame, allowing relative displacements between the wall and the frame (separated infill), and (iii) external enclosure systems, attached to the frame or to backup infill walls, having the possibility of controlled relative movement (veneer). Combining research and industrial needs, product and technology development will be achieved through extensive experimental and numerical activities, aimed at developing theoretical knowledge and practical expertise, including technical-economic implications, and resulting in clear design, detailing and construction procedures for non-structural masonry elements. These developments respond to the need of a large community of European SMEs, including producers of masonry units, mortar and steel connectors/fasteners, contractors, practising designers and professionals, for innovation in this field in order to stop the progressive market lost and turn the current negative trend into an opportunity to improve their market shares.
Considering different structural systems for buildings, levels of seismic input and displacement/ductility demand, solutions of connection between the structure and the enclosure system and properties for the material components constituting the enclosure wall (i.e., masonry units, mortar, in some cases reinforcement and/or connectors/fasteners), a broad range of possible

enclosure systems of varying properties will be addressed. In addition, non-structural issues will be considered with the aim of developing smart solutions in terms of sustainability, energy saving and healthy indoor environment.
The outcome of the project intends not only to focus on the introduction of innovative materials and the improvement of construction technologies, but also to address wide-ranging difficulties related to the implementation of satisfactorily performing masonry enclosures in seismic regions, from the conceptual design phase to the erection of the building. In particular, the project is aimed to result in the definition of design and detailing rules, the publication of practical design manuals and the development of a software package for the design of masonry infilled rc structures. The demonstration on prototypes for selected systems is envisaged, in order to improve the overall quality of the masonry infill and veneer solutions in terms of mechanical and physical performance criteria. Even though the main attention will be directed towards design, detailing and construction of enclosures for new buildings, some of the principle approaches may be applicable also for the assessment and verification of masonry infills and/or veneers in existing structures.
Enclosure "specialization" for adequate earthquake resistance is the core of the project and will consist in defining **integrated and innovative** systems, such as to:

- **optimize (maximize) the local structural performance**, **by limiting damage under the most frequent (and less intense) earthquakes and minimizing the probability of detachment and out-of-plane collapse under the effects of the most intense**, i.e. the “design”, **earthquakes** (for verification at the ultimate limit state);
- **minimize the negative effects that inadequate design and construction of enclosures walls cause on the global structural behaviour** of the rc framed structure under the effect of the design earthquake, i.e. at the ultimate limit state;
- **enhance and exploit the non-structural performance of the infill/veneer walls**, i.e., from one side, all the properties related to environmental, energy saving and comfort aspects, but also, on the other side, those related to the capacity of limiting damage under serviceability limit states, thanks to the use of innovative smart solutions.

For this purpose, the project’s RTD core foresees the definition of a set of technological-constructive combinations (WP3, Product and construction technology development), that will be subjected to series of tests (WP5, Multi-scale experimental testing), and on which various modelling strategies and types of analysis will be applied, with the aim of providing reliable calculation rules (WP4, Modelling of seismic response). The outcome of the research, from the integrated approach of the project and the availability of results throughout the whole work-plan, will be the development of fully constructible and economically feasible innovative systems. The achievement of this goal is ensured by WP6 (Demonstration of constructability), and will find application in the tools and rules given in WP7 (Guidelines for optimized design), which will thus constitute the final research objective. Thanks to the presence of institutions involved in the drafting/reviewing of either national and European norms in the consortium, the research findings will set up the basis and provide input for the development and implementation of building codes.

<u>The main scientific and technological objectives are:</u>

a) **organisation of a comprehensive catalogue** of different structural frame typologies and related types of enclosures systems. Definition of: enclosure systems damage, sources of deficient performance and failure mechanisms; enclosure walls requirements and design parameters, for guiding the knowledge-based development of new products and technologies as well as the optimization of design procedures (see also description in WP3, at PM6);
b) **development of advanced materials** (masonry units, mortar, reinforcement, connectors/fasteners etc.), **innovative technologies and building process** for infill and veneer walls, diversified according to seismic risk level, regional construction traditions and environmental conditions. This will aim at reducing the possibilities of seismic damage and failures, fulfilling all necessary functional (thermal, acoustic and deformational), durability and sustainability requirements (see also WP3; delivered and updated between PM12 and PM18);
c) **experimental characterization at material and masonry assembly level**, for deriving the main constitutive laws relevant for numerical simulation. Activities will include development of test set-ups and testing strategies for frame/enclosure walls sub-assemblies and experimental testing for evaluating the system performance and the influence of the wall in-plane damage on

the out-of-plane response (see also description in WP5, with material characterization delivered at PM12 and sub-assembly characterization delivered at PM18);

d) **numerical simulation of the behaviour of bare frames and frames with infill/veneer walls for evaluating** their mutual influence in the seismic response and clarifying **the seismic load acting** on the non-structural elements. Results will be used for design purposes (see also description in WP4; with definition of proper modelling strategies at PM15 and results at PM27);
e) **numerical parametrical assessment of enclosure walls** to define critical mechanical parameters, seek for structural limitations of the intended technologies and thus **to develop rules for optimized design** (see also description of WP4, with definition of calibrated models at PM21 and definition of design formulations and charts results at PM30);
f) **experimental quantitative characterization of the overall seismic response of model buildings** and of the frame-to-enclosure wall dynamic interaction by shaking table tests, to validate and obtain information on the system performance of the developed solutions (see also description in WP5, delivered at PM24);
g) **manufacturing of prototype** products (masonry units, mortar, reinforcement, connectors/fasteners etc.), design and construction of prototype enclosure walls for assessment and demonstration of constructability and cost-efficiency. Calibration of non-destructive on-site testing procedure for final validation of the proposed technologies and for setting-up quality assessment procedures (see also description of WP6, delivered at PM33);
h) **implementation of the project results into software package and design guidelines** for an effective and large-scale applicability of the proposed technologies and design methods, and subsequent transfer into codes of practice and standards (see also description of WP7, delivered at PM36). The guidelines will cover: (i) construction and site related aspects; (ii) design rationales and procedures. (See also description of WP7, delivered at PM36);
i) **dissemination and exploitation** of the project results. Dissemination, training and exploitation objectives are summarized in WP2 description and will be treated in Section 3.2. These objectives will also be pursued by promoting standardization in the relevant field. The environmental, economic and societal outcomes of the project, i.e. reducing energy consumption (LC and thermal efficient enclosure systems), improving the quality of life (healthy indoor environment in buildings, crack-free and aesthetically satisfactory external building appearance), and increasing safety (seismic resistant enclosure systems), will be considered.

1.1.3 Offering a solution to SME-AGs and their members

As it emerges from Sections 1.1.1 and 1.1.2, there are many technical aspects related to material properties, technology conception, definition of performance requirements and system design that need to be considered in developing new solutions for masonry enclosures. Hence, the effort has to be accomplished in an integrated manner, combining research, industrial and professional expertise from all the involved sectors. However, the great majority of companies in the clay unit sector are SMEs (in EU-27, about 80% of the annual turnover in the clay unit sector is made up by SMEs, Ref. 51) that, individually, do not have the resources and/or knowledge to carry out such an RTD program. In addition, it has to be highlighted that the definition of performance requirements and the consideration of masonry infill/veneer solutions in structural design represent a major issue in the achievement of an adequate building performance in seismic conditions. Even though today the structural design of enclosures is mandatory, support is neither provided by adequate knowledge nor by well-defined measures, rules and procedures. In these conditions, it is likely that **a single SME, developing an innovative system on its own, might not be able to promote it** and achieve any increase in market share, **because of the implicit difficulties related to necessary code compliant design provisions and application guidelines for end-users. Consequently, designers and contractors** are faced with a reduced choice of available enclosure systems safely applicable in seismic regions, and **often overcome these difficulties by choosing light pre-fabricated solutions instead of masonry. Considering the higher performance of masonry walls in terms of functionality, durability and habitability compared to light solutions, such choice results in decreasing life quality for the final customer.**
The benefits deriving from the achievement of the project results have the potential to be applied to virtually all ranges of enclosure walls, different from those that will be tested in the project, thereby representing an important development across the sector. Exploitation of the research results

would therefore have greatest impact if the work was driven by, and the knowledge owned by, clay unit producer organizations that have the capability to interact directly with large numbers of companies, designers and stakeholders. At the same time, SME-AGs in the clay unit production sector have already established relationships with corresponding Associations of Constructors (for example, ANCE in Italy, see also support letters in Annex I, APCE in Spain, etc.), with Professional Boards of Designers (both engineers and architects), and play an important role in regulatory and standardization committees. Therefore, **SME-AGs are in the conditions to reach end-users (contractors and designers)** through training courses and technical publications, **and also to participate in the drafting/updating of structural codes, so as to make the main project results truly exploitable,** thus complementing efficiently the SMEs efforts.

European Associations of clay unit materials are ideal vehicles to drive the research development and turn results in practice; in this project 5 SME-AGs (from Italy, Germany, Portugal, Turkey, and the European Association - TBE), have formed a consortium with 4 SMEs from sectors related to the technological solutions under study (clay unit industry, innovative fasteners and reinforcement, an engineering firm and a software house). The previously mentioned SME-AGs and SMEs have recruited, on a subcontract basis, 7 expert research organizations to carry out the specialist R&D required. The SME-AGs (with all their members, also not directly involved in the project partnership) and the participating SMEs will support the research activities with contributions to specific R&D tasks (mainly concerning product and technology development), demonstrating the results to a wider European SME community, validating the results at an early stage and driving forward dissemination and exploitation measures. For these reasons, and given the fact that common technological problems are addressed and pre-normative research is envisaged, the proposed project is being submitted for consideration under Research for SME Associations.

It has to be noted that the masonry wall sector corresponds to a significant share of the overall construction sector. Clay masonry walls alone (without rendering, etc), represent around 1% of the total value of the building construction market [Ref. 51; Ref. 127]. Construction market at EU 27–2008 was estimated in more than 1.500 billion € [Ref. 76], with the non-residential and new housing market representing the 43% of the total [Ref. 127]. The total European pre-crisis market value for walls can then be estimated at very significant value around 10,6 billion € [Ref. 51]. The production for clay masonry enclosures (i.e., clay units for non-structural function and facing walls), is about 40% of the total clay products in Italy, and more than 60% of the clay masonry products [Ref. 52]. It should be also noted that 50% of the entire EU clay unit production is concentrated in 4 of the 5 countries represented in the project (Italy, Portugal, Germany, Greece, Ref. 51).

With respect to the general crisis of the economy started in 2008, and looking at the 2008-2011 period, contraction of the construction sector is on a European average (EU-15), around 13,3%, with peaks of 33% in Greece, 25% in Spain, 25% in Italy. It is significant that in some countries, also in the pre-crisis period, when a general trend of growth was characterizing other sectors, the building market was in contraction, with values of about 30% between 2002 and 2006 in Portugal and Greece [Ref. 76]. In Germany the contraction is lower because investments in constructions have started shrinking only from 2009 (see also Section 3.1.2, Ref. 76; Ref. 52). However, if we look in detail at the masonry sector, the 2007-2009 (two-year!) period has seen a contraction of 40,6% of production in Italy (from 21 million tons of product in 2007 to 12 in 2009, with production lower than the historical minimum of 15 million tons reached in 1965), with projections of -46,5% in the 2007-2011 four-year period [Ref. 52]. In Spain a reduction of approximately 30% on the production of ceramic materials occurred only between 2007 and 2008, resulting in a severe reduction of companies (35%) and employment (35%); but the reduction in the three-year period has reached even 70% [Ref. 7]. In Greece, where the clay industry represent 10,3% of the total industrial production of transforming raw materials, the decrease in only one-year period 2008-2009 is 25,6%, and raise to 37,1% if we take the 2005-2009 period [Ref. 12]. Hence, the scenarios of the world crisis and the construction market crisis have been resulting in even more considerable losses in the production of masonry units in the last years. These figures illustrate the urgent need of stopping this trend; however, the survival of SMEs in the sector will only be achieved through continuous and sound innovations, by providing new solutions fulfilling deficient existing construction technologies, improving construction quality standards, and providing design and detailing rules for application.

The successful achievement of the objectives of the project and the implementation of the results by a large number of SMEs in the clay unit industry will allow to enhance the added value and competitiveness of their enclosure wall systems, while gaining improved end-user acceptance for their products, leading also to the protection and improvement of the clay masonry market. Moreover, it is important to recall that through the involvement of industrial partners an increased competitiveness of the sector towards non-EU countries (in markets such as America or Asia), will be promoted, by knowledge exported by European companies' leaders but also by means of SMEs that have an international projection. Finally, it can be remarked that the larger impact of the project does not refer only to the brick and block production sector, but also to the sector related to production of reinforcement and other steel components (such as connectors and fasteners). Other sectors positively affected by the project results include building construction companies that will be able to provide economically feasible and improved technological systems, as well as practicing professionals in architectural and structural engineering firms, who thanks to clear design rules emerging from the project may benefit from the increased choice of sound and safe solutions and improved productivity. In addition, software houses will be able to implement clear design rules in their structural analysis software packages. Other spin-off effects, i.e., benefits for close industrial sectors, such as prefabrication, mortar and rendering products, are also of relevance.

1.2 Innovative character in relation to the state-of-the-art

1.2.1 Principal objectives in relation to the international state-of-the-art

Building enclosures are usually subjected to several different requirements as regards indoor comfort, environmental properties and energy efficiency. Indeed, many comparisons with competing solutions show that masonry enclosures can satisfy at their best these requirements [Ref. 119, Ref. 80, Ref. 82]. To summarize, building enclosures are commonly not considered as structural elements. However, veneer walls need to have structural performance to span between ties [Ref. 27], and due to their mass and connection to the structure, they may influence the overall dynamic response under seismic actions [Ref. 92]. In the case of infill walls, the influence on the global behaviour of rc frames subjected to earthquake loadings is more widely accepted [Ref. 49]. Infill masonry panels, if properly distributed and considered in the seismic design of new structures, can have a beneficial effect [Ref. 121]. They increase the stiffness of the structure, result in reduced displacement demands, and contribute to the structure's dissipation capacity, offering significant extra shear resistance to the earthquake, [Ref. 113]. Hence, for existing rc buildings, constructed before the advent of current seismic codes, severe damage or even collapse can be attributed to poor original design or deficient construction detailing [Ref. 132].

Damage and collapse of rc buildings is often caused due to improper consideration or neglecting of the influence of infill walls on the surrounding rc elements. One cause of adverse effects is associated with the infills leaving a short portion of the column clear [Ref. 50, Ref. 111, Ref. 31]. In addition, the irregular arrangement of infill walls along the height of the building causes an abrupt change of the building stiffness, resulting in the possible activation of soft-storey mechanisms. Moreover, the asymmetric distribution of the infill masonry walls on the building plan can introduce torsional effects, and hence, induce large displacements of rc columns [Ref. 78, Ref. 47].

Under accidental actions, such as earthquakes, deficiencies of the enclosures themselves (infills and veneers) may be significant. Indeed, masonry enclosure walls mobilize their maximum in-plane resistance for small values of imposed shear deformation, usually with the appearance of shear cracking. Their response is rather brittle, characterized by a decrease of resistance for larger values of shear deformation imposed by the frame during earthquakes, thus resulting in severe damage, possibly even disintegration or partial collapse of the wall [Ref. 68]. In addition, infill and veneer walls detach from the surrounding frame elements at early stages of the seismic event and they can collapse out of their plane. Thus, they may cause injuries or even casualties and they become the main cause, disproportionate and unjustified, of damage to property, as highlighted by recent earthquakes [Ref. 65, Ref. 66, Ref. 89, Ref. 111, Ref. 134, Ref. 92]. This phenomenon is unfavourable also because it requires extensive repair, or demolition and reconstruction, associated with major time consumption and high costs (Section 1.1.1).

Several recent research programs have focused on the development of strengthening techniques for existing and possibly damaged infills, aimed at improving both the in-plane and out-of-plane performance. Various techniques for the retrofitting of unreinforced masonry walls have been introduced, namely pre-stressing, jacketing and surface treatments. More recently the application of innovative materials, such as fiber reinforced polymers (FRP) and steel reinforced grouts (SRG), has been also proposed [Ref. 20, Ref. 28, Ref. 122, Ref. 130, Ref. 79, Ref. 85, Ref. 86]. Today, these techniques have been largely tested; they have been even introduced into several guidelines for the retrofit and strengthening of existing buildings [Ref. 23], and are being applied for the repair of damage induced by recent earthquake [Ref. 28].

However, surprisingly enough, no substantial research efforts have been done for the development of improved solutions for new construction of masonry enclosure walls. In fact, the evaluation of damage to masonry infills themselves, possibly causing the exceedance of damage limitation and/or ultimate limit state requirements, previously has received little attention, and has been only recently more widely recognised in the earthquake engineering community. In particular, reflecting the urgent need to develop specifically designed methods of constructing infill buildings to make them safer and more earthquake-resistant, GeoHazards International supported by the Earthquake Engineering Research Institute (EERI) and the U.S. National Academies has formed an international network (called *Framed Infill Network* [Ref. 5]) focused on the particular structural configuration consisting of rc frames with unreinforced masonry infill walls, with the aim, among others, to draft engineering design documents for new framed buildings, outline research needs for infill buildings and improve collaboration between researchers and practicing professionals [Ref. 6]. Specifically in the European context, within the scope of the on-going SERIES research project, two prototype masonry infill typologies, i.e. a traditional and an innovative type of infill, have been addressed [Ref. 11]. Improvements in the seismic response of the masonry infills have been reported based on preliminary results due to the application of enhancement techniques (i.e. bed joint reinforcement) [Ref. 94]. Within the DPC-RELUIS 2010-2013 project, a series of numerical analyses based on models calibrated on existing test results have been carried out, resulting in implications for the design of new rc frames with masonry infill [Ref. 83, Ref. 84], and an experimental research program related to the combined in-plane and out-of-plane response of several clay masonry infill typologies has been accomplished [Ref. 55]. The research results do not only confirm the need to enhance current approaches for the design of new rc buildings with masonry infill, revealed also following recent earthquake events as previously discussed, but also indicate that satisfactory in-plane and out-of-plane infill performance can be achieved through the application of enhanced construction techniques and design approaches, encouraging the further development of innovative masonry infill systems and related design provisions.

Some measures for new infill walls are mentioned in Eurocode 8, such as light wire meshes well anchored on one face of the wall, wall ties fixed to the columns and cast into the bedding planes of the masonry, and concrete posts and belts across the panels and through the full thickness of the wall [Ref. 19]. The first solution outlined (i.e. light wire mesh) may rise doubts related to durability and external appearance, in particular, when traditional materials are used. Moreover, experimental validation for its effectiveness is limited to few specific types and thicknesses of infills. The wall ties fixed to the columns solution give some possibility for development, although technological improvements still need to be achieved [Ref. 44, Ref. 81]. The concrete posts and belts solution, if massive, is costly, invasive and gives rise to issues regarding the possible interaction effects. Actually, due to the possible, not reliably predictable, interaction of the embedded concrete elements with the frame, during the recent reconstruction after the L'Aquila earthquake, this type of solution has not been allowed [Ref. 3].

Enclosures with deformable joints, leaving an empty space between the infill and the frame elements, aim to minimize the infill-structure interaction [Ref. 38]. In these systems, the use of e.g. shelf angles for guaranteeing out-of-plane stability is often proposed. Also in this case, problems of durability, aesthetics, and indoor comfort arise. Very recently, masonry infills with addition of frictional sliding fuses, that increase their in-plane deformation capacity, have been proposed [Ref. 105]. However, the out-of-plane behaviour of such systems, which is subdivided in several horizontal portions, has not been taken into account.

Most of the patents in international databases [Ref. 13, Ref. 14, Ref. 15] are related to thermal insulation units used for enclosure (CN/2009/64650). There are also many patents of construction systems for structural masonry and claddings, and for seismic strengthening of existing infill walls. Systems for post tensioning masonry (MX/2008/010390; MX/2008/006044), can be generally applied only to load bearing masonry, where the top edges of the walls, to which post tensioning is applied, are free before casting the above floors (which is not the case with infills). Only few patents are related to construction systems for new seismic enclosure masonry walls. Some solutions refer to the use of embedded horizontal and/or vertical reinforced concrete elements, cast within masonry cavities (WO/2008/015407; W0/2009/098446). Other solutions refer to the use of FRP units, joined with resins, and connected with embedded elements in the horizontal joints all along the frame (JP/2009/062725-6-7). It is worthwhile mentioning that this latter system appears to be extremely costly, not to mention the fact that the production of FRP units is definitely less environmentally friendly than clay unit production. FRP applications seem therefore to be unfeasible for new construction, also because of the usual conditions on new construction sites (presence of dust and/or humidity) that may endanger proper bonding. The only solutions that are in line with the proposed research project relate to the development of special masonry ties for cavity wall construction and veneer walls (CA/2467932; US/2004/231270; WO/03087487; etc.). In this field, “structural veneers” have been recently developed in the US. These enclosures are made of hollow clay or concrete units, cast with concrete and reinforced, and are attached to the frame with few robust anchorages. By doing so, veneers and frames can have independent relative horizontal displacements, thus avoiding in-plane damage [Ref. 27].
The principal objective of the project is thus to identify and develop optimized new masonry enclosure solutions for enhanced earthquake resistance, respecting local materials and construction practice, **and to provide clear design rules, so that the proposed systems can be used effectively.** The release of design, detailing and construction guidelines for masonry infills and veneers, as well as accompanying software for design, is aimed to constitute a helpful additional tool to promote the new systems. Clearly, referring to constructive solutions having a strong and long-lasting tradition, as in the case of clay masonry, **the innovative character of the proposed systems cannot be sought exclusively in the development of thoroughly new materials and construction techniques, but in the smart combination of (i) conventional materials (i.e. clay brick or block masonry units, mortar) and/or innovative materials (e.g. clay masonry units of particular shape, sliding mortar, various steel components), (ii) sophisticated enhancement techniques (e.g. through application of reinforcement, connectors/fasteners, joints, angles, shelves) and (iii) original design methods**. In the following, expected enhancements with respect to the state-of-the-art are reported referring to the project’s objectives, the foreseen activities and the proposed work plan.

1.2.2 Targeted development of materials and technologies

Possible types of **innovative masonry enclosure systems** to be developed, with reference to their main conceptual characteristics and details described as follows, **may be divided in three major groups: (i) systems built of conventional material components, following original design methods, (ii) systems built of conventional material components and applying sophisticated enhancement techniques, following original design methods, and (iii) systems built of innovative material components, following original design methods.**
A masonry enclosure system, simple in principle, but still requiring RTD efforts for its practical implementation, can be achieved, ensuring within the thickness of infills (i.e. using thick clay units), without additional interventions, sufficient thermal and acoustic insulation, and providing improved seismic performance due to higher strength. The resistance in the out-of-plane direction of such simple system can be ensured due to the possibility to fully exploit the arch resisting mechanism [Ref. 55]. However, due to the significant drop of the out-of-plane resistance due to previous or contemporary in-plane damage, as shown in previous studies on other types of infill [Ref. 44], the limitation of in-plane damage in the design through original design criteria is indispensable and has to be quantified. Despite being very simple, this infill type has not been used so far, as during the 50s and 60s, 0.15-0.20m thick units were typically used, and later on, to reduce material and improve thermal properties, double-leaf cavity walls with very thin leaves (0.05 to 0.10m thick), were applied [Ref. 23, Ref. 132]. The solutions of thick (~0.30m), single leaf and self-insulated

enclosures are very interesting because only clay units are used. When the unit geometry is properly designed and the composition has proper additives/pores, this type of enclosure can fulfil the internal environment requirements alone. This solution leads to great energy saving and reduced environmental impact, as it does not require the use of any insulating material, and it is likely that it would be sufficient (without any reinforcement) in low to moderate seismic risk areas.
Further improvement can be achieved by using novel dry stack semi interlocking units, which further economize the construction process (as they are mortarless), but enhance the possibility of exploiting interlocking and friction to increase energy dissipation and, hence, the behaviour of the entire structure. Indeed, mortarless joints or specific grooves allow for relative in-plane sliding of portions of the masonry panels and increase structural ductility, while the semi-interlocking units are locked against relative out-of-plane movements, solving at once the two combined problems related to the behaviour of infill walls. Another alternative, still for low to moderate earthquake countries, is using single leaf walls made of hollow clay masonry units with thin layer mortar. To provide high flexural strength of masonry, the geometry of the units (pattern of holes and outer geometry), and the mechanical properties must be optimized. Specifically, the envisaged approach for optimization is the design of the front face of the units (head joints), as to provide an improvement of the contact surface in the vertical joints. In this case, also, the head joints are not filled with mortar. Top and side connections of the enclosure will be improved by special corner units and optimized anchors, with the aim to positively affect the physical properties of the units.
Further possible solutions can be derived from the previous through the application of different enhancement techniques and are related to the improvement of serviceability performance. Indeed, we currently accept extensive damage to infills, with high economic losses, even in the case of medium earthquakes. However, there are two interrelated problems: firstly, the acceptable extent of damage depends on the performance level adopted for the design of the entire structure; e.g., in case of hospitals or other strategic structures, an almost elastic overall behaviour of the building is required to keep full functionality also immediately after earthquake events. Secondly, also for ordinary structures, limiting damage and enhancing the ductility of the infills, thus allowing for more evenly distributed cracks that could protect embedded installations and be more easily repaired without the need of special facilities, would be of great advantage. Indeed, as demonstrated on load-bearing masonry, this condition can be reached by adding normal or prefabricated bed joint reinforcements (Fig. 6). This has been also proved for infill walls, but only in the case of systems with thin elements (11mm; Ref. 44, Ref. 113).

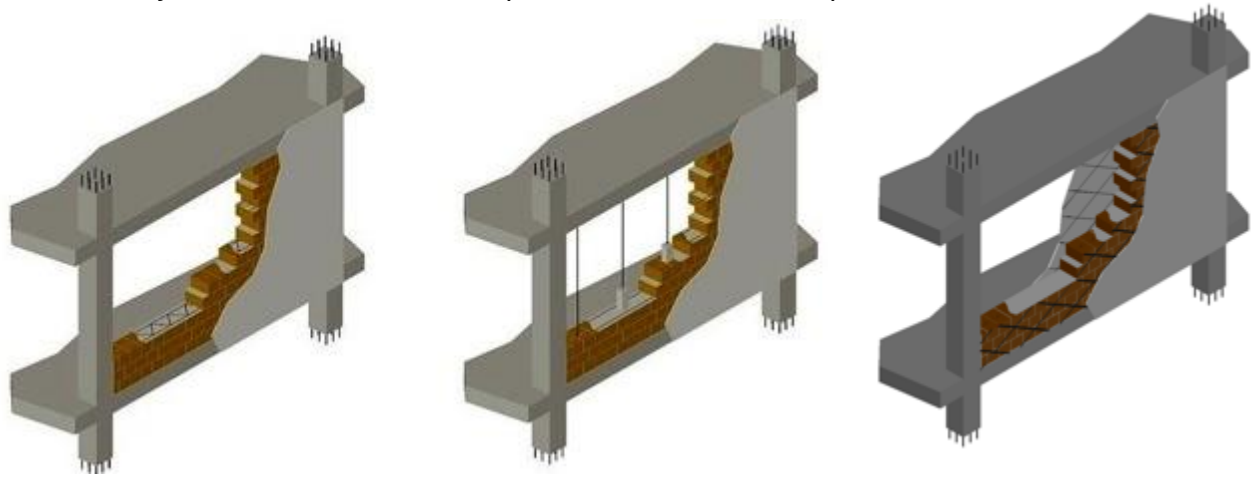


Fig. 6: Solutions: horizontal reinforcement; horizontal and vertical reinforcement; new types of plastered wire meshes (from left to right).

Further developments consider, in addition, the use of vertical reinforcement, providing a system that is more similar to load-bearing reinforced masonry (Fig. 6). It has to be highlighted that these solutions improve serviceability performance but also enhance the response to out-of-plane loads at the ultimate limit state. Indeed, for “design” earthquakes (most intense and occurring with long return periods), in high seismic risk areas, it is foreseen that the masonry infill walls will undergo severe damage, but thanks to the presence of reinforcement, the cracked portion of masonry will not fall, ensuring the fulfilment of life safety requirements. Related to the practical implementation

of these solutions, it will be necessary to study the unit geometry, so as to make it possible to lay the units after vertical reinforcement has been already put in place, as recently proposed for load bearing masonry [Ref. 108, Ref. 39], thus resulting in a system that can be constructed within an already built frame. In these systems, there will also be the need of designing mortar and reinforcement depending on the exposure conditions (durability), keeping in mind, for mortar, also the need for developing adequate bond (mechanical properties), properly filling the unit recesses (workability and constructability), and keeping good insulation properties.
Other solutions that rely on the enhancement of the ductility of enclosure walls are based on the use of wire meshes inserted in the plaster, on both wall sides. However, instead of the traditional steel based meshes, or those relying on expensive FRP, today a new generation of cheap and very light materials (nylon, polyester, polypropylene, etc) with engineered cementitious matrix and cruciform inter-support systems, are available. These new composite materials have the advantage of being very cost-effective and easy to be applied, as the process is similar to common plastering; in addition, they can be used to limit damage related to serviceability states. To improve the ductility of enclosure walls, another approach may be to take advantage of the composite action of rc concrete and masonry in confined masonry typologies. This can be achieved through the insertion of lightly reinforced ties embedded in the masonry wall, combining the advantages of very light concrete belt and post solutions, allowing displacements in the wall to occur.
Further solutions rely on the separation of infill walls from the surrounding frames, as already proposed in practice and discussed in Section 1.2.1. In this case, several advantages can be pointed out: serviceability performance is dramatically increased in these solutions, as the frames can sustain relative in-plane relative displacements without interacting with the infills. Also, despite the fact that the positive stiffening effect of infills might be lost while keeping their mass, there is a significant advantage when infills are not regularly located in a building [Ref. 27]. As of today, adequate solutions for practical application are still missing; in particular, as far as habitability issues are concerned, hence adequate materials in the joints between infill and bearing elements to ensure efficient insulation need to be provided. The use of external shelf angles for connection to the upper frame beam should be avoided (Fig. 7, above), and replaced with advanced connectors and fasteners in the masonry mid-plane, in order to create a technological ‘sliding joint’ between masonry and frame (Fig. 7, below). The innovative connectors that will be developed in the project will solve the problem of allowing in-plane relative displacements of frame and infill, while counteracting the out-of-plane failure of the latter.

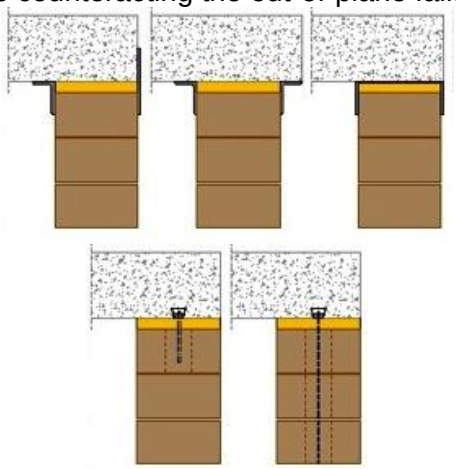


Fig. 7: Horizontal displacement joint: current shelf angle connection (above) and new solution with sliding connectors (below)

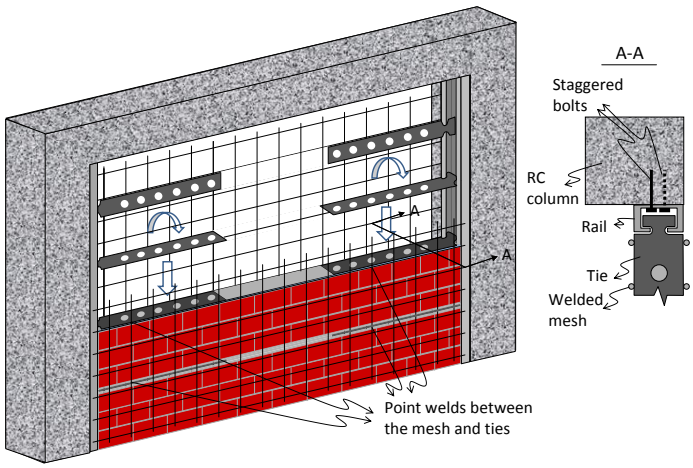


Fig. 8: Solutions with special vertical joints and internal tie mesh system

Besides solutions based on horizontal displacement joints at the top, innovative solutions based on special vertical joints will be developed (Fig. 8). The envisaged tie system is designed to ensure the stability of infill walls under both in- and out-of-plane forces, contributing to the lateral load resistance of the frame. The system makes use of two shaped steel members connected to the columns using driven bolts. A simple connector shaped like a dog bone at one end is easily locked in the rail, simply by inserting and rotating, and laid flat on a course of the masonry wall to tie the

wall to the column. The connection only works in the horizontal direction and enables free movement in the vertical direction, which allows flexibility during construction. The steel plate includes punched holes to promote bonding and interlocking as well as to save on material. Design parameters for all elements must be determined through experimental and numerical studies.
Attention will be devoted to the development of another innovative infill typology that allows the implementation of new materials in close cooperation with the producers. In particular, the introduction of a smart masonry infill system is foreseen, allowing the infill to follow the in-plane deformation of the RC frame through special sliding bed joints, controlling at the same time out-of-plane displacements. For the development of such system, possible adequate innovative mortar types need to be studied in detail and brick shapes capable to restrain the out-of-plane expulsion have to be identified. Alternatively, elastomeric strips may be used in the mortar joints. As demonstrated in [Ref. 77], the deformation capacity can be increased by 5 to 10 times in comparison to conventional mortar. Exposed to earthquake actions, such infill system would not just be able to show a significantly improved behaviour in terms of reduction or absence of in-plane damage, but would also allow for a notable increase in energy dissipation, and reduce problems of adverse local effects on the vertical structural elements due to interaction with the infill walls.
As far as veneer walls are concerned, the main research issue to be studied is related to the use of specific ties, connectors and reinforced systems that can concurrently improve out-of-plane strength and in-plane ductility, reducing the impact of non-severe earthquakes in terms of damage, ensuring proper connection and avoiding out-of-plane failure in severe earthquakes. Special structural veneer systems will be also pursued based on the use of special clay bricks (according to EU tradition) instead of hollow units, without using concrete. The improved mechanical behaviour will be used to enhance serviceability states (for example, under wind), to reduce the number of connectors, and to allow relative in-plane displacements with the frame.
It should be noticed that the envisaged solutions should refer to integrated, but easy to be built and cost-effective systems, so as they can be commercialized and largely applied in constructions.

1.2.3 Modelling seismic response of enclosures and seismic input

The problem of the wall-to-frame interaction, i.e. how the enclosure systems modify the response of the structure inducing a positive, or more often a negative, effect, has been object of many studies and researches [Ref. 29, Ref. 30, Ref. 44, Ref. 45, Ref. 48, Ref. 62, Ref. 117, Ref. 132, Ref. 31, Ref. 109, Ref. 93, Ref. 114]. Many studies also concentrated on how the infill wall effect should be modelled to reproduce the stiffening effect of masonry on the frame. This can be made by using equivalent struts, able to reproduce the various in-plane failure modes of the walls (compressive failure at the centre of the wall or at the wall corners, failure for sliding shear, shear failure with diagonal cracking, Ref. 40, Ref. 48, Ref. 123). Struts elements have been created for both non-linear static analyses and, introducing hysteresis rules, also for non-linear dynamic analyses [Ref. 48, Ref. 110, Ref. 98, Ref. 63, Ref. 114, Ref. 115, Ref. 116]. In the project, a very new and recent combined in- and out-of-plane deformation limit state model proposed by [Ref. 88], which considers interaction between out of plane bending moment and in plane axial forces occurring in the simple compression strut models, will be used. The complete detachment of the infill wall is modelled using element removal algorithms [Ref. 124]. However, this model has not yet been validated on experimental evidence, hence requires establishing deformation interaction curves based on methodical test results to be obtained within the scope of the proposed project. Hence, although the today's software allow for infills to be considered in the design process [Ref. 131], they are most often neglected [Ref. 132], and design of rc framed structures is simplistically carried out, most of times, on the bare frame, or according to still inconsistent rules.
Further on, and most importantly, until today research work, and in particular numerical analyses, have focused on the effect that enclosure systems have on the structural frame response, yielding to the above-mentioned, although still not final, rules. However, the reverse problem, i.e. **how the structural response of the frame influence the behaviour of the infill**, has been to some extent recognized only in few recent initial studies [Ref. 55, Ref. 125]. Hence, **the numerical and experimental work of the project will mainly focus on this latter, almost unexplored, aspect** with the aim to provide original integrated solutions with respect to the choice of materials, design, detailing and construction, for a wide range of earthquake resistant masonry enclosures, addressing both in- and out-of-plane damage control.

One of the main aspects in this field is the definition of seismic input, in the out-of-plane direction, under which the infill wall must be verified. A formulation for its calculation has been recently introduced in some structural codes in Europe [Ref. 19, Ref. 22]. However, many national codes still do not have such information [Ref. 90], and, if we compare our codes to those available in other non-European countries [Ref. 24, Ref. 25, Ref. 26, Ref. 78, Ref. 90], we can see that there are significant differences in the approach, bringing to some doubt on the validity of the various methods. Indeed, recent dynamic analyses [Ref. 101; Ref. 102] demonstrated the inconsistency of the proposed approach with the actual out-of-plane response of masonry walls. This can be due to filtering effects of the structure and their changing nature during the seismic motion, following the elastic or inelastic response that the structure can have. **The definition of seismic input, which is necessary for the design of the walls,** call for further research, and indeed this topic **will be investigated in the framework of the proposed project**, by means of linear and non-linear dynamic analyses (calibrated on the basis of experimental dynamic tests presented in next Section). It is foreseen that, on the basis of the extensive numerical calculations carried out, **it will also be possible to have new findings on the above-mentioned, direct problems related to the influence of infill walls on the frame**.

1.2.4 Experimental/numerical testing of combined in-plane/out-of-plane behaviour

A fundamental aspect related to the influence of the frame behaviour on the response of enclosure walls is that during an earthquake, enclosures are simultaneously subjected to in- and out-of-plane actions. Due to limited shear resistance of masonry, the damage caused by frame in-plane deformations results also in a reduction in the corresponding out-of-plane capacity of the infills [Ref. 44, Ref. 45, Ref. 112, Ref. 113].

Numerical studies carried out so far has never systematically tackled this aspect, coherently with the fact that out-of-plane behaviour of infill walls and veneers has seldom been taken into account. Indeed, very few studies have addressed the definition of limit states of infills based on frame inter-storey drift [Ref. 83, Ref. 84, Ref. 96, Ref. 98]. No methodical definition has been achieved to quantify how the extent of in-plane deformation of the frame influences the mechanical properties in the enclosure systems, and consequently, the corresponding out-of-plane response. Therefore, in the project extensive numerical simulations will be aimed at studying this aspect. These models will be developed mainly using non-linear static analyses and adopting models for anisotropic continua and interfaces, able to reproduce both masonry and its interface to concrete elements, with the final aim of deriving simple methods for safe calculations of infill walls.

Understanding the combined in- and out-of-plane behaviour of hollow clay unit infilled RC frames requires experimental evidence to establish deformation limit states and to validate seismic performance of new technologies. Since the early studies on infilled frames, in fact, lot of experimental tests were carried out for evaluating the influence of different types of walls on the in-plane stiffness of the frame [Ref. 48, Ref. 62, Ref. 123, Ref. 110], necessary also for the calibration of numerical models. Commonly, tests were performed on one-bay, one-story frames, filled with various masonry walls, subjected to increasing quasi-static in-plane displacements, on both real-scale and reduced scale frames [Ref. 30, Ref. 68, Ref. 117, Ref. 31, Ref. 93]. Some experiments were carried out in presence of openings, having different length to high ratios also in relation with the frame geometry, to investigate the effects of openings on the in-plane behaviour of the infill and calibrate the corresponding models [Ref. 104].

Conversely, the combined in- and out-of-plane behaviour of infills, aimed at assessing the influence of the in-plane infill damage on the infill out-of-plane response, has been reproduced experimentally only in few very recent studies. Indeed, even though some work has been conducted related to the simple out-of-plane behaviour of masonry infills, tested in ideal conditions [Ref. 85, Ref. 67, Ref. 54], very few studies deal with the combined problem [Ref. 44, Ref. 45, Ref. 113]. Hence, from the little available experience, it is not possible to extrapolate general results. In the proposed project, the achievements from recent studies will be exploited and further developed, so as to: **(i) derive an adequate testing methodology, still not existing, concerning reference rc frame, in-plane displacement history, out-of-plane loads application method, quasi-static or dynamic loading procedure; and (ii) carry out tests on a large (differentiated) number of clay unit infill walls,** taking into account the various technologies developed in the project framework.

Besides these combined tests on single bay structures, also dynamic shaking table tests will be carried out on at least two model buildings, with the use of at least two different enclosure systems developed during the project, and dynamic tests will be carried out on the real buildings adopted for the prototype enclosure construction. These tests will constitute the real validation under dynamic loads of the adopted solutions. Indeed, some shaking table tests of infilled rc frames have already been carried out in the past, with the aim of studying the effect of infill walls on the frame [Ref. 128, Ref. 92, Ref. 67], examining the out-of-plane behaviour of the enclosure walls [Ref. 128], and focusing in particular on the effect of retrofit measures for the infills [Ref. 128].
The tests to be carried out in INSYSME, besides being necessary for corroborating the new construction systems, will have a different approach, providing new results of general validity for the scientific advancement. Particular importance will be given to the “reverse” problem, i.e. studying in detail the dynamic response of the infills in relation to the dynamic behaviour of the frame. The envisaged contribution is of particular importance for solving the problem of combined influence of in-plane and out-of-plane damage. The results will also be applied for calibrating models and defining the seismic input on the enclosures, as described in Section 1.2.3.

1.2.5 Rules for verification of enclosure walls and guidelines

Based on the numerical analyses and experimental tests carried out, briefly introduced in previous Sections 1.2.3 and 1.2.4, **it will be possible, first of all, to define the structural performance requirements of non-structural elements** on the basis of the overall performance level defined for the building. **The experimental and numerical work will lead to the development and calibration of formulations and procedures for out-of-plane verification.** Indeed, in those countries where recent seismic events have highlighted the vulnerability of the infills, the codes have introduced their mandatory assessment [Ref. 19, Ref. 22, Ref. 90]. E.g., the Italian code [Ref. 22] requires that, excluding only internal partitions having thickness lower that 100mm, the non-structural construction elements that may endanger people, must be verified together with their connections to the structure, in relation to the seismic action corresponding to each limit state.
Hence, once the seismic input has been defined, it should be stated how to apply this action on the walls. Different approaches are, for example, point/line load [Ref. 22] or uniform distribution [Ref. 26]. It is of course necessary to properly define the wall capacity. At this regard, besides the US guidelines for evaluation of earthquake-damaged buildings [Ref. 26], the codes do not suggest any particular procedure. It has to be reminded that the values of out-of-plane capacity that can be defined on the basis of the sole section modulus and flexural strength are rather low and conservative [Ref. 54]. For the verification, it is possible to consider a static scheme with the formation of a resisting arch in the masonry thickness, in analogy with proposal given by the codes for load bearing masonry [Ref. 18]. However, it is also necessary to consider the defects arising due to non-perfect adherence of the wall along the rc frame extension (beams and columns), the dependency on the masonry thickness (i.e., the thinner the masonry wall, the less exploitable is this effect), and, finally, the influence of in-plane damage on this resisting mechanism. Indeed, when masonry gradually loses its mechanical properties (compressive strength) due to the in-plane displacement of the frame, also the arch resisting mechanism is likely to be reduced (from the only experimental evidence in literature on this issue Ref. 44, this reduction can be from 3 up to 5 times). These aspects, which have not been taken into account yet, will be numerically studied within INSYSME using calibrated models, to reach a reliable calculation of out-of-plane infill wall capacity on the basis of the frame in-plane drift, and formulate simple rules and procedures for design. Cleary, due to the interaction of in-plane and out-of-plane response, for some types of masonry enclosures, the out-of-plane stability can be guaranteed only up to a certain level of in-plane damage that can be effectively controlled through the introduction of adequate in-plane drift limits. Hence, the clear definition of a design procedure, accounting for the displacement capacity of the enclosures during the design of the rc frame, accepting the evident fact that the choice of the type of enclosure has to be accomplished in function of the level of seismicity, contributes to the innovative character of the envisaged outcome of the project.
It is also worth noting that the current codes do not set clear rules for the design of connectors and anchors of cavity and veneer walls. As an example, if we take into account some proposals in the literature [Ref. 64, Ref. 129] and by different codes [Ref. 18, Ref. 16, Ref. 17.], it can be easily seen than the calculated axial force on connectors may vary up to 250%. In addition, most codes

give very low values of connectors/m^2 (2 in Eurocode 6, Ref. 18), regardless of the wind and earthquake zones. The codes do not even provide performance requirements for serviceability limit states of veneers, that in principle could be even more restrictive than damage and ultimate limit state requirements, due to the necessity of preserving as much as possible the external appearance of the brick walls. In the case of the more advance structural veneer solutions, the definition of the in-plane behaviour (e.g., as a shear wall or a deep beam) is also a pre-requisite for safe design of enclosure systems.
All these problems of infill and veneer walls will be tackled and solved within INSYSME, to achieve simple, sound construction details and rules, and will flow into construction and design guidelines.

1.3 Contribution to advancement of knowledge / technological progress

In order to accomplish the objectives of the proposed project, the achievements from recent studies, emphasising the urgent need to focus on the damage control of masonry enclosures in rc buildings and to define relevant performance levels [Ref. 83] and providing initial implications for required improvements in the current design procedure [Ref. 84] will be accepted as a reference for the development and implementation of innovative enclosure systems, including a clear and complete procedure for design, detailing and construction for earthquake resistance. Given that the related most recent and currently on-going studies are primarily based on analytical investigations [Ref. 84] and the calibration of numerical models from previous experimental campaigns with little available data [Ref. 44], and/or addressing selected types of infill typologies [Ref. 94, Ref. 55], the ambition of the proposed project is to address the well-recognised problem of masonry infill/veneer damage, accounting for combined in- and out-of-plane actions, primarily in the design of new structures, in a complete manner, through experimental and numerical investigations for a wide range of infill typologies, and resulting in generally applicable solutions.
Enclosure walls have been considered for a long time as non-structural elements; according to the new regulations and life standards, the requirements in terms of thermal and acoustic insulation and, indoor comfort and environmental impact in general have definitely increased. At the same time, it has been recognized that masonry enclosures also play an important structural role in frame buildings, and that the consequences of neglecting this structural role are serious under a social and economic point of view. Such issues need to be tackled in different ways and INSYSME aims to make an important contribution to the overall improvement of enclosure wall technologies.
The novel applications, besides a significant technological development, entail both implicit and explicit advancement to knowledge, leading to the achievement of a wider societal progress. The contribution of the project, in terms of enhancement of the state-of-art, has been presented in Section 1.2. In synthesis, the **main innovations of the project** are:

- Advanced innovative building technologies for enclosures (with respect to units, reinforcement, fasteners/connectors, mortar, and their assemblages), diversified according to seismic risk levels, regional construction traditions and environmental conditions, satisfying all requirements of insulation, indoor comfort, durability, sustainability, as well as serviceability and ultimate limit states;
- New and/or advanced testing procedures for the experimental assessment of the combined in-plane out-of-plane behaviour of infills and validation/qualification of the developed solutions;
- Definition of the interaction between frame and infill, in terms of seismic input on the infill for various frame conditions (type, elastic or inelastic behaviour, etc.), and seismic risk level;
- Original and complete sets of guidelines (i) for the design of rc structures with enclosure walls, (ii) for the design, detailing and construction of enclosure walls, including assessment of in-plane strength and of out-of-plane strength for varying level of in-plane damage, as well as the definition of relevant limit states for different infill/veneer typologies, and (iii) for the verification of ties, fasteners/connectors and other components in special systems;
- Transfer of guidelines for design, detailing and construction into standards;
- Advanced practical tools for the analysis and design of enclosure walls (design charts, software package etc.);
- Achievement of public knowledge in terms of understanding, acceptance and use of the new systems, as well of the new design provisions by end users of different nations.

1.4 Quality and effectiveness of S/T methodology and associated work plan

1.4.1 Overall strategy of the work plan

The project aims at developing innovative systems for a wide range of masonry enclosures, by improving their overall technological performances and developing sound design rules, for code updating. To reach this goal, the project is structured into two main steps, in three-years time:

- Assessment of the technical and economic feasibility of the envisaged production and construction technologies by performing parallel experimental and theoretical studies. The progress towards successful completion of this phase will be checked during the first term review (PM 15) and will constitute a milestone for the subsequent project prosecution;
- Development of design methods. Demonstration of design and construction of prototype walls in real constructions, and on-site testing to completely validate the proposed solutions. Software for design and guidelines for end-users will ensure full use of the developed knowledge and technologies. Subsequent milestones will assess this phase, until PM36.

The technical program has been organized according to this research approach. It is divided in 7 interactive Work Packages (WP), described in details in the following. Reviewing the results and conclusions of each WP and implementing them into the solution process ensure a continuous, targeted progress of the research project. The main objectives and RTD steps of the project are:

- **WP3** (starting on PM1), definition of requirements for the enclosure products (clay units, reinforcements, fasteners, special purpose mortar) and technologies; development of new products and associated construction technologies for the envisaged solutions. Delivery of materials and production of first prototypes. This objective is achieved by means of iterative work, receiving input mainly from the experimental activity (WP5) and from the combined technological/economic assessment (WP6). The main assessment will occur together with technology presentation and practical demonstration of construction at PM18 (milestone M3);
- **WP4** (starting on PM3), numerical characterization, for evaluating the influence of the response of the structure on the local response of walls. This objective receives input from the shaking table tests in WP5. The objective of defining performance levels and response parameters for seismic design will be verified at PM24 (milestone M4). Different numerical analyses for detailed characterization of enclosure walls, calibrated on the basis of the combined in-plane/out-of-plane tests of WP5. The objective is the calibration and the development of design rules for the combined enclosure behaviour; this work is clearly correlated with WP7. The final results will be checked at milestone M5 (PM30);
- **WP5** (starting on PM3), experimental characterization of environmental and mechanical properties of basic materials (products and masonry delivered in WP3), derivation of constitutive laws used for modelling in WP4. Development and execution of procedures for combined in-plane/out-of-plane testing of enclosure walls, tests on the solutions developed in WP3. These activities will be verified by means of milestone M3 at PM18. Another objective is to perform a global assessment of performance of enclosure masonry walls under real seismic loading by shaking table tests (input for WP4). This will be verified, together with the corresponding numerical objective in WP4, at the end of the work of WP5 (PM24), by milestone M4. Results of WP5 will serve as input for the assessment in WP6 and the guidelines in WP7.
- **WP6** (starting on PM15), prototype walls in laboratory and in real buildings will be built and tested. This subtask of WP6 has to be regarded as a demonstration activity. The final step for validation is also composed of RTD activities related to assessment of costs and feasibility, that will run in parallel with the development of technologies in WP3 (milestone M3 at PM18) and by application and calibration of non-destructive on-site tests to fully validate the real case applications and to create a quality assessment procedure for certification (milestone M6 at PM36). Information gathered by design and construction will flow into the guidelines of WP7.
- **WP7** (starting on PM21), development of software for design; preparation of construction and design guidelines, containing practical information and simple rules for the envisaged masonry enclosure walls; development of software for design. This work package is clearly associated with (and require input from) the numerical work in WP4, but it is also related to WP5, as the tests carried out there will provide information on the behaviour laws to be implemented into

the software. Guidelines will include all the necessary information regarding design, detailing and cost estimation (with inputs from WP6). Software and guidelines will represent the basic milestones of WP7, M5 and M6 to be respectively reached at PM30 at PM36.

In addition, the project plan includes WP1 devoted to management of the consortium as a whole; and the specific work package 2 for dissemination and exploitation of the project results.

- **WP2** (starting on PM6), ensure dissemination of projects results at various level and among various communities, and exploitation by participating institutions. It will also set up the basis for future exploitation of results by training of SME-AGs and SMEs personnel. The detailed description of WP2 can be found in Section 3.2.2. After the initial issue of a plan for dissemination and exploitation (PM9), the continuous monitoring and reporting of the activity will ensure the achievement of a "work-in-progress" milestone (M2) during the project.
- **WP1** Project Management, lasting for the whole duration of the project and beginning with PM1 is aimed at ensuring that the technical and scientific targets of the project will be duly met by coordinating and monitoring all the activities, verifying the successful achievement of the expected milestones, carrying out administrative and financial management. It will be assessed through the public access to the project website (milestone M1 at PM3) and by the regular plenary meetings and progress reports.

1.4.2 Appraisal of risk

Technical risk, yet inherent to any research and innovation activity, seems moderate. Overall, the risk factors are low and the highest risk factor is 9 (see table below), mainly because of the previous expertise of the research organizations and of the SME-AGs composing the consortium. In addition, 3 of the SMEs are product developers and 1 SME (the engineering consultancy office) is final end-user of the project results, so their participation in the project ensure a day-by-day control on the activity flow. Risk factors can be both internal and external to the project activities. The main instrument for moderating internal risks is the project structure itself. The project foresees progressive implementation of different types of activities, in various work packages and in various RTD centres. Delivery of results and reports is very regularly distributed. Cadenced milestones allow to constantly monitor the project progress, and take ready counteract measures as soon as deviations from the initial plan occur.

In particular, WP3 is related to a major amount of research and development activities on products and technologies, influencing to a significant extent the progress of other actions during the project. The accomplishment of this task greatly depends on the successful interaction and cooperation between the RTDs and SME-AGs and SMEs partners. The expected results and the duly completion of the required actions are aimed to be achieved through a smooth and skilful joint effort, based on the relationships already established among the principal participants.

The possible internal and external risk factors for the project are:

- (int) The technologies to be developed in WP3 must combine energy, indoor comfort and durability requirements with mechanical requirements. A combined optimization has to be achieved, since the solutions to optimize various parameters may clash with each other. This risk is mitigated by the simultaneous research work carried out not only on the mechanical, but also on the micro-structural and physical properties, whereas generally these steps are characterized by a "cascade" process. UNIPD and CTCV staff includes experts of acoustics and thermal;
- (int) The complexity of numerical simulations (WP4) may induce certain difficulties to predict the achievement of fully reliable results. At this regard, besides the renowned expertise of the RTDPs involved, it has to be underlined that different numerical strategies, tools and codes will be adopted, and the analyses will be carried out in parallel on the different enclosure systems under development. Thus, it will be possible to optimize the process, correcting adopted strategies with reference to the approaches that appear to be the most functional. It has also to be underlined that WP4 has a progressive implementation (from PM3 to PM30) that allows, with a constant monitoring, to activate prompt contingency plans;
- (int) Particular attention has been devoted to the organization of the experimental activity (WP5), with the aim to achieve a maximum flow of data from one laboratory to the others. However, in all experimental activities, unforeseen complications may occur, possibly requiring

additional time consumption for testing. Task 5.1 and 5.2 are mainly based on harmonized procedures. The main sources of uncertainties are related to the special tests to be carried out in Task 5.3 and 5.4. Considering that WP5 starts at PM3, but Task 5.3 and 5.4 starts at PM9 as they are carried out on the already characterized masonry, the test rationales definition will commence earlier, before the full system definition, so as to avoid any delay between the results in Task 5.1-5.2 and the beginning of the following tasks. As in the case of WP4, the progressive implementation of WP5 contributes to the mitigation of possible risks.

- (int) The implementation of constitutive laws for new elements at numerical code levels (WP7) is complex and may require more time than expected. This risk is mitigated by the fact that full design guidelines and charts will be produced during the project duration. Possible delays in the software development could therefore be absorbed by the timely delivery of the guidelines, allowing for full use of the new technologies. It should be noted, however, that besides the expertise of SDA, several RTD partners are experienced in the cooperation related to similar problems (UMINHO, UNIPV) and this risk is very unlikely to occur.
- (int) Certain risk is related to the possibility that any of the envisaged construction technologies, despite being generally feasible, has some performances, which are not as satisfying as desired. This risk is mitigated by several measures. Firstly, the various systems will be developed contemporarily in the various participating countries. Hence, for a solution that may require further adjustments, it will be verified if the obtained performance can be suitable for the use in environmental and/or seismic conditions different from those initially conceived. The obtained experimental and numerical results will still be valid, as they can be extended by parametric analyses, and their contribution will still be significant in the response to the need of developing effective design methods.
- (ext) At this stage, the building process for innovative enclosure walls can be estimated as being slightly more costly than that used for common enclosure walls. This is a marketplace factor and this fact has been addressed also in Section 3.1. Staying on the safety side, a maximum increase of some (less than 10) percentage points can be expected, similar to the comparison between reinforced and unreinforced masonry. This risk can be mitigated achieving the objectives that the new enclosures are expressly marketed for having higher durability, energy saving, mechanical and indoor environment properties, and in particular, are aimed to ensure earthquake resistance, resulting to be more appealing to the end user. When the final client is not involved in the construction process, the contractor has to satisfy in any case demanding regulatory requirements, and will certainly accept the slight additional cost, given the considerable advantages of the new systems and the corresponding guidelines for design, detailing and construction.

Risk	Likelihood (1-5)	Effect (1-3)	Risk Factor (1-15)*	Mitigation
1. Combined (mechanical and physical) optimization.	3	3	9	Mixed staff; and mixed RTD staff expertise
2. Numerical simulations.	2	3	6	Expertise of the RTD-Ps; use of various approaches
3. Experimental tests.	1	3	3	Expertise; flow of data; early defining rationales;
4. Software	1	2	2	Concurrent issue of guidelines; expertise RTD
5. Feasibility of the construction technology	2	1	2	Different systems, different application, useful for developing design rules
6. Cost of the systems	4	1	4	Customer acceptance for high added value
* High risk factor: 10-15, Medium: 5-9, Low: 1-4				

1.4.3 Workplan and timetable (Gantt Chart)

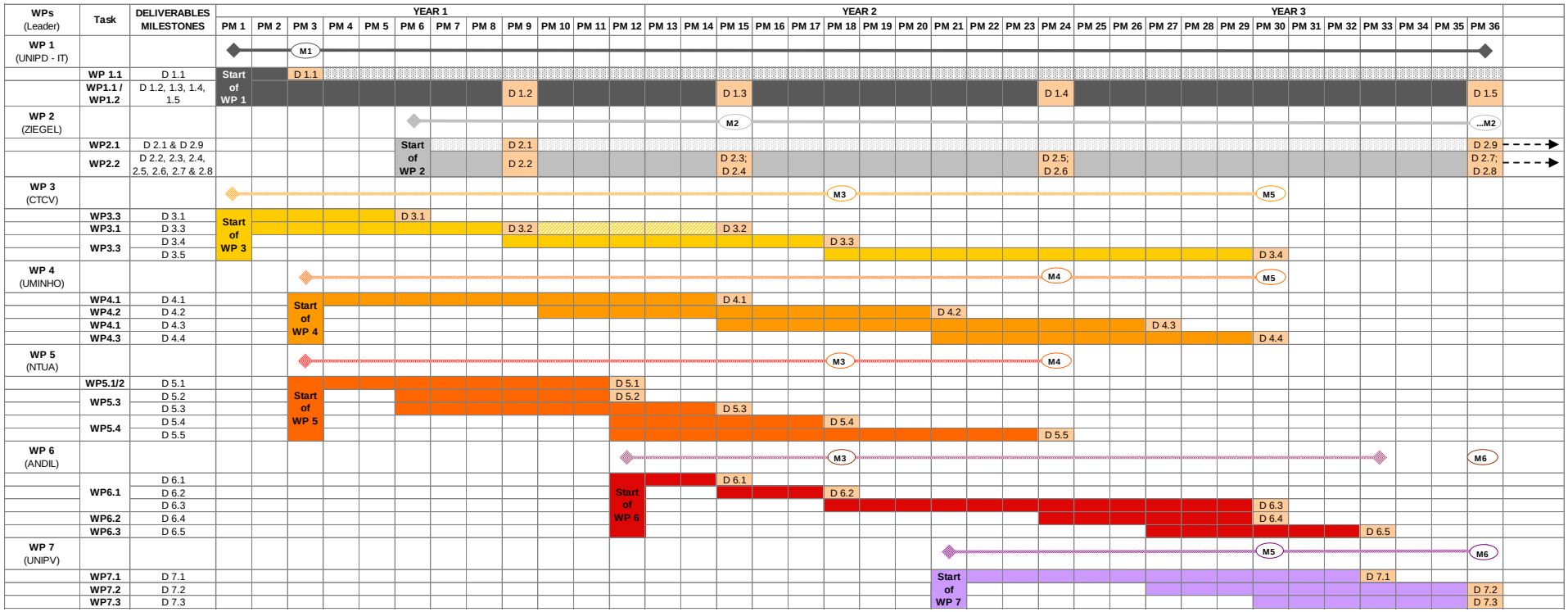


Table 1.4 a: Work package list

WP No	Work package title	Type of activity	Lead participant No	Lead participant short name	Persons month	Start month	End month
1	Project Management	MGT	01	UNIPD	27	1	36
2	Dissemination, Training and Exploitation	OTH	04	ZIEGEL	46	6	46
3	Product and construction technology development	RTD	11	CTCV	63	1	30
4	Modelling of seismic response	RTD	07	UMINHO	79	3	30
5	Multi-scale experimental testing	RTD	09	NTUA	97	3	24
6	Demonstration of constructability	DEM	03	ANDIL	45	12	33
7	Guidelines for optimized design	RTD	08	UNIPV	58	21	36
		TOTAL			415		

Table 1.4 b: Deliverables List

Del. No[1]	Deliverable Title	WP No	Nature[2]	Dissemination level[3]	Delivery date[4]
D1.1	Project Website	1	O	PU	PM 3
D1.2	Intermediate progress report	1	R	CO	PM 9
D1.3	First-term report	1	R	CO	PM 15
D1.4	Intermediate progress report	1	R	CO	PM 24
D1.5	Final report	1	R	CO	PM 36
D2.1	Project presentation – leaflet, poster, fact sheet	2	O	PU	PM 9
D2.2	Platform for dissemination and exploitation	2	O	CO	PM 9
D2.3	Dissemination plan	2	R	PP	PM 15
D2.4	Exploitation plan	2	R	PP	PM 15
D2.5	Dissemination plan - update	2	R	PP	PM 24
D2.6	Exploitation plan - update	2	R	PP	PM 24
D2.7	Dissemination final report	2	R	PP	PM 36
D2.8	Exploitation final report	2	R	PP	PM 36
D2.9	Project presentation – video	2	O	PU	PM 36
D3.1	Report on types of structural frames, related enclosure wall systems, and requirements for the construction systems (masonry units, reinforcement, mortar, etc.)	3	R	PU	PM 6
D3.2	Prototype masonry units, reinforcement and fastenings	3	P	CO	PM 9/15
D3.3	Report about the construction process and the feasibility of the proposed technologies	3	R	PP	PM 18
D3.4	Final report about product and technology development	3	R	CO	PM 30
D4.1	Report about optimal modelling strategies for bare and infilled frames	4	R	CO	PM 15
D4.2	Report about the accuracy and reliability of the numerical simulations, with guidelines for optimal modelling strategies	4	R	CO	PM 21
D4.3	Influence of the global response of the structure on the local response of the non-structural element	4	R	CO	PM 27
D4.4	Design formulations and design charts for typical construction and connection systems, spans, boundary conditions and materials, level of in-plane damage	4	R	PU	PM 30
D5.1	Technical report with the experimental results of materials and small masonry specimens	5	R	CO	PM 12
D5.2	Demonstration of testing of masonry enclosures	5	D	PU	PM 12
D5.3	Technical report with the experimental results on masonry enclosures	5	R	CO	PM 15
D5.4	Laboratory demonstration of shaking table test	5	D	PU	PM 18
D5.5	Technical report with the shaking table test results	5	R	CO	PM 24
D6.1	Practical demonstration of wall construction	6	D	PU	PM 15
D6.2	Individuation of the proper building for applying new technology	6	O	PP	PM 18
D6.3	Prototype walls design, detailing and construction	6	D	PU	PM 30
D6.4	Technical and economic feasibility assessment	6	O	CO	PM 30
D6.5	Report on in situ testing for validating the construction system	6	R	CO	PM 33
D7.1	Software and manual	7	O	CO	PM 33
D7.2	Design guidelines for end-users	7	R	PU	PM 36
D7.3	Guidelines for site organization and execution	7	R	PU	PM 36

Table 1.4 c: Work package description

Work package number:	**1**						**Start date or starting event:**									**PM1**
Work package title:	**Project Management**															
Activity type:	**MGT**															
Participant number:	**1**	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Person-months/part.:	**12**	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Objectives

- To perform the global scientific and administrative management of the project.
- To co-ordinate single work-packages.
- To co-ordinate the flow of information among partners. Relevant input/output among WPs.
- To control the time schedule, manage costs, effort and modifications, communicate with the EC. To prepare intermediate progress report and final report.
- To create a dedicated website with public and private access for communication and exchange of information among partners.

Description of work

Task1.1: Overall management of the project. The work in this task includes general partnership policies, project consortium agreement, arbitration policies, IPR, interface with the management boards of the partners, information exchange plan and dissemination policy, discussion of the obtained results and encountered problems, control of the planning and of the deliverables, overall technical co-ordination and management of the project, preparation of the plenary meetings and supervision to the specialised technical workshops, co-ordination of technical exchanges between partners, and ensuring a good information transfer on the project evolution to all its contributors. The communication and data exchange between the partners within the project will be performed by implementation of a project web site (D1.1) for internal and external use, together with an e-mail distribution list; regular project meetings. Special technical meetings for different WPs with the participation of selected partners involved in the specific tasks will be fostered and supervised.

Task1.2: Internal coordination of WPs. The co-ordinating activity is delegated to the partner with the maximum expertise and workload in each WP as follows. All the WP leaders will also have the responsibility of collecting inputs from partners and reports preparation.

Partner 04 (ZIEGEL) co-ordinates WP2 collects output from all WPs and partners and ensure its transfer to end users, SMEs, etc., by means of workshops, publications, training activities.

Partner 11 (CTCV) co-ordinates WP3 and ensure transfer of output to all WPs, in particular to and from WP4 and WP5, and to WP6 and WP7.

Partner 07 (UMINHO) co-ordinates WP4 and ensures transfer of output from WP3 and to WP5 and WP7.

Partner 09 (NTUA) co-ordinates WP5, ensuring transfer of output from WP3, and to and from WP4 and WP7. Collect inputs from other partners and report writing.

Partner 03 (ANDIL) co-ordinates WP6, ensures transfer of output from WP6 to WP7, and collects input from WP3 and WP5.

Partner 08 (UNIPV) co-ordinates WP7, collects input from all WPs and prepare output for further development of the technology after the project end.

Deliverables

- Project Website (**D1.1**), delivered at PM3 and regularly updated
- Intermediate progress report (**D1.2**), delivered at PM9
- First-term report (**D1.3**), delivered at PM15
- Intermediate progress report (**D1.4**), delivered at PM24
- Final report (**D1.5**), after PM36

Work package number:	**2**					**Start date or starting event:**										**PM6**
Work package title:	**Dissemination, Training and exploitation**															
Activity type:	**OTH**															
Participant number:	1	2	3	**4**	5	6	7	8	9	10	11	12	13	14	15	16
Person-months/part.:	3	4	5	**4**	1,5	2	2	2	3	3	3,5	2	4	3	3	1

Objectives

- Promotion of the results to industry (mainly SMEs and SMEs Associations) and decision-makers through the organisation of workshops/training courses in each country.
- Promotion of the results to relevant end-users and decision-makers (contractors, developers, architects and engineers) in EU and worldwide through: (a) guidelines on how to design enclosure walls, (b) compared economic studies and performance with respect to other techniques; (c) description and examples of the executed case studies; (d) seminars and workshops.
- Promotion of the results to students, professionals and scientist by means of lectures, training courses, publications and seminars.
- Promotion of the results to the general public through participation in annual construction fairs such as CONCRETA/TEKTONICA (Portugal), BAU (Southern Germany) and DEUBAU (Western Germany), INFACOMA (Greece), SAIE and MADE (Italy), etc.
- Promotion of the results in appropriate standardisation and regulatory communities (CEN, CIB, RILEM, and national committees).
- Commercial exploitation opportunities and SMEs marketing.

Description of work

All partners will participate in this workpackage. Specific activities are as follow:

Task2.1: Scientific and technical dissemination and training. All Associations will promote the results of the project via workshops for SMEs, and training courses and continuing education oriented to architecture and engineering expert. RTD partners will promote the results of the project via educational activities carried out for undergraduate and postgraduate students, training courses and continuing education oriented to engineers and architects, publications and seminars. In particular, a form of technical and commercial dissemination is foreseen, by the participation to some of the most important community-wide fair and workshops for industry and practitioners; visits to case studies sites with the support from masonry industry are planned, in particular in Italy and Portugal. Conference contributions and publications in specialized journals are expected, to inform other end-users, service providers, industry and regulatory and standardization forums. Finally, the dedicated website for project management will include a public area so that non-confidential results of the project can be accessed worldwide. Press releases, posters, leaflets and fact sheet (D2.1) and a short video film (D2.9) will be used to inform the general public and spread awareness.

Task2.2: Exploitation of methodology and technology. Each partner works out its own exploitation plan. However each individual exploitation plans will be supervised from three points of view:
a) technological: the results will improve the performance, expertise and competitiveness of the partners both commercially and research-wise;
b) contractual: specific commercial agreements with third parties will be established;
c) marketing: the individual plan will be checked for coherence with current market trends by the SMEs. Case studies and research results will be made available for the purpose of marketing.
The dissemination and exploitation draft plans will be prepared during the first nine months. The dissemination and training actions will commence when first results are available (after PM6), while the exploitation will start from twelve months before the project end and will fully develop after the project closure.

Deliverables

- Project presentation - leaflets, posters, fact sheets (**D2.1**), delivered at PM9.

- Platform for dissemination and exploitation, including structure, target groups and other (**D2.2**), delivered at PM9.
- Dissemination plan (**D2.3**) and exploitation plan (**D2.4**) describing dissemination actions and the necessary steps for exploitation, delivered at PM15. To be updated at PM24, incorporating changes in planned actions and reports of completed actions (**D2.5**; **D2.6**).
- Dissemination final report (**D2.7**), Exploitation Final report (**D2.8**) and Project presentation (video, **D2.9**), delivered at PM36.

Work package number:	**3**					**Start date or starting event:**										**PM1**
Work package title:	**Product & Construction Technology Development**															
Activity type:	**RTD**															
Participant number:	1	2	3	4	5	6	7	8	9	10	**11**	12	13	14	15	16
Person-months/part.:	5	1	2	1,5	1,5	1	8	6	9	2	**4**	9	3	-	7	3

Objectives

- To define typical structural frames types and enclosure/veneer wall systems
- To define the main requirements and design parameters for the enclosure/veneer walls and their components (masonry units, reinforcement, fastenings, mortar, etc), not only under the mechanical, but also under the habitability point of view
- To develop new products (masonry units, reinforcement and connections) and adequate and feasible construction technology for new masonry wall enclosures in compliance with the performance requirements
- To produce the number of components (masonry units, reinforcement and fastenings) required for testing and case studies

Description of work

This workpackage represents the basis of the project and therefore almost all partners are expected to participate (besides the engineering firm and software house), to ensure effective transfer of industrial, technological and research expertise into a true “constructability” approach. It is essential that product development starts from definition of multi-level requirements for the single products (including not only mechanical, but also insulation, environmental, and durability aspects), and following, selection and improvement of exiting elements to the desired performance level. The first prototypes will not be final and will be continuously updated with the other WPs, mainly WP5, until the second year of the project, with the planned construction of real walls (on construction site, WP6). This workpackage will develop in strict correlation with WP5, in which the structural testing of materials, small masonry specimens and structural sub-assemblies, for the determination of properties and constitutive laws, will be carried out. The very first step of WP3 will be the analysis of the current practice to clearly identify performance and requirements.

Task3.1: Design and production of special clay units. Most of the work consists in defining the main design parameters of masonry units and developing them (D3.2). The design parameters can be grouped into three categories: geometrical quantities, structural properties and non-structural ones. The main geometrical parameters are: global size (length, height, thickness), shape profile (percentage and shape of holes) and surface grooving (channels might need to be carved to accommodate ties and possible reinforcements). Lateral sides might be non-vertical (“fly wing”) to minimize the spaces between adjacent units (joints) and to allow the insertion of reinforcement (task3.2). Among structural properties, a key parameter is the compressive strength of masonry units; this value mostly depends on mixture (clay) composition, extrusion pressure and oven baking (firing) temperature for clay units. Another relevant parameter is the thermal conductivity, which might require lightweight materials. This will reduce the weight of the masonry units enhancing also the ergonomics in the construction. Sustainable additive materials can be also used enhancing the sustainability of the enclosure masonry walls (for example cork dust, saw dust wood, paper mill sludge). Other non-structural parameters deal with water permeability, density, acoustic insulation properties, durability, aesthetics, and surface texture, etc. A set of global criteria to select the values of these parameters for any situation will be established in D3.1. Since some of these aspects depend on the properties of the clay, as well as local practice and production equipment, research has to be done locally, with the help of the Associations. The properties will be then tested in task5.1.

Task3.2: Design and production of special reinforcement, fastenings, and mortar. Again, the main design parameters (mechanical, bond, protection to corrosion, features for advanced – smart - wall assemblage) of reinforcement and fastenings will be defined, bringing from standard elements to special newly developed ones. The reinforcement can be either truss reinforcement or specially designed profiles to fit the special purpose units (task3.1) and connections. Fastenings to fix the reinforcement or the whole wall to the bottom and top slabs are also to be developed and

designed. Solutions for deformations joints able to accommodate in-plane movement, while preventing out of plane collapse will be provided (D3.2). Reinforcement and, to a certain extent, fastenings, will be inserted in mortar. Mortar has to ensure good bond and protection for reinforcement and also adequate workability and plasticity to be used for both bed-joints and to fill vertical cavities. These properties will be developed starting from commercial products (D3.2), and tested in task5.1.

Task3.3: Development of construction technologies. There are two highly coupled issues: to design the main characteristics of the construction materials (tasks 3.1 and 3.2) and to define the principal steps of the construction process. The aim is to design economical, secure, fast and easy-to-use (not requiring neither highly skilled personnel nor complex devices) technologies for construction of masonry enclosures that are safe with respect to earthquake actions and comply with appropriate serviceability requirements. The first step of this task will include identification of infill/veneer walls types, of their components, possible detailing and connections, typical geometry and boundary conditions, etc. The data will be analysed to find typical or common features. This work should be carried out by all RTD performers and Associations, as construction tradition are quite different in the distinct European countries. The major data obtained in this task will help defining requirements for the construction systems (D3.1), will support product development in tasks 3.1 and 3.2, will help defining the global model in task4.1 and the experimental testing campaign in WP5.

Various developments of technologies are envisaged at this stage. For single leaf walls, the possibilities are: vertical and/or bed joint (and/or plaster) reinforcement; complementary anchoring systems to the frame elements; disconnection from the frame and use of advanced anchoring systems to allow the in-plane relative displacements while counteracting the out-of-plane movements. For cavity walls and veneers, different possibilities are envisaged, using the internal leaf as an earthquake resistant wall and properly tying the external leaf with special fasteners. The more advanced solutions will be directly attached, with special structural fasteners, to the frame, allowing for in-plane relative displacements and taking care of the connections for out-of-plane restraint. The solutions will be reported in D3.3 and will also take into account of thermal insulation, mainly given by the usage of novel designed units (task3.1) or by special composite systems. The new solutions should take into account the placing of installations (electricity, hydraulic, communications, etc) by proposing special units, avoiding grooving and wasting of materials and time in construction. This WP will also provide valuable information about technical and economic feasibility of the proposed technologies (D3.4). The construction of wall specimens is foreseen, in the framework of WP5-WP6, both in laboratories and in real buildings. The cost will be compared to that of competing solutions and to that of traditional solutions taking into account, for the latter, the extra cost of repair in case of non-advanced, prone to damage, solutions. The information arising from this WP will be significant for the acceptance and success of the proposed technologies in the market, and provide an estimate of the possibility of reducing time to market, which can be of great advantage for the SMEs involved in the project as can lead to rapid recover of the investment and improve business benefits.

Deliverables

- Report on types of structural frames, related enclosure wall systems, and requirements for the construction systems (units, reinforcement, mortar, etc.) (**D3.1**), delivered at PM6
- Prototype masonry units, reinforcement and fastenings (**D3.2**), delivered at PM9 and updated at PM15 (for prototype construction)
- Report about the construction process and the feasibility of the proposed technologies (**D3.3**), delivered at PM18
- Final report about product and technology development (**D3.4**), delivered at PM30

Work package number:	**4**						**Start date or starting event:**									**PM3**
Work package title:	**Modelling of seismic response**															
Activity type:	**RTD**															
Participant number:	1	2	3	4	5	6	**7**	8	9	10	11	12	13	14	15	16
Person-months/part.:	17	-	-	-	-	-	**17**	12	6	12	-	13	-	1	-	1

Objectives

- To numerically simulate the behaviour of bare frames and frames with enclosure/veneer walls for defining their mutual influence in the seismic response;
- To perform sensitivity studies aimed at defining the seismic input on the non-structural elements;
- To perform parametric numerical analysis to seek for the influence of in-plane damage on the out-of-plane response of masonry walls; the structural limitations of the intended technologies; and the detailed interaction of structural and non-structural elements;
- To provide design procedures and design charts for a wide range of enclosure walls and veneers, and assist the drafting of design guidelines.

Description of work

This work package is essential for the definition of a) the seismic input to the walls, which is affected by the filtering response of the building and b) the design/verification criteria which despite being necessarily simple must be calibrated on mechanical models of the response of the walls to the seismic input. Different modelling approaches and types of analysis will be considered and the work will be organized according to the following tasks.

Partner UNIPD; UMINHO; UNIPV; NTUA; UKASSEL; METU

Task4.1: Modelling and analysis of bare and infilled frames. Under this task, the dynamic response of framed constructions, and the influence of the global response on the local response of the enclosure/veneer, will be studied. Hence, considering the numerous work examining various aspects of the seismic behaviour of infilled structures, the attention will focus more on the effect of earthquakes on the infills themselves, and will deal more with deformations rather than with strengths, trying also to define performance levels of the infill walls. The aim is defining the seismic input for the enclosure/veneer wall, during the elastic regime of the load-bearing structure, for various structural configurations (simple frames but also frames including rc shear walls), storey levels, etc, and deriving simple rules needed for the everyday design. The study will be extended to the non-linear range to define how the infill response changes according to the dissipative behaviour of the overall structural system and define the most critical condition for the walls, using various types of numerical analyses (D4.1). The behaviour of these structures under repeated shaking will allow identifying the frame displacement/drifts, that will serve as an input for the analyses of task4.2, to assess limit thresholds associated with various damage levels of the infill walls. In addition, the experimental behaviour under dynamic actions evaluated in task 5.4 will be used for calibrating the proposed models and carry out further parametric analyses on the basis of the updated models. The results of these analyses will be assessed against formulations for the definition of seismic input of non-structural elements, for their calibration or for creation of new ones (D4.3).

Partner UNIPD; UMINHO; UNIPV; NTUA; UKASSEL; METU

Task4.2: Detailed analysis of masonry walls and their connections. When, in tasks 5.1-5.2-5.3, the main constitutive laws relevant for modelling are obtained, they will flow into task4.2 and used to numerically simulate the experimental behaviour. The intrinsic difficulties in the formulation of composite inelastic behaviour and the foreseen presence of an unusual type of steel reinforcement/fasteners complicates the simulation and poses higher demands on the accuracy of the representation of the material behaviour. The partners have complex computer models available for anisotropic continua and interfaces, but also simple meso-scale models able to carry out time integration response reasonably fast. The complex models include individual yield surfaces, for tension, for shear and for compression, according to different failure mechanisms. The contribution of the steel reinforcements will be added directly to the global stiffness matrix and, at the constitutive level of masonry, by including tension-stiffening effects. The time dependence

effect can also be represented by the models. The objective of this task will be to calibrate the models and carry out parametric analysis involving different height to length ratios, different material properties and quantities of reinforcement, different types of wall-to-frame-structure connections, and also different level of wall in-plane damage. The numerical analysis will also be useful for improving the understanding on the interaction between masonry enclosures and enclosing reinforced concrete elements (D4.2).

Partner UNIPD; UMINHO; UNIPV; NTUA; UKASSEL; METU; SDA; H.I.STRUCT

Task4.3 Development of optimized design rules. Based on the calibrated models developed in task4.2, and on the results of WP5, it is possible to evaluate the effectiveness of various approaches for the safety verification of enclosure walls and veneers. It is very likely that the design rules will change according to the various conditions taken into account (i.e., type of connections, boundary conditions, thickness of the enclosure walls), hence procedures for the different type of tested (experimentally and numerically) non-structural elements will be developed, in a common framework. In addition, a new approach for the out-of-plane safety assessment, that takes into account the in-plane damage, will be developed and implemented. On the basis of the calibrated/new design rules and of the complex parametric numerical simulations carried out in task 4.2, it will be possible to produce and provide design charts, which will provide immediate and simplified design for typical construction systems and conditions (D4.4).

Deliverables

- Report about optimal modelling strategies for bare and infilled frames (**D4.1**), at PM15
- Report about the accuracy and reliability of the numerical simulations, with guidelines for optimal modelling strategies (**D4.2**), at PM21
- Influence of the global response of the structure on the local response of the non-structural element (**D4.3**), at PM 27
- Design formulations and design charts for typical construction and connection systems, spans, boundary conditions and materials, level of in-plane damage (**D4.4**), at PM30

Work package number:	**5**						**Start date or starting event:**									**PM3**
Work package title:	**Multi-scale experimental testing**															
Activity type:	**RTD**															
Participant number:	1	2	3	4	5	6	7	8	**9**	10	11	12	13	14	15	16
Person-months/part.:	13	-	-	1	-	1	12	18	**24**	13	-	14	-	-	1	-

Objectives

- To carry out the experimental characterization of the properties of the new masonry components (bricks, blocks, mortars, fasteners and reinforcement) and walls;
- To carry out combined in-plane and out-of-plane tests, for evaluating the system performance and the influence of the wall in-plane damage on the out-of-plane response;
- To carry out shaking table tests of model buildings to characterise the seismic behaviour of various type of non-structural elements in relation to the behaviour of the frame, and obtain information on the systems performance;
- To define the main constitutive laws relevant for the numerical simulation of walls and to obtain experimental results under cyclic and dynamic loading on structural sub-assemblies and entire structures for model calibration.
- To assist the drafting of practical guidelines.

Description of work

Partner UNIPD; UMINHO; NTUA; UKASSEL; METU; XALKIS

Task5.1: Characterization of materials. Testing program for the characterization of materials. The following routine tests will be carried out: (a) Uniaxial compressive testing of masonry units, mortar, grout; (b) Uniaxial tensile testing of steel reinforcement and connections; (c) Uniaxial tensile and shear testing of the mortar-unit interface; (d) Uniaxial tensile tests of masonry units; (e) Determination of shrinkage / expansion coefficients of masonry. Tests (a) to (d) are standardized. Tests for the assessment of long-term behaviour of masonry infill are not standardized. This aspect of the behaviour of masonry being significant for the solutions to be developed (e.g. shrinkage affects the state of connections between infill and frame), specific test procedure and program will be designed. Although the main goal of this program is the development of solutions adequate for structures subjected to earthquakes, the durability of the solutions is a prerequisite for their efficiency and sustainability. Thus, various types of reinforcement and connections will be tested under alternative environmental conditions. The results of the accelerated durability tests are of major importance for the formulation of the final guidelines.

Partner UNIPD; ZIEGEL; TUKDER; UMINHO; NTUA; UKASSEL; METU

Task5.2: Testing of masonry walls. Testing program for the assessment of constitutive laws for masonry and for connections. The tests to be carried out within this WP include tests of masonry specimens under (a) vertical compression, (b) various combinations of compression and tension along the two main diagonals of masonry specimens, (c) only the necessary local tests on reinforcement and connections and their interaction with the walls and the frames (pull-out, pull-off, shear tests, etc), according to their specific type, will be carried out. It has to be noted that the tests of this WP5.2 will be performed under monotonic and cyclic imposed displacements, in in-plane or out-of-plane direction separately, to obtain information about the post-peak behaviour of the mechanisms and simulate the actions developed during a seismic event. The results obtained in tasks 5.1 and 5.2 will flow into the deliverable D5.1 and will be used for the numerical simulation in task 4.2.

Partner UNIPD; UMINHO; UNIPV; NTUA; UKASSEL; METU

Task5.3: Testing of sub-structures. This task includes the tests that are necessary for the assessment of the efficiency of the solutions to be developed in WP3 and, possibly, also for their correction. Hence, this task includes testing of rc infilled frames under combined in-plane and out-of-plane loads. Test will be carried out on structural sub-assemblages including the frame beams and columns (one-bay) and the enclosures, and will be carried out under quasi-static cyclic and/or dynamic loading (D5.2). This procedure allows evaluating the out-of-plane performance of the walls under different levels of in-plane damage. The selection of parameters to be investigated will

be made on the basis of the results of the preceding tasks and also on results obtained by modelling (task 4.2). The aim of this WP is to test (a) alternative infill types, (b) alternative reinforcing schemes, (c) alternative types of connection between frame and infill (e.g. perfect adherence, no connection, extension and anchoring of the reinforcement of the infill into the rc elements, use of special fasteners), (d) alternative geometry (presence of openings, etc) and aspect ratios for the infill walls, (e) level of imposed in-plane deformations and damage. The study of the influence of other aspects will be eventually taken into account during the phase of test program design, which will entail also detailed study of the test procedure, as this test is not harmonized and has been carried out only seldom (twice) in the past. The evaluated performances will also provide data for cost-benefit analyses to be carried out in task6.3. The distinct solutions proposed in WP3 for enclosure walls and veneers will be tested by the involved RTD performers. These results will flow into D5.3, and will be used for the definition of adequate solutions, particularly in WP6 and 7, and for the validation of the numerical simulation in task 4.2.

Partner UMINHO; UNIPV; NTUA

Task5.4: Shaking table testing of model buildings. The assessment of the overall seismic response on model buildings requires the preliminary definition of the factors to be investigated, that will be clarified in task5.3. At least two representative approaches will be chosen to be tested for seismic performance, on the two shaking tables available at UNIPV and NTUA. Each model structure will be multi-storey and will present the same features in terms of structural system, but two different types of enclosures. The tests will be carried out by imposing two (three) simultaneous uncorrelated signals in perpendicular horizontal directions (and vertical) in order to test simultaneously the in-plane as well as the out-of-plane behaviour of the masonry infill walls (D5.4). The dynamic tests are fundamental for the global assessment of the performance of enclosure masonry walls system under real seismic loading. With this respect, besides the simultaneous in-plane and out-of-plane behaviour, it is worth noting that most of the similar tests that can be found in the literature are basically aimed at identifying the behaviour of bare frames under different conditions, or, in the case of presence of infill walls, the effect of the walls on the global response of the frame. In this case, conversely, the main aim is to study the filtering effect of the structure, in the elastic regime and after undergoing a certain degree of damage, and its influence on the local response of the enclosure wall. This new perspective and test rationale will lead to new set-ups and specimen instrumentations compared to previous experiences and, of course, new results (D5.5). The accomplishment of this task will be achieved by the strong collaboration between RTD performers and SMEs. It will be then of basic importance to use the results of task 4.1 for designing the tests, and using back the results in these tests to calibrate the models of task 4.1, and come to the sensitivity analyses needed for the definition of the seismic input in that task.

Deliverables

- Technical report with the experimental results of materials and small masonry specimens (**D5.1**), at PM12
- Demonstration of testing of masonry enclosures (**D5.2**), at PM12
- Technical report with the experimental results on masonry enclosures (**D5.3**), at PM15
- Laboratory demonstration of shaking table test (**D5.4**), at PM18
- Technical report with the shaking table test results (**D5.5**), at PM24

Work package number:	**6**					**Start date or starting event:**									**PM12**
Work package title:	**Demonstration of constructability**														
Activity type:	**DEM**														
Participant number:	1	2	**3**	4	5	6	7	8	9	10	11	12	13	14	15	16
Person-months/part.:	7	2	**7**	0,5	1	1	6	1	4	2	4,5	1	2	1	3	2

Objectives

- To address the construction requirement and the real case application of the technology
- To design and build prototype walls
- To assess the execution of the prototype walls with on-site testing and develop procedures for quality control
- To assist the drafting of practical guidelines.

Description of work

This Work Package is fundamental for the consolidation of the project output as it encompasses the final assessment and demonstration of the proposed technologies. It will provide also the practical material for producing guidelines for the construction in real conditions and more accurate information on the cost estimation of the proposed solutions, which is essential both for end users and SMEs. The leader of this task is a SME-AG given that it is of priority importance that SMEs will fully incorporate the main results of the project. The goal will be reached with the following sub-packages, and the main partners:

Partner UNIPD; ANDIL; UMINHO; CTCV; RUREDIL; SDA

Task6.1: Construction of prototypes. Prototype enclosure walls will be constructed in each country, under the technical and scientific assistance of RTD-performers. The SMEs will provide masonry units and fasteners. The actual erection of real walls will allow assessing the specific problems connected with this kind of structure, which are of a higher degree of complexity than those examined in WP3. This process will follow two steps. The envisaged enclosure walls solutions, in fact, have to be erected both for testing purposes and in a real site. The laboratory construction will bring to a rough estimate of costs and construction times, to be used for the assessment in task 6.2. The construction will be documented and presented in form of promotional video/slideshow (D6.1). In the meanwhile, proper case studies, where adopting the newly defined construction technology, will be found in the various countries addressed by the research (D6.2). As different solutions will arise from the project, the construction of more than one prototype, using different solutions, is fostered. The construction costs will be not charged to the project, as it will be applied on selected construction sites under way. Using the calibrated models, the design charts and simplified calculations under development in WP4, and the experimental results obtained in WP5, all prototype walls will be designed and, then, erected (D6.3). An amount of about 250 m^2 of prototype walls for each selected system will be constructed. The actual erection of real walls will allow to assess the specific problems connected with this kind of structure, which are of a higher degree of complexity than those examined before, since they involve a real site, with a real client having real needs. Output obtained from real construction will be used to update the production times in order to perform a more effective cost estimation of each solution and further comparison with competing solutions, in task 6.2, and will be also used for the preparation of the final reports for WP3, for eventual further optimization of the product, besides, obviously, for the guidelines of task7.2 preparation.

Partner TBE; ANDIL; ZIEGEL; APICER; TUKDER; CTCV; METU; RUREDIL; XALKIS; H.I. STRUCT

Task6.2: Assessment of technical and economic feasibility. The objective is to incorporate the constructor's viewpoint and the cost/effectiveness evaluation of the enclosure/veneer walls system in the definition of the technology. The task is of paramount importance in defining the future feasibility of these solutions, since through the definition of the site organisation specific to this kind of structure it will be possible to properly assess the actual cost of non-prototype structures and therefore their competitiveness with other kinds of structure. The assessment will account for technical, security and economic aspects (D6.4). Through the experience of designing and building prototype structures subject to actual outdoor conditions of use, and their concurrent testing

(task6.3), it will be possible to draw practical guidelines for the future building of such structures, as regards structural and technological requirements, integration with services, limitations to and from specific functions, trimming, waterproofing, site organisation, etc. This task will therefore proceed in parallel and in close association with task7.2. The requirements will be refined along the way, and will result, at project completion, in a new set of requirements having a more universal validity and in a precise cost estimate, that will flow together with the construction process definition into the final report D3.4.

Partner UNIPD; UMINHO; UNIPV; NTUA; UKASSEL
Task6.3: In-situ testing of the prototypes. The assessment of real case execution is of critical importance to validate the workmanship and adequacy of the proposed solution. Simple steel detector and ground penetrating radar (GPR), when needed, are intended also to be used to evaluate the presence of possible defects/the system detailing, i.e. the quality of construction and workmanship. Dynamic identification will be used to assess the adequacy of the boundary conditions and structural performance of the walls. Other possible techniques, such as sonic and ultrasonic, etc., will be evaluated. These tests will be also applied to develop NDT on-site testing procedures for quality control of real constructions. All these results will flow into D6.5.

Deliverables

- Practical demonstration of wall construction (**D6.1**), at PM15;
- Individuation of the proper building for applying new technology (**D6.2**), at PM18;
- Prototype walls design, detailing and construction (**D6.3**), at PM30;
- Technical and economic feasibility assessment (**D6.4**), at PM30;
- Report on in situ testing for validating the construction system (**D6.5**), at PM33.

Work package number:	**7**						**Start date or starting event:**									**PM21**
Work package title:	**Guidelines for optimized design**															
Activity type:	**RTD**															
Participant number:	1	2	3	4	5	6	7	**8**	9	10	11	12	13	14	15	16
Person-months/part.:	8	2	1	1	-	-	8	**10**	8	5	-	4	1	5	2	3

Objectives

- To produce software code for the design of masonry walls made with the envisaged technology.
- To produce guidelines for end users and SMEs regarding the design of masonry enclosure/veneer walls, and for current code updating
- To produce guidelines for SMEs and constructors regarding the construction of masonry enclosure/veneer walls.

Description of work

To ensure commercial expansion of the intended technology it is crucial to provide the potential users (designer architects and engineers and construction companies) with understandable, easy to use, unambiguous yet accurate and sound design guidelines. It is strongly convenient that these rules be implemented in an interactive and user-friendly software package, so that the supplier of the constructive technology can give altogether guidelines for its use and instruments for its calculation. In addition to the implementation of the derived design criteria in user-friendly software, also the behavioural laws defined by the extensive testing of WP5 will be included. Moreover the incorporation of these recommendations into norms and codes (e.g. EC6 and EC8) can make any mistrust vanish and it will, thus, strongly foster the use of the intended structural solutions. Experience obtained after WP4 and WP5 will generate a thorough understanding of the behaviour of reinforced masonry walls under service and ultimate conditions, subjected to diverse possible actions. Furthermore, good knowledge of their actual durability and service life expectancy will be obtained. Hence, it will be possible to derive user-oriented design guidelines for the intended walls. These rules and tools should provide the average user with easy criteria to safely design masonry walls for most of the expected situations. Finally, this WP is of basic importance for the consolidation of the project output as it will provide also practical guidelines for the construction in real conditions, which is essential for both end users and SMEs. The leader of this task is an SME given that it is of priority importance that SMEs fully incorporate the main results of the project.
The goal will be reached with the following sub-packages:

Partner UMINHO; NTUA; SDA; H.I. STRUCT

Task7.1: Software implementation. The information derived from the extensive numerical modelling of WP4 and from the experimental testing of WP5 will be written in a code-like form, including new elements or new behavioural laws in already existing codes, either open and non-open source (D7.1). To implement new laws starting from scratch, would indeed make it unfeasible to obtain a result, in terms of methods of analysis, in such a short time-lapse. The partner which is more directly involved is, of course, the SME working in structural codes development. Nevertheless, implementing the project results also in open-source codes, make it possible to widely disseminate the developed analysis and design methods, i.e., the use of the envisaged construction system. A manual will be included to the developed software package, including trial tests by the engineering firm.

Partner UNIPD; UMINHO; UNIPV; NTUA; UKASSEL; METU; SDA; H.I. STRUCT

Task7.2: Design guidelines. These guidelines (D7.2), to be used by structural designers, will contain information on how to calculate the input for the enclosure/veneer walls, and how to calculated and design the walls. They will be thus strongly based on the results of WP4 connected, to a certain extent, to the results of WP5. These guidelines will be in the format of a full, comprehensive report, including detailed examples and the design charts developed in task4.3. This report will be also useful at two other levels. First, the guidelines can be easily converted into code-like form, to develop simplified tools for the assessment of the envisaged construction systems. Second, their simple but sound form will make them usable for standardization purposes, hence it will be used at the standardization committees level to show the advancement brought

about by the project.

Partner TBE; ANDIL; ZIEGEL; UNIPV; NTUA; UKASSEL; METU; RUREDIL; XALKIS; H.I. STRUCT

Task7.3: Construction guidelines. These guidelines (D7.3), to be used by Associations, SMEs and constructors, will contain some basic information about the project planning phase, on the materials used for constructing the envisaged enclosure/veneer wall systems, the site organization, the execution of such walls, and on quality assurance measures during/after construction. They will be thus based on the results of WP3 and, to a certain extent, WP5. They will be also strongly based on the experience carried out in task 6.1, and on the combined results of tasks 6.2 and 6.3. In addition, the guidelines will contains some examples of details (drawings) and pictures taken during the real construction. They will be thus of paramount importance for the dissemination of the project results among the Associations partners and beyond, for real constructability of the proposed systems.

Both design and construction guidelines, as one of the most important outputs for disseminating the project results, will be written in a form which is not only technically excellent, but is also very well suited to the needs of design and construction practicioners.

Deliverables

- Software and manual (**D7.1**), at PM33
- Design guidelines for end-users (**D7.2**), at PM36
- Guidelines for site organization and execution (**D7.3**), at PM36

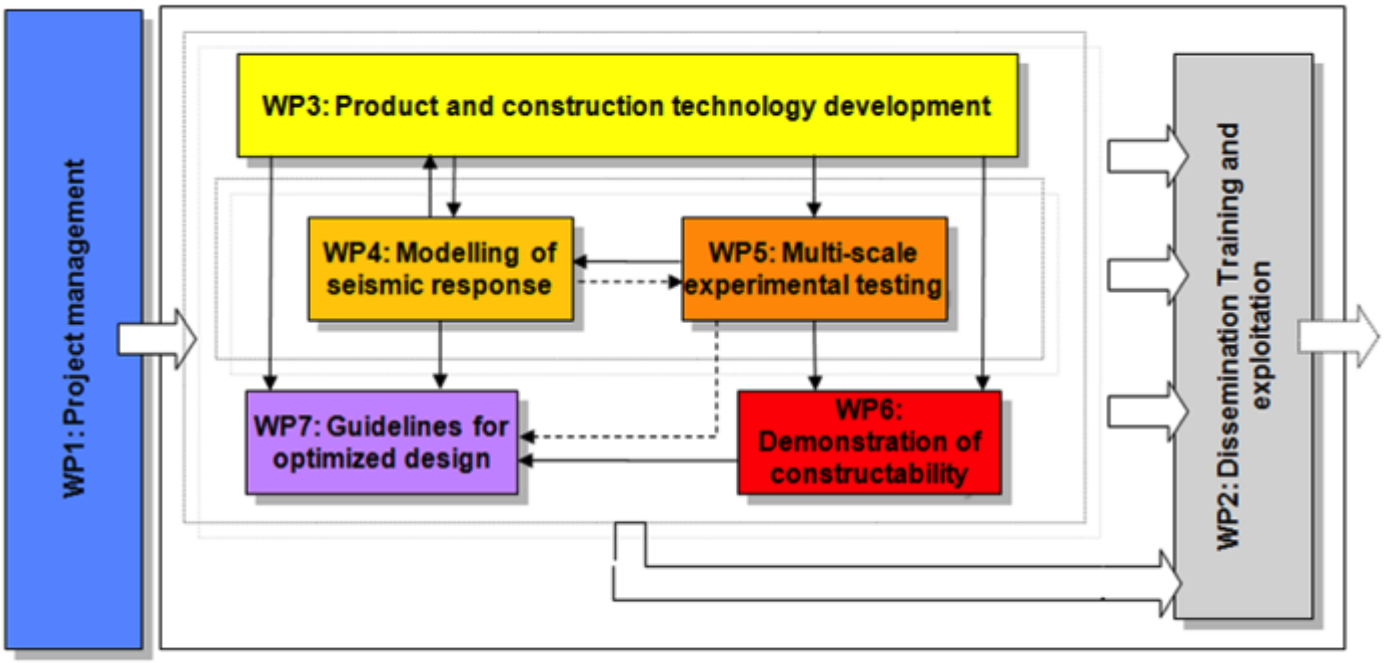
Table 1.4d Summary of staff effort

Participant no. Short name	1 UNIPD	2 TBE	3 ANDIL	4 ZIEGEL	5 APICER	6 TUKDER	7 UMINHO	8 UNIPV	9 NTUA	10 UKASSEL	11 CTCV	12 METU	13 RUREDIL	14 SDA	15 XALKIS	16 H.I.STRUCT	TOTAL SME-AG	TOTAL RTDP	TOTAL OTH	TOTAL ALL
Research & Innovation Activities - TOTAL	43	3	3	3.5	1.5	2	45	46	47	32	4	40	4	6	10	7	13	257	27	297
WP3	5	1	2	1.5	1.5	1	8	6	9	2	**4**	9	3	-	7	3	7	43	13	63
WP4	17	-	-	-	-	-	**17**	12	6	12	-	13	-	1	-	1	0	77	2	79
WP5	13	-	-	1	-	1	12	18	**24**	13	-	14	-	-	1	-	2	94	1	97
WP7	8	2	1	1	-	-	8	**10**	8	5	-	4	1	5	2	3	4	43	11	58
Demonstration Activities - TOTAL	7	2	7	0.5	1	1	6	1	4	2	4.5	1	2	1	3	2	11.5	25.5	8	45
WP6	7	2	**7**	0.5	1	1	6	1	4	2	4.5	1	2	1	3	2	12	26	8	45
Other Activities - TOTAL	3	4	5	4	1.5	2	2	2	3	3	3.5	2	4	3	3	1	16.5	18.5	11	46
WP2	3	4	5	**4**	1.5	2	2	2	3	3	3.5	2	4	3	3	1	16.5	18.5	11	46
Management Activities - TOTAL	12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	18	4	27
WP1	**12**	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	18	4	27
TOTAL ACTIVITIES/ Project Participant	**65**	**10**	**16**	**9**	**5**	**6**	**54**	**50**	**55**	**38**	**13**	**44**	**11**	**11**	**17**	**11**	**46**	**319**	**50**	**415**

Table 1.4e List of milestones

Milestone No	Milestone Description	WP(s) involved	Expected date	Means of verification
M1	Public access to the web-site	WP1	PM3	Functional web-site private interface for communication and data exchange between partners; appealing external interface for public access.
M2	Favourable platform for dissemination and exploitation.	WP2	During project	Structure and target groups for dissemination and exploitation including international mailing list of end-users and stake-holders. Organization of at least 4 main events (3 workshops/training courses and 1 international conference) and other minor events. Delivery of reports with track of progress.
M3	Materials and techniques for enclosure walls	WP3; WP5; WP6	PM18	Definition of requirements. Delivery of developed materials and associated construction techniques for enclosure/veneer walls. Practical demonstration of construction. Complete mechanical characterization of materials, masonry elements, structural sub-assemblages.
M4	Experimental and numerical modelling of overall seismic response	WP4; WP5	PM24	Initial numerical simulation and dynamic analysis of bare and infilled frames. Parametric analyses to define frame-to-wall interaction, performance levels and response parameters for seismic design. Definition and specification for shaking-table tests. Complete dynamic tests of at least two model buildings, with different enclosure wall/veneer systems.
M5	Seismic input, design methods; software development	WP4 WP7	PM30	Sensitivity studies of frames for definition of seismic input to walls. Definition of design parameters, analyses of various types of enclosure/veneer walls, and development of design methods. Creation of design charts. Derivation of new elements and/or behavioural laws to be implemented in software codes.
M6	Case-study application and guidelines for end-users	WP6; WP7	PM36	Demonstration of the overall construction technology/design procedures on real case studies. On-site testing for validation and technical/economic assessment. Transformation of obtained indications into user-friendly, design and construction guidelines for end-user.

1.4.4 Graphical presentation of the components (Pert Diagram)



2. Implementation

2.1 Quality of the consortium as a whole

2.1.1 Description of project management structure and procedures

The structure of the project management is designed to guarantee clear responsibilities and establish effective communication channels within the project. The management separates the activities and the participants into the following modules:

1. Coordination (**CO**)
2. Management Board (**MB**)
3. Technical Committee (**TC**)
4. Exploitation Committee (**EXC**)

The project will be coordinated through the CO and the MB, that will constitute the decision making level, ensuring that the RTD performer acting as coordinator will act in the interest of the participating SME-AGs and SMEs. The technical management will be operated at workpackage level by the TC, whereas the management of the exploitation of results and IP issues will be operated by the EXC. The plan is to implement a management system based on shared responsibilities to enable efficient monitoring of the progresses of the planned work. The responsibilities, cooperation and interests of the partners in the framework of the project will be drawn up in a Consortium Agreement.
The communication will be supported by a web based exchange platform, where documents and data can be exchanged. That means this platform will not only serve as a pool for technical results, but also as management supporting tool.

2.1.1.1 Project coordinator

The SME-AGs partners of the INSYSME proposal has entrusted the University of Padova (UNIPD) as project coordinator, for its proven track record in forming successful European partnerships, attracting funding from the European Commission, and performing successful project management. **UNIPD has more than 100 research projects financed by the UE in the FP6; 161 (to date) funded in FP7, it's one of the first Italian Institutions for amount of attracted funding in the current Framework Programme**. UNIPD has a devoted office, the International Research Office (SERI), with consolidate skills and expertise which ensure administrative and financial management support to the Departments and Academics of UNIPD for research projects in the framework of several programmes, especially in FP7. SERI directly manages some FP7 research projects: RealNet, CyberRat, CSN, MODES, GenderTIME, PISCOPIA and Venetonight among others. The selection of an experienced and structured partner, capable of combining research and management, as project coordinator provides stability and exact progress monitoring. Claudio MODENA, Full Professor at UNIPD, Director of the Material Testing Laboratory of the Department of Civil, Environmental, Architectural Engineering, will be the responsible coordinator of the project. He has several years experience of research work within the frameworks programmes of the EU as responsible of UNIPD Research Unit: BRITE-EURAM "Industrial Development of Reinforced Masonry Buildings", BREU-CT95-0575; ISOBRICK "Industrialized Solutions for Construction of Reinforced Brick Masonry Shell Roofs", GROW-1999-70420; ON SITE FOR MASONRY "On Site Investigation techniques for the structural evaluation of historic masonry buildings" EVK4-CT-2001-00060; "Improving the Seismic Resistance of Cultural Heritage Buildings", EU-India Economic Cross Cultural Programme (ALA-95-23-2003-077-122). He coordinated the DISWall Project "Developing Innovative Solutions for Reinforced Masonry Walls" (COOP-CT-2005-18120; FP6-2003-SME1) for which the final evaluation was excellent. He is currently coordinating the NIKER Project (FP7-ENV-2009-1-GA244123). He has participated and has been responsible with coordination and management responsibilities for UNIPD Research Unit in several research projects founded and co-founded by the Ministry of Education, University and Research (MIUR ex MURST), by the National Research Council (CNR), by the National Group for Earthquake Defence (CNR-GNDT) and by the RELUIS consortium (Network of University Laboratories of Seismic Engineering). He has also a long experience as responsible of R&D

contracts with the industry, in particular for the study of innovative masonry materials (research contracts with ANDIL); for the study of FRP application to masonry, wood and concrete elements (research contract with industries of the sector, such as BASF-CC S.p.A., etc); for the development of special mortars and injection grouts (research contract with industries such as Tassullo S.p.A.; Röfix S.p.A.); for the development of special fastenings and connectors (research contract with industries such as Fischer S.p.A.; ITW S.p.A.); for the monitoring of highway and highway bridges (research contracts with societies for highway and railway management); for monitoring, structural assessment and design of interventions on heritage buildings (research contracts with public bodies owners of monumental buildings) and many others.
The Project Coordinator (**CO**) will have overall responsibility for the execution of the work programme, communication with the EC, technical and financial reporting, correct problem solving procedures and implementing corrective actions, in close consultation with the other members of the Management Board and Committees. His responsibility will also include ensuring proper:

- resolution of any administrative or contractual issues within the partnership and with the EC; drafting, management and updating of the Consortium Agreement among the partnership;
- organisation and chairing of the periodic Management Board and Technical Committee meetings, drafting and circulating the agenda; arranging the presentations of progresses with WP Leaders; preparing the minutes; ensuring that decisions and actions are executed;
- establishing systems for periodic tracking and reporting of effort, progress and deliverables; defining document templates; defining and implementing quality assurance processes for all project deliverables and published materials; discussion of the obtained results and encountered problems; monitoring and evaluation of progress; preparation and distribution of reports on deliverables and milestones according to schedule;
- management of general partnership (ownership, confidentiality, background/foreground compensation) and arbitration policies, interface with Management Board and Exploitation Committee, information exchange among partners and creation of a Web-site/ftp-server for dissemination (public area) and data exchange (secure area); exploitation and dissemination policies (see also Section 3.2.2);
- legal and financial administration according to EC requirements, receipt of funds and distribution among partners; collation and submission of participant cost statements, preparation and distribution of financial reports; transfer of administrative, technical and financial documents to/from partners/Commission.

2.1.1.2 Management Board

The Management Board (**MB**) will be chaired by Eng. Di Fusco, Manager of the R&D division of the Italian Association of Clay Bricks and Roofing Tiles Producers (ANDIL). The MB will be in charge of the overall direction and major decisions with regards to the Project. It will be its responsibility to ensure that the correct procedures are carried out and all deadlines and obligations are met. It shall be in particular responsible for:

- preparing a 'budget' for the Project; deciding upon its allocation and any proposed amendments thereto; deciding upon the allocation of work;
- evaluating the subcontracted activities reported by the RTD Performers, monitoring both technical progress and value for money; evaluating any proposed amendment to the work programme based on the reports received;
- proposing the evolution of techniques and processes needed for the Project; proposing the review and/or amendment of terms of the contract including any major change in the Project; authorizing the implementation of any contingency plan that may be required;
- resolving any problems such as arbitration regarding technical choices and other conflicts if any; devolve the Coordinator to report for approval to the EC any proposal for major changes to the management plan.

2.1.1.3 Technical and Exploitation Committees

The Technical Committee (**TC**) is composed of the Project Partners that are also WP leaders: UNIPD (CO and leader of WP1), ZIEGEL (leader of WP2), CTCV (leader of WP3), UMINHO (leader of WP4), NTUA (leader of WP5), ANDIL (leader of WP6), and UNIPV (leader of WP7). The

TC is thus composed of the project coordinator and six members, and will be chaired by Prof. Modena (also project CO). Each member of the TC will ensure that the tasks set in the respective WP are carried out in time and according to the project aims. The TC, managing the progresses, will prevent risks during the course of the project, planning eventual remedial actions with the Management Board, if necessary. With these objectives, the WP leaders and members of the TC have been selected as most qualified and experienced in the respective fields, and have proven track of technical excellence and management skills in the framework of EU funded project (see also Section 2.2). More in detail, the TC will be in charge of:

- detailed technical coordination and management of each WP; reporting technical issues to the Management Board;
- collecting periodic reports and effort tables from the partners involved in each WP, preparation of WP reports and effort tables and timely transfer to the Project Coordinator; collecting information from the partners for arranging the presentations of the WP progress during the meetings;
- continuous control progress in the prime objectives of the project within each WP; timely information transfer to CO and MB in case of problems and proposal of contingency measures to be undertaken; proposing revisions of the project work plan and schedule;
- drafting and circulating the structure and list of contents of each deliverable; exchanging data and collecting information from partners; preparation of the final and revised version of each deliverable; monitoring of advances towards the milestones and their achievement;
- preparing informal technical meetings on specific tasks within each WP, if necessary.

The Exploitation Committee (**EXC**) is composed of the SME-AGs participating in the project (TBE; ANDIL; ZIEGEL; APICER; TUKDER), and will be chaired by Dr. Udo Meyer, responsible for the exploitation of research results in trademarks and patents of the German Association of Clay Tiles and Brick Producer (ZIEGEL), being also leader of WP2. The goal in setting up the Exploitation Committee is to make sure that SME AGs Partners agree between themselves on industrial efficiency and consistency and broader impact of the results. The overall responsibility of the Exploitation Committee is the supervision of the results, in terms of fitness of the implementation of the Project towards the internal organization of the SME AGs, the assessment of technical and exploitation reports, the specific expert missions concerning the dissemination and use of the knowledge, the preparation of the decisions concerning the ownership of the results, the granting of Access rights to the RTD Performers and Other Partners, the exploitation of results and the preparation of the overall opinion of the SME AGs for the Management Board. The EXC will be also responsible for the protection and management of knowledge and foreground IP. The consortium has already agreed upon an IP management strategy (see Section 3.2.1), that will be encompassed in the Consortium Agreement.

2.1.1.4 Management and decision-making structure

The **TC** will meet, in principle, 6 times along the project duration, to discuss technical issues, agree actions for the next period and prepare progress reports. WP leaders, having direct liaisons with the involved partners to coordinate their activity and interactions within the given WP, will collect, edit, and present for discussion the work within the WP. The resulting deliverables will be subject to internal review according to the mechanisms of peer review in place within each of the participant organizations. The TC chair and the CO will ensure that activities in all WPs are developed and dispatched in a concerted manner, avoiding duplication of efforts and maximizing the exchange of results and data among partners, and that collaboration and communication is maintained lively and effectively throughout the duration of the project. In addition, informal task groups will meet periodically on an ad hoc basis under the chairmanship of the relevant WP leader.
The **EXC** will meet periodically, particularly during year 2 and 3 of the Project, to consider exploitation strategies and implement and evaluate actions. If deemed appropriate by the SME AGs, representative of the project SMEs and RTD performers may be invited to attend the meetings to provide specific inputs regarding, for instance, individual future commercialization targets or technical issues.

The **MB** and the Technical and Exploitation Committees will convene with meeting dates coinciding with the plenary meetings. In principle, the meetings will last for two days, the first day devoted to the above mentioned meetings of the two committees (held in parallel), the second day with TC and EXC reporting to the MB the main technical (with presentations by the Leaders of each active WP), financial, and impact assessment issues. The CO will report also on administrative issues. Minutes of the MB meetings will be issued within two weeks of the meeting date and placed on the consortium area of the Project Website, along with the presentation and reports, to communicate the information to the project participants and to act as an archive. The minutes will include a list of agreed actions, partners responsible and delivery dates.
The MB will seek consensus on project steering, and, in the unlikely case of dispute, will have the authority to implement decisions taken by majority vote with the SME-AGs and the SMEs having a 'one participant, one vote system'. The Consortium Agreement, which will be signed by all partners and contractors before project initiation, will define further arrangement (representation, delegation and quorum, etc.).
Moreover, the WP leaders will inform monthly the CO about the work progress, sending effort, work and deliverable progress short reports, according to templates distributed by the CO, every other three months. In case of any difficulties, due either to the questions of methodology or delay in producing deliverables, the WP leaders will report the CO and both will try to find a solution. Members of the EXC will also inform the CO, in case of eventual issues or problems arising in the adopted exploitation strategies or in management of knowledge and foreground IP. If no adequate solution is found, an extraordinary plenary (MB) or committee meeting will be organised depending on the kind of problem and on the impact of these difficulties in the achievement of the project objectives. If disputes cannot be solved through these mechanisms, the advice of the Commission Project Officer will be sought. Fig. 9 shows the coordination structure.

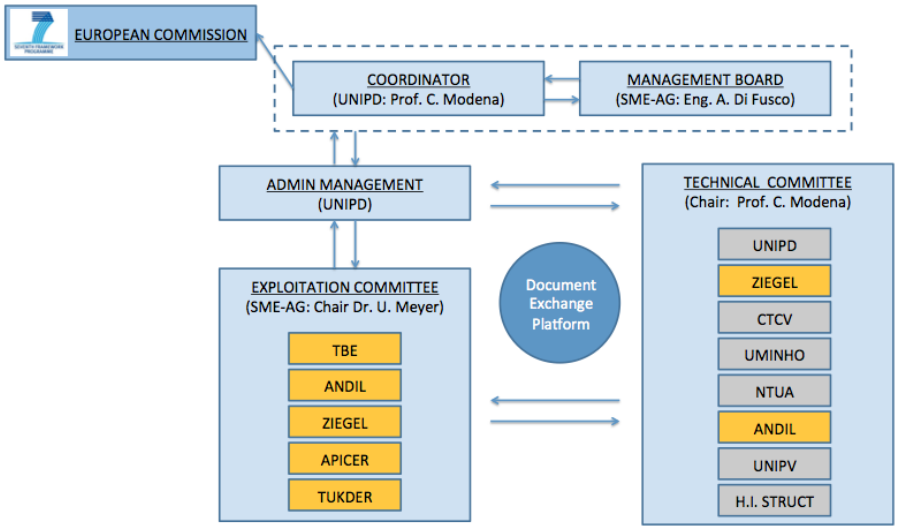


Fig. 9: Coordination Structure

As can be seen, the INSYSME project has a flexible control and management structure, which meets the need of its participants for efficient decision-making and information flow. This structure reduces administrative overheads, which will be only the responsibility of the Project Coordinator, assisted by the administrative personnel of the Dept of Civil, Environmental & Architectural Engineering and of the SERI office at UNIPD, which is expected to have an overall workload of a about 2 days a week for a total equivalent of 12 person/month. The coordination team will be leaded by Prof. Modena (Project Coordinator) and will be assisted in this task, for the day-by-day actions, by Assistant Prof. da Porto. They will be assisted in the scientific coordination by devoted assistants and PhD students. Mrs Brugnaro will be the administrative responsible and responsible for financial reporting of UNIPD. Mrs Giacon will be responsible for the money transfer and expenditures, and will help in the task of financial reporting. Mrs Trovò will be responsible for contacts between CO and partners for financial reporting matters. Dr Borrelli will be responsible for contacts between CO and EC and for the general preparation of contracts and consortium

agreement. Mrs Drigo will be responsible for drafting, managements and amendments of contracts and consortium agreement.
To reduce management and travelling costs, and make communication and discussion, outside the regular consortium meetings, easier, an electronic web-based communication system will be launched at the project Kick-off meeting, hosted by UNIPD (project CO). The redistricted area of the project web-site will allow interactive amendment to documentation and exchange of data. To support the project information flow and ensure good communication among the different decision-making components of the management structure and among all participants, electronic mail, teleconferencing and webinars will be also adopted. Formal reporting to the EC will be responsibility of the project coordinator, and will consist of a First-Term and Final Report, plus an intermediate report for each reporting period. Project management software will be used and all reports made available to partners on the IT platform. The public web-site will be developed within 3 months from the project start, and will be used for dissemination of non-confidential information to a wider audience. This public area will be linked to the protected area for consortium members.

2.1.1.5 Meetings

The tentative schedule for the plenary meetings is as follows: kick off meeting at the onset of the project, and subsequent meeting in a six months period, for an effective onset of the project activities. Project review meeting at the end of the first reporting period (at PM15), and a subsequent meeting in a six months period, to accurately assess the project during the period of maximum workload and achievement of main results. Project meeting at PM30 and final meeting, for organization of the final work to be done and for checking the final achievements of the project. It is expected that the activity of the project will result in the following agendas:

PM 1 (to be held in Italy) – Kick-off meeting to agree common methodology and criteria and detailed plan of activity for the first year. Specification of document standards. Detailed plan of activity for the first six months.

PM 6 (to be held in Portugal) – Web site. Presentation of the types of structural frames, enclosure walls and related modelling strategies. Requirements for masonry materials. Initial material and technology development. Detailed action plan for the next nine months.

PM 15 (to be held in Germany) – First-term report. Project presentation. Platform and plan for exploitation and dissemination. Prototype products and technology. Experimental results on materials. Construction process, practical demonstration, and feasibility assessment. Results of in-plane/out-of-plane tests on enclosure walls. Presentation of frame and infill walls models and analyses. Detailed action plan for the next six months.

PM 21 (to be held in Greece) – Final report on the construction process. Individuation of proper buildings for applying new technologies. Results of frame and infill walls models and analyses and guidelines for optimal modelling strategies. Shaking table test results. Planning of real construction (initial design and detailing). Detailed action plan for the next nine months.

PM 30 (to be held in Turkey) – Updated exploitation and dissemination plan. Final report about technical and economic feasibility of the proposed technologies. Definition of global structure to non-structural element interaction. Design formulations and charts for various conditions. Prototype walls design, detailing and construction. On site testing. Detailed action plan for the next six months.

PM 36 (to be held in Italy) – Final project report. Dissemination and exploitation final report. Final project presentation (promotional video). Report of in-situ testing on prototype walls and validation of the proposed technologies. Presentation and demonstration of software. Presentation of construction and design guidelines.

PM 38 final reports to Brussels

2.1.2 Description of the consortium

The Consortium has been carefully selected to deal with this highly interdisciplinary undertaking. All necessary disciplines are in the Consortium, nevertheless avoiding internal competition. The Consortium is well balanced, bringing together all the needed expertise provided by RTD performers to answer the needs of the SME AGs and of the industrial (SME) partners, composed by: brick and block producers, company for fastenings and systems, developers of structural analysis software, engineering firm. The common interests and complementary roles are:

- private non-profit institution which are clay unit producer Associations and have high experience in dissemination of knowledge among professionals and enterprises (TBE-Europe; ANDIL-Italy; ZIEGEL-Germany; APICER-Portugal; TUKDER-Turkey);
- expert for experimental testing, numerical analysis and structural modelling of masonry systems and buildings, that are also higher education centres for dissemination of knowledge (UNIPD-Italy; UMINHO-Portugal; UNIPV-Italy; NTUA-Greece; UKASSEL-Germany; METU-Turkey);
- Manufacturer and supplier of clay masonry units and developer of construction systems (XALKIS-Greece; RUREDIL-Italy);
- developer, manufacturer and supplier of fastening and reinforcement systems (RUREDIL-Italy);
- developer (UNIPV-Italy) and developer and supplier of software for numerical analysis and design of structures (SDA-Germany);
- professional and consultancy expertise in the field of structural engineering (H.I. STRUCT, plus a branch of SDA-Germany, and the involved RTDPs);
- private research institution specialized in development and dissemination related to clay products (CTCV-Portugal);
- private and public institution involved in national and international code and standards preparation (TBE-Europe; ANDIL, UNIPD, UNIPV-Italy; ZIEGEL, UKASSEL-Germany; UMINHO, APICER-Portugal; NTUA-Greece, METU, TUKDER-Turkey).

The selection of the Consortium Participants (PAs) was done based on the following base:

- The SMEs Association (SME AGs) of the clay brick/block industry sector are leading the project through their role in the Exploitation Committee and the Management Board. In Europe, the participant SME AGs (ANDIL-IT, ZIEGEL-D, APICER-PT, TUKDER-TU) are representative of countries where clay industry still has a leading role compared to competing solutions. The scope of TBE, with members in more than 20 European countries, allows spreading the project results to a wider audience of potential users. In addition, they actively participate in the European standardization process and in the respective National Standardization Bodies.
- The involved manufacturer of units (XALKIS), is a small medium enterprise with a long experience in production and supply of masonry units both for structural and non-structural masonry systems, having thus enough knowledge of the market state of the art. It is one of the final addressees of the results that take-up directly the innovation generated in the project and holds the important role of addressing the SMEs Association member's needs.
- RUREDIL is a leading group in the development, production and commercialization of materials, technologies and systems for prefabrication, fastenings, reinforcements. Its presence ensures an approach from the single product to the construction element, and a constant contact with all the actors in the construction sector (manufacturers, prefabricators, contractors and designers). Its role is in development of fastenings, reinforcements, and entire technology, with a view on the construction process for the envisaged clay systems;
- SDA has a strong background in software development, together with expertise in structural engineering consultancy. This combination guarantees the development of a software component for the optimized design procedures, which will fulfil the demands of the engineering practice. By working on the demonstration part of the project, SDA will have an opportunity to obtain hands-on experience on the new design tools, for their dissemination.
- H.I. STRUCT has a strong background in structural engineering consultancy and thus brings the design-engineering viewpoint into the project. It will mainly deal with demonstration of the prototype and dissemination of the project results. The practical application experience will

furnish important feedback for continuous improvement of the new design concepts and is regarded as an essential prerequisite for their successful dissemination and exploitation.

- The universities and research centres involved (UNIPD, UMINHO, UNIPV, NTUA, UKASSEL, METU, CTCV) have strong and complementary background in the analysis, modelling, testing, development and optimization of masonry materials and buildings. They have a very good balanced regional distribution of complementary testing facilities, useful for developing and assessing the mechanical, physical and environmental properties of different enclosure systems, applicable to different realities in a trans-European perspective. In addition, they are all members of National and European scientific organizations, and regulatory committees, for the preparation of guidelines, standards, and structural codes (CEN, CIB, RILEM, etc.).
- UNIPV, NTUA have a strong background in the dynamic testing of structures by performing shaking table tests on full/reduced scale masonry buildings and related dynamic non-linear numerical analyses. Their laboratories with shaking tables and reaction walls are included among the largest European facilities. NTUA and UNIPV-EUCENTRE are in fact consortium partners of Seismic Engineering Research Infrastructures for European Synergies (SERIES);
- UNIPD, UMINHO have a strong background in material testing, from single material to constitutive laws to the characterization of construction elements and subassemblies under quasi-static cyclic loads, and large experience of non-linear micro-modelling of masonry;
- UKASSEL, METU also have an important background in numerical modelling and experimental testing, and have strong background in reinforced concrete framed structures, too.
- CTCV is a private research centre specialized in ceramics and glass products, with an emphasis also on technological (construction systems) related issues. Their presence ensure that problems such as thermal and acoustic insulation, energy saving and recycling, life-cycle assessment, plant and installations integration, technological feasibility and compatibility are taken into account. In addition, they have a long-lasting experience in dissemination of results.

The RTD activities are mainly concentrated on WP3, WP4, WP5, and WP7. The central concern of the project is the development of innovative systems for masonry enclosures enabling the extension of the brick/block industrial sector by addressing its needs. **Due to the different seismic hazard of the countries participating in the consortium, the different environmental conditions (climate), the different building traditions, and the different needs of the SMEs directly involved in the project or SME-AGs members, different solutions will be studied in parallel by the different RTD partners, which are suitable for the different needs.** Hence, all RTD performers appears to have a significant contribution to the most important RTD activities based on masonry materials design, new construction technologies, mechanical validation of the solution, numerical simulation and application. Considering also the well balanced contribution in terms of personnel efforts, it should be stressed that it is not intended to have neither duplication of information nor work carried out in different countries/laboratories. The presence of parallel activities on different systems allows addressing the needs of the industry sector of any European country. The Consortium thus intends to solve the problem of brick/block SMEs, providing tailored solutions that cover the entire European construction market.

The Consortium Participants are key international players in their specific field, mainly as concerns RTDs performers and the SME-AGs involved. They have already established relationships between each other at national and international level to carry out innovation and dissemination activities, thus assuring the quality, competence and team spirit of the Consortium. All the Consortium Partners have already relationships with manufacturers and suppliers of other construction materials, which assure good cooperation with other industry sectors. Hence, the project results will advantage also other activity areas. The support letter in Appendix to this document also demonstrates this.

In the table below, a more detailed area of activity and main contribution to the work plan of each participant is described. The leadership and main contribution (as can be also drawn by the WP description in section 1) were defined according to main competences of the partners, (see also the project participants profiles, presented in brief next). Concentrating the partner activity in their elected field of expertise maximizes the output. The high level of exchange and interaction among partners within each WP will also ensure high standards through the output.

CP no	Activity code	Contact Person	Partner short name	Country	Area of activity	Role or main contribution
01	HE	C. Modena	UNIPD	IT	Experimental testing of materials and construction elements (subassemblies), numerical analysis, on-site testing and guidelines.	Leader of WP1 Main contribution to WP4-5-6-7
02	SME-AG	A. Aiello	TBE	BE	Dissemination and coordination of contact between the Consortium and the CEN.	Main contribution to WP2
03	SME-AG	A. Di Fusco	ANDIL	IT	Development, standardization and promotion of products and construction technologies. Dissemination and exploitation.	Leader of WP6 Main contribution to WP2-3
04	SME-AG	U. Meyer	ZIEGEL	DE	Knowledge transfer to SMEs, designers and constructor. Dissemination and exploitation of results. Standardization.	Leader of WP2
05	SME-AG	M. Chichorro	APICER	PT	Development of products and construction technologies; knowledge transfer to SMEs. Dissemination and exploitation.	Main contribution to WP2-3
06	SME-AG	C. Çelik	TUKDER	TR	Development of products and construction technologies; knowledge transfer to SMEs. Dissemination and exploitation.	Main contribution to WP2-3
07	HE	P. Lourenço	UMINHO	PT	Computational modelling of structural behaviour. Experimental characterization of materials, development and implementation of constitutive laws. On-site testing and guidelines.	Leader of WP4 Main contribution to WP3-5-6-7
08	HE	G. Magenes	UNIPV	IT	Experimental testing by shaking table, numerical simulation, seismic structural analysis. Development of guidelines for end users.	Leader of WP7 Main contribution to WP4-5
09	HE	E. Vintzileou	NTUA	GR	Structural behaviour and design of structures under seismic actions, experimental analysis by shaking table. Design guidelines.	Leader of WP5 Main contribution to WP3-4-7
10	HE	E. Fehling	UKASSEL	DE	Experimental testing of materials, and construction elements (subassemblies), numerical simulation, structural mechanics, structural analysis and design.	Main contribution to WP4-5
11	RES	B. Dias	CTCV	PT	Technological development of ceramic materials and related construction technologies. Specialized training, dissemination and promotion.	Leader of WP3 Main contribution to WP2
12	HE	A. Yakut	METU	TR	Experimental testing of construction elements (subassemblies), and numerical analysis.	Main contribution to WP3-4-5
13	SME	G. Mantegazza	RUREDIL	IT	Development of construction system. Design, optimization and supply of fasteners/reinforcement.	Main contribution to WP2-3
14	SME	C. Butenweg	SDA	DE	Development and supply of software code for structural analysis.	Main contribution to WP4-7
15	SME	K. Deligiannis	XALKIS	GR	Design, optimization and supply of clay units. Development of construction system.	Main contribution to WP3-6
16	SME	M. Mosoarca	H.I. STRUCT	RO	Development and technical and economic feasibility of construction technologies. Contribution to guidelines	Main contribution to WP3-6-7

2.1.2.1 Partner n° 01 (RTD/Coordinator) – UNIPD – IT

The **University of Padova** was founded in 1222. It offers any level of graduation (BS, MS, Ph.D.) in 13 Schools, including several Erasmus Mundus Advanced Masters Courses. The **Department of Civil, Environmental, Architectural Engineering** includes 21 professors, 14 associate professors, 34 assistant professors, about 43 Ph.D. students and 50 persons of administrative and technical staff. The department has a section involved since many years on experimental and theoretical research topics related to the structural behaviour of historic masonry buildings and of innovative systems for unreinforced and reinforced clay masonry walls. The experience includes laboratory testing on structural elements, laboratory calibration and on-site testing with non-destructive methods, experimental and numerical analyses of the structural response of buildings under static and dynamic actions, static and dynamic monitoring of structural behaviour and dynamic identification of buildings, and non-linear numerical modelling. The researches are carried out within European projects, with funding of the University and Scientific Research Ministry, and with direct funding of associations and enterprises (see Section 2.1.1.1). The experimental activities are carried out at the Test Laboratory of DICEA, which is provided with an isolated reaction floor that allows executing static and fatigue tests on real scale structural elements for any load level (up to 10 MN). Several test systems, all force and displacement controlled allowing the application of cyclic loads with electronic actuation, are available. Collaborations with the Department of Geosciences (Prof. G. Artioli), and the relevant laboratories of thin sections, XRPD diffractometer, electron microscopy and other, have been established for the purpose of multi-scale study of materials and interfaces. Already established collaboration with the Industrial Engineering Department (Proff. A. Di Bella, M. De Carli), and the relevant laboratories of Acoustics Measurements, Thermal Properties, and Assessment of the Global Quality of Indoor Environment, have allowed to study various construction solutions also under the point of view of their physical properties, their problems of integration with instalments, and energy effectiveness.
Key personnel: Prof. Claudio Modena; Dr. Francesca da Porto, Proff. G. Artioli, A. Di Bella, M. De Carli. Drr. Maria Rosa Valluzzi, Enrico Garbin; Engg. Paolo Girardello, Giovanni Guidi, Elena Stievanin, Luca Nicolini, Giovanni Tecchio, Paolo Zampieri. **Prof. C. Modena**: his CV is provided in Section 2.1.1.1. **Dr. F. da Porto**: Assistant Prof. of Structural Engineering (since 2006). Ph.D in "Modelling Conservation and Control of Materials and Structures" (2005), University of Trento. Graduated in Building Eng. (2000), University of Padova, summa cum laude. Visiting scholar at the Technical University of Catalunya, Spain (2001-02). US/ICOMOS Intern at HAER, National Park Service, U.S. Department of Interior, (2002). Visiting scholar at the Slovenian National Building and Civil engineering Institute (2005-06). Author and co-author of about 150 notes.

2.1.2.2 Partner n° 02 (SME AG) – TBE – BE

Tiles & Bricks Europe represents industry associations and companies from 20 European Union Member States plus Croatia, Norway, Russia and Switzerland. The association promotes the interests of the clay brick and tile industry in Europe. It provides a forum for its members to exchange information on technical development, sustainable construction, climate change, resource efficiency and other emerging issues. The European brick and tile industry represents more than 700 companies, from SMEs to large international groups, which employ around 50,000 people across Europe. The activities are organized around specialized working groups of technical experts from national associations and companies. Members are regularly informed about upcoming issues through monthly newsletters. The association organizes public events on the most relevant subjects for the industry, which are attended by EU officials, trade associations' representatives, architects and other interested stakeholders. Furthermore, TBE is a full member of Cerame-Unie, the European Ceramic Industry Association. TBE also coordinates the representation of the clay brick and roof tile industry at the Sustainable Building Conference. Last but not least, we collaborate closely with our corresponding associations in Australia, North America and South Africa. Our main partners are the European Commission, the European Parliament and the Comité Européen de Normalisation (CEN).

Key personnel: **Adolfo Aiello**, TBE Secretary General- He is in charge of climate and energy issues for the whole ceramic industry association (Cerame-Unie) and manages the TBE secretariat. Nuno Pargana, Construction and Sustainability Manager - He deals with all the technical issues concerning construction and sustainability at TBE and Cerame-Unie level.

2.1.2.3 Partner n° 03 (SME AG) – ANDIL – IT

ANDIL - Associazione Nazionale degli Industriali dei Laterizi is the National Association of Clay Bricks and Roofing Tiles Producers. In Italy 170 factories, with more than 6,500 workers, produce different types of clay construction products in particular for residential building in its various forms (masonry, roofing, partition walls, veneers, flooring and horizontal structures). In 2011, only the Italian brick/tiles industry produced over 10.5 million tons, with a value of approx. 920 million euro.
ANDIL operates as a representative, on a national and international scale, of the whole sector by means of: (a) a wider policy, with active participation in federative bodies carrying out programmes of general interest relative to “Building systems"; (b) a more specific field policy, with active cooperation in the conception and revision of rules and agreements in the specific context of the production process; (c) a product policy, by carrying out initiatives specifically aimed at promoting greater knowledge of the products with regard to performance and correct usage, and by involvement in the field of research.
ANDIL is a member of "Confindustria", the leading organisation representing the manufacturing and service industries in Italy, of Federcostruzioni (Italian industry federation of constructions) and, on a European scale, of the "TBE" (European Tiles & Bricks Producers Federation). Companies of all sizes distributed throughout Italy are members of ANDIL that represents over 80% of overall national production. "Commercial departments" operate under the auspices of the Association, which unite companies with similar production and develop promotional programme.
Key personnel: Eng. Giovanni D’Anna, Eng. Alfonsina Di Fusco.
Eng. Giovanni D’Anna, graduated in Chemical Engineering, his role in ANDIL is the management of environmental, energetic and safety aspects concerning the manufacture of clay products. He is also in charge of industry statistics on production, sales, employees, etc. With regard to products in brick he has been involved in issues related to environmental sustainability and energy.
Eng. Alfonsina Di Fusco, graduated in Civil Engineering at the Università di Napoli, she got her MSc from the Civil Structures Master School “F.lli Pesenti” of Politecnico di Milano. Her role in ANDIL is the management of research and development activities, she is involved in the revision work of national standard code concerning the masonry structures. She is author of several articles published by ANDIL house organ “Costruire in Laterizio”; she organizes many training courses and academic seminars concerning the constructive applications of clay products.

2.1.2.4 Partner n° 04 (SME AG) – ZIEGEL – DE

Ziegel is an industrial association representing more than 80 clay masonry unit producers in Germany with an annual turnover of about 330 Million Euro. The main tasks of Ziegel are the coordination of the joint research and development activities of its members, the information and training of the personnel of its member SMEs about new developments in production and application and the knowledge transfer to designers in the field of masonry design and application of masonry materials. The main tasks of Ziegel, will be the exploitation management to ensure the knowledge transfer about the projects results both to the European SMEs and designers as well as the coordination of the research and development activities related to hollow clay units with concrete infill. Dr. Meyer will also participate in the preparation of national and international information days and brochures.
Key personnel: Dr. Udo Meyer. In Ziegel he is responsible for the exploitation of research results in trademarks and patents. Dr. Meyer is among many other activities German delegate to CEN TC 250/SC 6 (masonry) and SC 8 (earthquake), member of the relevant technical committees in TBE (European clay producers union) and has experience as author of brochures in different fields of

masonry application (materials, design, fire design, ecological aspects) as well as in training personnel of the SMEs, students and designers in these fields.

2.1.2.5 Partner n° 05 (SME AG) – APICER – PT

APICER is the Portuguese Association for Ceramic Industry. Founded in 1996, has the mission to represent, protect and boost the Portuguese ceramic sector. Major activities of the association are: to protect and promote the interest of the ceramic sector in Portugal; to support activities and represent the interest and the image of its members; to develop support strategies though national and international co-operation networks and finally, to act as an institutional partner with public administration and international organizations.
The Association has 91 associates, which represents 80% of the Portuguese ceramic industry. It has 8 collaborators to give support to the companies in several areas: management and accounting, taxes, internationalization, environment law, training, standardization and health and safety.
Key personnel: **Martim Chichorro** - Responsible for internationalization projects and the marketing in APICER. In APICER since 2001, is responsible for projects in the area of the internationalization. Also participated in the research project ADOPTIC.

2.1.2.6 Partner n° 06 (RTD) – TUKDER – TR

TUKDER (TUGLA ve KREMİT SANAYİCİLERİ DERNEGİ) is the Turkish Association of Manufacturers of Bricks and Tiles of Clay. The association was founded in 1997 in Istanbul to represent industrialists manufacturing clay products. The main objectives of TUKDER are to find solutions to problems of the sector, to increase quality, to reach the level of international or national standards, to carry out activities for correct use of clay and tile by public, manufacturers, implementers and marketers. TUKDER has increased its activities in Ankara after 2000 and made significant progress in achieving its goals. The Association has 108 registered members and is among the prominent officially recognized non-governmental organizations representing a wide base of Turkey. Clay and tile industry mainly targets construction sector in Turkey manufacturing materials using clay as raw material. The number of employees working in the subsidiary industry is over 25.000 persons. Sector's turnover is around 1.200.000.000 TL and its export is near 8.000.000 USD per year. There are approximately 330 clay brick and 70 tile factories throughout Turkey. TUKDER regularly organises and runs training courses for its members introducing new standards on clay and tile, laboratory applications, and quality management.
Key personnel: Çetin Çelik, Buket Çopuroglu.
Çetin Çelik has graduate from the structure department of technical education faculty at Gazi University, Ankara (2001). He has carried out his graduate study on wall materials at structural department of Gazi University (2005). He has worked at inspection and structural materials laboratories of several companies. He has joined TUKDER in 2008 as technical expert being responsible for training and continuing education activities, organization of seminars and computation and laboratory studies on heat conduction for wall materials. **Buket Çopuroğlu,** is a graduate of department of chemical engineering at Gazi University (1976). She has retired as director of laboratory division from the ministry of public and settlement in 1997 where she served for 20 years. She has worked as laboratory director at a private company between 2001-2008. She has been working as Lab. Director at Yapı- RD which is a financial enterprise of TUKDER since 2010.

2.1.2.7 Partner n° 07 (RTD) – UMINHO – PT

The **Department of Civil Engineering of the University of Minho** is a young and dynamic department including 60 scholars, from which 40 hold a Ph.D. degree. The technical staff consists of 10 technicians. The Structural Group is highly involved in the areas of computational modelling of the structural behaviour, experimental testing under displacement control and non-destructive testing. A 400 m^2 structural laboratory equipped with a strong floor was completed in 2002 and a new laboratory (additional 400 m^2) has been recently prepared. Available resources include most

of the necessary equipment to perform quasi-static cyclic tests, under deformation control, and state of the art NDT. Research interests includes survey, monitoring, assessment, repair and strengthening of historical structures including non-destructive testing, experimental characterization of constitutive laws, development and implementation of constitutive laws in the fields of cracking, plasticity and damage mechanics, long term behaviour, and numerical analysis. The group has organized several conferences, up to 500 participants, and participated in several funded research projects in the area of masonry structures. The group successfully attracted several sponsored industry contracts in the area of masonry, including product development, large non-load bearing masonry infill design and confined masonry design.
Key personnel: Prof. Paulo B. Lourenço, Dr. Daniel V. Oliveira, Dr. Graça Vasconcelos, Dr. Francisco Fernandes, Dr. Luís Ramos.
Prof. Paulo B. Lourenço: Graduation in Civil Eng. (1990), FEUP / University of Porto. Ph.D, Delft University of Technology (1996). Head of Department and Head of the Structural Group. Specialist in masonry, concrete, stone, ancient and historical constructions, structural analysis and testing. Editor of the International Journal of Architectural Heritage. Coordinator of the Erasmus Mundus Master Course in Structural Analysis of Monuments and Historical Constructions. Editorial Board of 5 journals. Scientific Commission of 40+ conferences. Previously involved in several international R&D projects and committees. Supervisor of 33 PhD theses (18 completed) and over 400 scientific publications. Over 600 citations in the Science Citation Index.

2.1.2.8 Partner n° 08 (RTD) – UNIPV – IT

The **Department of Civil Engineering and Architecture (DICAr) of the University of Pavia** includes presently 12 professors, 16 associate professors, 21 assistant professors, 11 persons Technical Staff, 9 persons Administrative staff. The Structures and Materials section of the department has one of the largest Italian university laboratories for experimental structural testing, and has access via an agreement of mutual collaboration to the adjacent laboratory of EUCENTRE, the recently established European Centre for Training and Research in Earthquake Engineering, equipped with one of the most powerful European shaking table facilities. Both laboratories have also the possibility of carrying out quasi-static tests on large structural elements or structures. Research activities of the Structures and Materials section of DICAr cover structural mechanics, structural analysis and design, earthquake engineering, experimental testing of materials, of structural components, of structural systems, with particular expertise in reinforced concrete and masonry structures. Teaching activities cover the fields of structural mechanics, structural design, computational mechanics, structural dynamics and earthquake engineering. The structural design group, which is involved in the present research application, is the core of the faculty of an international post-graduate doctoral and master school on earthquake engineering with over twenty doctoral students (ROSE school) and has attracted to the Department in the years 2007-2011 over 5.0 Million Euros of research grants from public and private, national and international sponsors on subjects regarding seismic analysis, design, retrofit, rehabilitation of concrete and masonry structures, risk analysis of structural systems, involving theoretical, numerical and experimental research activities.
Key personnel: Assoc. Prof. Guido Magenes, Dr. Timothy Sullivan, Dr. Andrea Penna, Dr. Paolo Morandi, Eng. Sanja Hak (UNIPV); Prof. G. Michele Calvi, Eng. Davide Bolognini (EUCENTRE).
Assoc. Prof. Guido Magenes: Associate Professor of Structural Engineering at the University of Pavia, local coordinator of the research unit. Head of the Masonry Division of EUCENTRE; member of the advisory board and teaching body of the ROSE School (European School for Advanced Studies in "Reduction of Seismic Risk") of Pavia; member of the Directing Board of the national consortium "RELUIS" (Network of the University Laboratories of Seismic Engineering); member of CEN/TC 250/SC 6 “Design of masonry structures”, convenor of the Italian national mirror committee SC6 Eurocode 6 and member of the Italian working groups for the National Technical Norms and the National Appendixes to the Structural Eurocodes. Author or co-author of over 160 scientific publications in great part devoted to masonry and reinforced concrete structures and national coordinator of several research projects on the seismic behaviour of masonry structures.

Prof. Gian Michele Calvi: Professor of Structural Engineering at IUSS Pavia, Director of the European Centre for Research and Training in Earthquake Engineering (EUCENTRE) Pavia, Director of the Centre of Research and Graduate Studies in Earthquake Engineering and Engineering Seismology (ROSE School), is an internationally recognized expert in seismic engineering with special reference to reinforced concrete and masonry structures. He has published more than 300 papers, is co-author of two internationally published books, is member of the board of Directors of the International Association for Earthquake Engineering (IAEE) and is Associate Editor of the Journal of Earthquake Engineering. He has coordinated numerous international research projects, and has been involved in the seismic design or verification of several hundreds of buildings and bridges worldwide, including a large rapid reconstruction project after the L'Aquila 2009 earthquake.

2.1.2.9 Partner n° 09 (RTD) – NTUA – GR

The **Department of Structural Engineering from the National Technical University of Athens** is a part of a public Greek University. NTUA is active in research and teaching (in under- and post-graduate level) related to reinforced concrete and masonry structures (including historic structures). The research carried out at NTUA includes analytical work and experimental work. The testing facilities comprise a 6-degree of freedom shaking table, a strong floor and a reaction wall for testing full scale specimens, actuators, data acquisition systems, etc. In the work carried out at NTUA, emphasis is given to the behaviour and design of structures under seismic actions, as well as to (pre- and post-earthquake) interventions to existing structures. Monitoring and dynamic identification of structures is another field of excellence of NTUA. The group of NTUA is also active in code-making on a national and international level.
The group involved in the project is active in experimental and analytical work related to the behaviour and design of rc and masonry structures. The seismic behaviour of masonry infilled rc structures was analytically and experimentally investigated (see list of publications). The group is in close cooperation with the Association of Brick Producers (SEVK) in an effort to improve the quality of infills in the country.
Key personnel: Elizabeth Vintzileou, Prof. C. Spyrakos, and Dr Harris Mouzakis, Asst Professor
Elizabeth Vintzileou, Professor at the Department of Structural Engineering, teaches rc and Masonry structures, as well as a course on seismic behaviour and design of rc structures. National representative for Eurocode 6, reviewer of papers in 6 international periodicals, 40 research projects (scientific person in charge for over 25), evaluator of proposals and of research projects for the General Secretariat of Research and Technology, Member of the Administrative Council of the Earthquake Planning and Protection Organization, as well as of the Central Council for modern and contemporary monuments (Hellenic Ministry of Culture). She has authored/co-authored more than 1560 papers related to the behaviour and design of rc and masonry structures. **Prof. Constantine Spyrakos,** Director of the Laboratory of Earthquake Engineering, was graduated in Civil Engineering, NTUA. He is specialised in Earthquake Engineering, Seismic Rehabilitation of Structures, Experimental Earthquake Engineering, Soil- Structure Interaction. Author of three books on Structural Dynamics, Linear & Nonlinear FEA Analysis of Structures and Repair & Strengthening of Structures for Seismic Loads. Author of over 200 papers in referred journal publications and conference proceedings. Editorial board of international journals and scientific publishing institutions. Principal investigator of over 50 research projects funded by USA, EC and the Industry. ***Asst. Prof. Harris Mouzakis*** was graduated in Civil Engineering, NTUA. He specializes in large scale laboratory testing, analysis and in situ measurements and monitoring of historic structures. He has participated/is participating to numerous research projects He has authored/co-authored more than 30 papers related to the seismic behaviour of structures. During the construction of the Athens Metro, he has conducted in situ measurements related to ambient vibrations, to monuments and historic structures within the region of the metro sites, etc. He has carried out in situ measurements in numerous bridges and buildings, whereas he is responsible for the monitoring system of important Byzantine monuments in Greece.

2.1.2.10 Partner n° 10 (RTD) – UKASSEL – DE

The **Institute of Structural Engineering** is part of the Faculty of Civil and Environmental Engineering of the **University of Kassel**, a public institution. The Institute has four working groups on Concrete and Masonry Structures, Steel and Composite Structures, Timber Structures and Building Rehabilitation, and Structural Materials. The institute is very active in the field of seismic design of structures, especially with regard to masonry structures, seismic base isolation, and development and application of innovative testing techniques. Further interests are related to design and behaviour of structures using innovative materials, such as Ultra High Performance Fibre Concrete (UHPC), glued connections, and strengthening by fibre reinforced polymers. Structural Health Monitoring and Structural Identification using experimental vibration analysis are a further focus of research. The laboratories of the Institute comprise a 9m*17 m strong floor facility with reaction frames for loading in 3 dimensions (vertical loading up to 5 MN, a modular system for horizontal loading with several hydraulic ±400 kN cylinders), a stiff tension/compression testing machine with 6.3 MN capacity, a minor 2-D shaking table as well as several standard testing machines. The materials lab is equipped with several analytical instruments including a scanning electron microscope and a scanning force microscope. In addition to the laboratory capacities the institute is working with own and commercial Finite-Element software packages for nonlinear structural analysis. The group successfully has organized several national and international conferences with up to 300 participants.
Key personnel: Prof. Dr.-Ing. Ekkehard Fehling, Prof. Dr. -Ing. Uwe E. Dorka, Prof. Dr. -Ing. Werner Seim, Prof. Dr. rer.nat. Bernhard Middendorf, Dr. phil. nat. Alexander Wetzel, Dr. -Ing. Torsten Leutbecher, Dr.-Ing. Thomas Hahn. **Prof. Dr.-Ing. Ekkehard Fehling**: Graduation in Civil Engineering (Dipl.-Ing.) 1983, and PhD (Dr.-Ing.) 1990 at Technical University Darmstadt. Former Dean and Vice Dean of the Faculty, Head of the Concrete and Masonry Structures Group. Convenor of the DIN- Committee for Aseismic Design. Specialist for reinforced and Prestressed Concrete Structures, Fibre Concrete and UHPC. Consulting Engineer and Licensed Checking Engineer for R/C and P/C, Masonry, Steel and Composite Structures as well as for Railway Structures. Author/coauthor of over 100 publications, member of several task groups of fib. Previously involved in numerous national and international R&D projects and working committees, e.g. as Technical Coordinator of the European collective research project ESECMaSE.

2.1.2.11 Partner n° 11 (RTD) – CTCV – PT

CTCV is a private, non-profit organisation, founded in 1987 by a common agreement between Industrial Federations and Governmental Agencies of the Ministry of Economy of Portugal. It was created to support the Ceramic and Glass industries on a nationwide basis. Its main goals may be summarised as: to provide technical and technological support to the ceramics, cement and glass industries; to promote the development and quality of industrial products and processes; to promote highly specialised training to industry personnel; to divulge scientific, technical and technological information; to carry through and promote research, development and demonstration work, considering the scientific and technological progress of the ceramic, cement and glass materials processes and products. CTCV has close links with several Universities and Research Centres, both in Portugal and abroad. CTCV laboratories are accredited by Portuguese System for Quality (Instituto Português da Qualidade),according to EN ISO/ IEC 17025, by AAMVA-American AMECA ance Agency, Inc. (for the safety glass) and by European institutions within the framework of CerLabs-European Network of National Ceramic laboratories.
CTCV has extensive experience in New Products Design and Engineering, Technological and Laboratory Analysis, Implementation of Technological Innovation. CTCV has a wide range of services including: Total Quality Systems implementation, Analysis and Testing (testing of materials like finished ceramics and glass products, materials analysis, physical and technological materials characterisation, structural and micro structural characterisation of materials), Systems & Industrial Operations (direct industrial assistance, raw materials management, functional design, industrial project and engineering, energy and environment management), Specialized Training, Research and Development (classical ceramic and glass materials, new materials and technologies, advanced ceramic based thermal coatings), New products Design and Engineering,

Technological Innovation and Organizational Processes Implementation, Information technologies applied to management and applied R&D projects development.
Key personnel: **Dipl.-Eng. Baio Dias**: Chief Engineer, has an extensive experience in ceramic industry, responsible for CTCV overall support to ceramic industry, has developed MSc Thesis at Coimbra University in characterization of mechanical and thermal behaviour of bricks and new geometry design; His research area is actually the development of masonry elements structures; Author of several scientific publications and textbooks.

2.1.2.12 Partner n° 12 (RTD) – METU – TR

The Earthquake Engineering Research Centre at **METU** Middle East Technical University (METU), Ankara (eerc.ce.metu.edu.tr) is active in several fields of activity: microzonation, earthquake insurance, risk and mitigation, establishment of strong motion arrays, mitigation of disaster losses and economic impact, Master Plans for metropolitan areas, large scale urban housing retrofitting, rehabilitation of damaged buildings, development of rapid retrofit techniques applicable in urban buildings and innovative solutions to effective structural intervention/verification. The research group listed below has taken part in various activities of the LESSLOSS, 2007. Faculty members have also been participants in at least two other EU FP6 programs: SEAHELLARC and TRANSFER. METU was among the technical coordinators of the Istanbul Earthquake Master Plan project supported by the Istanbul Metropolitan Municipality. METU has also participated in the State-of the-Art-Report on “Seismic Microzonation for Municipalities”, prepared by DRM in 2004. Currently, METU conducts the “Compilation and standardization of Turkish strong ground-motion database” that is funded by the Turkish Scientific and Technological Research Council. METU also acts as the NATO project director of the NATO Science project entitled “Harmonization of seismic hazard maps in Western Balkans” and participates in the current FP7 project SHARE. METU is taking part in an ongoing FP7 project SYNER-G that started in 2010. The staff members have been involved in many research projects and consultancies with the UN, World Bank, EU Commission, NATO, OECD, IAEA, as well as served as consultants for large national rehabilitation and assessment projects, seismic safety evaluation and retrofitting of reinforced concrete and historic structures. They have been involved in several national and international (EU) research projects related to the seismic performance of existing unreinforced masonry and rc structures. They are organizer for national and international conferences, and editor for the most world-wide renown international journal on earthquake engineering, and have a number of peer-reviewed technical papers published in the well-recognized journals in this research area.
Key personnel: Polat Gülkan, Ahmet Yakut, Baris Binici, Oguz Gunes, Murat Altug Erberik, Erdem Canbay.
Polat Gülkan graduated at METU (1966) and University of Illinois, Urbana-Champaign (1971). He served as professor of structural engineering at METU, and was director of the Earthquake Engineering Research Centre, until his retirement in 2011. He has now joined the academic ranks of Çankaya University. He is registered PE in California. His work has dealt also with earthquake hazard, culminating in the earthquake hazard zones map for Turkey that went into effect in 1996. He has served on the Board of Directors of the International Association for Earthquake Engineering (IAEE) during 1996-2004, and was executive vice president of the same organization from 2004. He was elected to the presidency of IAEE in 2008, and is currently serving as President for the period 2010-2014. He was also on the Board of Directors of Earthquake Engineering Research Institute (EERI) for the period 2005-2008. **Ahmet Yakut:** Prof. at METU. Graduated of METU (BS in 1989, M.S. in 1992) and the University of Texas at Austin (PhD in 2000). He has worked at AIR, Inc. Boston, USA as a Senior Research Engineer responsible for seismic risk modelling for earthquake insurance (2000-2002). His areas of research cover earthquake engineering, seismic risk analysis, seismic performance and strengthening of RC structures, vulnerability of buildings and bridges. He has over 20 papers in the field of earthquake engineering, structural analysis, seismic risk and performance assessment published in well recognized international journals. **Barış Binici:** Prof. of Civil Eng. at METU. He researches the behaviour and design of reinforced and prestressed concrete structures focusing on testing and non-linear modelling of full-scale structural components. **Oguz Günes**, Assist. Prof., in the Dept of Civil

Engineering at Cankaya University, Ankara, Turkey. **Murat Altug Erberik**, Assoc. Prof. at METU, conducts research on the vulnerability of masonry and rc structures. **Erdem Canbay**: Assoc. Prof. at METU, graduated from İstanbul Technical University in 1992 and studied at METU receiving his M.S. (1995) and PhD (2001) there.

2.1.2.13 Partner n° 13 (SME) – RUREDIL – IT

Ruredil has been manufacturing building technology, which ranges from chemical admixtures for concrete and cement for ready-to –use- non shrink mortars, to products for the protection and waterproofing of works, for over 30 years. Ruredil boasts an efficient technical and marketing organization, formed by direct staff and 54 agents in Italy, assisting project engineers and contractors in solving specific building problems. Moreover, it has agents throughout a number of European and extra-European countries.
Many of the Ruredil resources are devoted to its own Research Centre, which works in close collaboration with University Engineering and applied Chemistry faculties, as well as with public and private research institute. (CNR – Italian University). Ruredil firmly believes that eco-sustainable policy, experimentation, testing and technological expansion are the fundamental principles for steady, innovative progress where products and services are concerned.
Key personnel: Dr Giovanni Mantegazza, Eng Sabina Valentino, Mrs Elena Alberti, Mrs Alessandra Gatti, Mr Diego Curtarello, Mrs. Antonella Catia Guerra.
Dr Giovanni Mantegazza, who has a degree in Chemistry is presently working for Ruredil Spa in Milan-Italy- where he is Technical Director . He is engaged for the development, marketing and technical advice of new technology and materials. He has published more than 100 papers in the field of building constructions (admixtures, repair mortar, reinforced cementitious materials for concrete and masonry structure). Besides He is an inventor of some of European and International Patents. **Eng. Sabina Valentino** who has a degree in Structural Engineering is working in Ruredil's Technical Department as specialist in designing for structural repair of concrete and masonry. She is particular skilled in development high performance materials (Mortars, FRCM, FRP), new testing methods, design and application. **Mrs Elena Alberti** who has a technical chemistry degree, is working in Ruredil's Technical Department as specialist in mortar for masonry and concrete repair. **Mrs Alessandra Gatti** is working in Ruredil's Technical Department as specialist in structural reinforcement of masonry and concrete structure. **Mr Diego Curtarello** who has a technical chemistry degree is working in Ruredil Technical Department as specialist in application and testing of mortars for concrete structural repair. **Mrs Antonella Catia Guerra** is Ruredil Technical Director's assistant and Ruredil Quality Manager. She is particular skilled in managing the relations between Public and Private Institution and Ruredil Technical / Administration depts.

2.1.2.14 Partner n° 14 (SME) – SDA – DE

SDA-engineering GmbH is a dynamic company highly active in the fields of structural dynamics, earthquake design and earthquake hazard assessment worldwide, with a strong background in structural engineering and software development. An important business segment is the plant engineering with structural design of industrial plants, components of power stations and machine foundations subjected to dynamic loading. A part of this work is the probabilistic seismic hazard assessment (PSHA) which has to be carried out for important plants and power stations. Furthermore SDA has considerable activities in the field of seismic design and retrofitting of buildings, many of which are of masonry, including historic and planed buildings. SDA has already developed software packages for silos (EASYSilo), signal processing (SeisPRO), risk and vulnerability assessment (SVBS) and seismic design of masonry structures (MINEA). All packages are successful introduced into the engineering practice.–SDA is working in close cooperation with RWTH Aachen University and is acting as a qualified industrial partner within research projects.
Key personnel: Dr.-Ing. Christoph Butenweg, Dipl.-Ing. Christoph Gellert
Dr.-Eng. Christoph Butenweg: Business manager and associate of the engineering company SDA-engineering GmbH since 2006; Chief Engineer of the Chair of Structural Statics and

Dynamics, RWTH Aachen University since 2001; Board member of the DGEB and DIN committee on seismic design of structures; Author of over 120 scientific publications and 3 textbooks on structural dynamics and statics; Leader of several research projects supported by the German science foundation and industrial partners.
Dipl.-Eng. Christoph Gellert: Business manager of the engineering company SDA-engineering GmbH since 2010; Research assistant at the Chair of Structural Statics and Dynamics, RWTH Aachen University between 2004 and 2010 with special reference to the numerical simulation of masonry structures; Chief developer of the software package MINEA (Design of masonry structures under seismic loading) since 2007; Coordination of several construction projects with focus on the seismic design of masonry structures.

2.1.2.15 Partner n° 15 (SME) – XALKIS – GR

The company-XALKIS S.A., has a history of half a century and two manufacturing plants, one in Vassiliko, in Evia, manufacturing roofing tiles and one in Schimatari, in Viotia, manufacturing bricks, is one of the most important Greek industries in the field of tile and brick manufacture. The outcome can be summarized in the numbers representing the daily production of superior quality certified products (900 tons of and 150,000 tiles). XALKIS S.A. invests on the constant upgrading of the quality of its products, on keeping up with the advancements of technology, on respecting the natural environment (Since 2000, Schimatari plant is linked to the natural gas pipe; it is one of the most environment friendly fuels. Furthermore, the gases of the kilns are filtered and more filters have been installed to capture the dust during the drying-grinding-flattening of the earth; moreover, all the waste of the production process are immediately recycled), on supporting in a friendly and reliable way the customers who entrusted it with small and large-scale projects, such as: the International Athens Airport "Eleftherios Venizelos", Athens Concert Hall (Megaron Mousikis), Athens Metro, Waste Management Centre of Psittalia, "Onassion" Heart Surgery Centre, Olympic Village, Reconstruction of the Athens Olympic Sports Complex, Olympic Sailing Centre, Elliniko Olympic Complex, Ano Liossia Hall, Olympic Weightlifting Hall, Olympic Equestrian Centre, Olympic Rowing Centre, Olympic Press Village, International Broadcasting Centre etc.
The company is constantly seeking quality, follows all advancements of technology and continuously modernizes its facilities; this is the reason it obtained the following certifications: in February 2000 it obtained ISO 9001 for the design and production of its products; it was renewed in July 2003 and then, again, in July 2006; it is an additional guarantee regarding absolute control throughout the production process (processing of the raw material, shaping, drying, firing, packaging). In December 2005 the company obtained a Certificate of Conformity with the Environmental Management System as per EN ISO 14001. The products of XALKIS S.A. are in conformity with the highest European quality control standards set for the quality control of fired clay roofing tiles and bricks; constant laboratory tests realized under the supervision of the Technology Development Institute for Terra Cotta and Refractory Materials (EKEPI), guarantee the best quality.
Key personnel: P. Hatiras, Electrical Engineer, New Business Director; **K. Deligiannis,** Chemical Engineer, responsible for the Quality Check; **V. Vavoulioti**, Financial Manager, **M. Stamatakis, A. Vavouliotis, N. Mastrogiannis, G. Chouliarakis**, Conservators.

2.1.2.16 Partner n° 16 (SME) – H.I. STRUCT – RO

SC H.I. STRUCT S.R.L. is a Romanian company founded in 1997 by Prof. Eng. Victor Gioncu and PhD. Eng. Marius Mosoarca, and has very dedicated personnel of structural engineers. The company makes projects of structural design for administrative buildings; banks; production buildings and offices; representations; commercial buildings; hotels and boarding houses; train stations, churches, monasteries. Technical expertise ranges among hospitals, schools, churches and other types of buildings. Projects of structural design for residential quarters and over 100 house projects. The company is very dedicated to research; its interests include strengthening of historical buildings; analyses of seismic behaviour of buildings; industrial archaeology; structural

engineering. The company has participated in many conferences and in several funded research projects and in the European research contract PROHITECH.
Key personnel: Prof. Eng. Victor Gioncu, Phd Eng. Marius Mosoarca.
Prof. Eng. Victor Gioncu: Graduated at the Polytechnic Institute from Timisoara, at the Faculty of Civil Engineering. PhD in 1971, Professor at the Polytechnic University Timisoara, Faculty of Architecture. Member of the Academy of Technical Sciences of Romania. He is researcher in the field of structures made of bars with thin walls, stability of metallic and concrete structures and was Head of National Institute of Research in Construction INCERC Timisoara. He has specializations for engineer as Technical expert, Specialist and Project verifier. He taught courses as invited professor at Universities like: England, Guildford; Brazil, Rio de Janeiro; Hungary, Budapest; Italy, Udine. He has 14 written books: The number of papers published in conferences and international journals are over 250 in all the above mentioned domains of research.
PhD Eng. Marius Mosoarca: Graduated the Faculty of Civil Engineering, PhD in 2004. His main activity fields are restoration and structural design. He has received 2 awards for professional activity. He is member in the Association of Design Engineers (A.I.C.P.S.). He works since 2009 at Polytechnic University of Timişoara, where he teaches Restoration of historical structures; Structural design; Industrial buildings. Since 2009 he is given the title of Specialist at the Ministry of Culture for inventory and classification of buildings with patrimony value. His research themes are**:** strengthening of historical buildings; analyses of seismic behaviour buildings; industrial archaeology; structural engineering; reinforced concrete. He has one published book and has participate at many conferences and presented there his research projects.

2.2 Appropriate allocation and justification of the resources to be committed

2.2.1 Overview of costs

The estimated costs of the project are presented in Tables 2.2a and 2.2b below. At this stage, it is clear among partners that SME-AGs and SMEs subcontract RTD and demonstration activities of the RTDPs and will be reimbursed of a great part of the subcontracting of the RTD activities. It was decided that all partners (SME-AGs, RTDPs, and other SMEs) will receive a contribution to partially cover the management and other costs, which indicates that all partners will make an investment, with SME-AGs and SMEs contributing more consistently to the project. Hence, the non-EC contribution of 824.327 € will be provided by the project participants mainly out of services in-kind, and eventually paid for out of their own financial resources. Each participant has confirmed, by accepting the terms of the project Consortium Agreement, that it has sufficient resources to cover its agreed contribution to the work program (and post-project exploitation activities). All SMEs and OTH partners have financial autonomy, being able to support the financial effort of the project.

Table 2.2a Project Costs Summary

Total costs for RTD	€	2245789	70%
Total costs for demonstration	€	226948	7%
Total costs for management	€	249122	8%
Total costs for other activities	€	472760	15%
Total project costs	€	3194618 *	
Total value EC-contribution	€	2519697	
Total subcontracting to RTDPs	€	2154810	
Max EC contribution (110% subcontract)	€	2370291	74%
Own in-kind contribution	€	824327	26%

The EC contribution will be allocated to the different participants, as a rule remunerating, first of all, the RTDPs for their RTD and Demonstration activities. The maximum EC contribution is 2.370.291 €, the remuneration to RTDPs is 2.154.810 €, hence the remaining EC contribution is 215.481 €. The remaining contribution will be distributed according to a share rule among the participants in proportion to the costs of their own management (249.122 €) and other activities (472.760 €) - total own costs 721.882 €. Table 2.2b also shows the distribution of the EC contribution among the Consortium Participants. Tables 2.2c show breakdown of the offer from the RTD Performers to the SME-AGs, whereas Tables 2.2d show the overall indicative breakdown of costs, divided per activity type (RTD, demonstration, management, other) and per cost voice.
Based on the large effort of RTD activities, it should be stressed that the total budget of this project (3,2M€) and the maximum related EC contribution (2,4 M€) is fully justified and very low compared to the annual value of the related market (4,5 to 6,5 billion €, i.e. 40% to 60% of the entire clay market, 10,6 billion €). The contribution of SME-AGs is considered marginal (8% of the R&D activities staff effort) and perfectly compatible with the strategy of the SME-AGs to lay on the research and innovation to improve their members competitiveness. It is important to make clear that the SME-AGs will be the main owners of the project results and will be able to fully exploit all the knowledge and the products resulting from the project. Arrangements on IPR are described in Section 3.2 of this proposal and specific matters related to cost of the project are described also in this section.

2.2.2 Personnel contributions in Research and Technical Development activities

The successful accomplishment of the project objectives requires a critical mass in terms of background knowledge, research facilities, industrial production capacity, material and research resources, human and budget resources. The proposed project brings together this critical mass of different specialization, experience, know-how and qualifications in an international and interdisciplinary team to guarantee the successful realization of the project. In particular, the research activities described require an important number of personnel possessing different skills.

Thus, the personnel resources are considered to be well balanced given the complexity of the tasks.
In the project there is a strong effort for development of materials and construction systems (WP3), numerical simulation of the static and dynamic behaviour of frames and masonry walls with definition of design procedures (WP4), experimental characterization of masonry materials, and of enclosure masonry walls both with quasi-static and dynamic combined in-plane and out-of-plane tests (WP5), technical/economic assessment (WP6), preparation of software and design guidelines (WP7). In particular, experimental activities are very time consuming and involves a work-team with qualified laboratory technicians and researchers. For this reason, the costs for RTD personnel as can be inferred by Tables 2.2c represent a significant cost of the project. In some specific portion of the research program, the RTDPs, carrying out the major part of the R&D activities, will be also aided by the SME-AGs and SMEs, particularly for what concern material and construction system development and technical/economic assessment of feasibility (all SME-AGs and XALKIS, RUREDIL, and H.I.STRUCT; WP3 and WP6), and design guidelines and software development (H.I.STRUCT and SDA; WP7). The costs for this personnel can be inferred from Tables 2.2d.
The number of person-months that each participant has allocated to the WPs has been calculated on a task-by-task basis, depending on their contribution to the work program. The total allocation of personnel effort can be seen in the effort Table 1.4d and is of 415 person-months in overall, of which 342 person-months are allocated to Research & Demonstration activities. Of these, 282,5 person-months are proposed to be subcontracted for research to the RTDPs; 24,5 person-months are directly deployed by SME-AGs, mainly working on WP3 and WP6; and 35 person-months are deployed by the other SMEs participating in the project. The subcontracted work to the RTDPs is broken down in terms of cost categories and Project Results for each Work Package in Table 2.2c.
Finally, as the RTDPs will retain the ownership of some project results related to numerical modelling (results 9 to 11, see IPR description in Section 3.2), although they will give full (free) access-right to their results to SME-AGs, the allocation of person-months and costs considered in the project take into account this fact. Indeed, considering the complexity of the numerical work to be carried out, it is foreseen that the RTDPs will work more person-months in WP4 than those presented in the effort Table 1.4d, and justified in terms of cost in Table 2.2c. This will amount to about 20 person-months of work, for a corresponding overall amount of 70.000 €, taking into account the different labour costs in the various countries involved.

2.2.3 Mobilization of own research facilities and costs for durable equipment

The knowledge and research facilities have been shortly addressed in Section 2.1. The RTD performers concentrate the major RTD activities, and are expected to provide or consolidate a tremendous amount of knowhow to the SME-AGs and SMEs partners, enabling them to develop new products to the market and find a rather fast return of the investment. In the research program, it is foreseen to carry out a large experimental activity, with parallel (but not overlapping) activities that will be carried out in Portugal, Italy, Germany, Greece and Turkey. At least six distinct masonry enclosure systems (but may be more), that can easily be adapted to the own national and possibly international markets following the tradition and needs of each one, will be tested under the mechanical and physical point of view. Of these, at least two selected systems will be also dynamically characterized on shaking table. Thus, the project stands on very strong testing activities, which will consume considerable (and already existing, as regard equipment and know-how, at the RTDPs premises) resources.
This is the reason why all partners are active in the experimental characterization (WP5), and have been selected for their Expertise and very well equipped testing laboratories, which are essential for extensive planned experimental program. The testing equipment found in the testing laboratories of UNIPD; UMINHO; UNIPV; NTUA; UKASSEL and METU amount, in values, from 1 million Euros to about 2-3 million Euros each. It has to be reminded that each laboratory has several testing machines and systems up to very high load capacity (up to 10 MN), which are displacement controlled by precision hydraulic systems, uses strong reaction floors and walls to work and high frequency electronic systems for data recording. Some laboratories (UNIPD, UMINHO, NTUA) are also well equipped to carry out non-destructive on-site testing and dynamic identification. The approximate costs of these equipment ranges to about 10 million Euros. In

addition, NTUA, which is leading WP5, has an installation which is part of the network of shaking table in Europe, and has been selected together with UNIPV-EUCENTRE as they are among the most advanced and active earthquake engineering laboratories in Europe. The cost of these installations is not even quantifiable.
To carry out the shaking table tests, UNIPV (INSYSME project beneficiary) will make use of the EUCENTRE TREES lab, with UNIPV leading and coordinating the research work. EUCENTRE can be thus considered as third party linked to UNIPV, and will be identified in special clause n. 10 of Article 7 of the ECGA. EUCENTRE is a non profit Foundation launched by the University of Pavia and other public bodies, with the aim of promoting, sustaining and overseeing training and research in the field of seismic risk reduction. UNIPV is also founding partner and has an established relationship of mutual collaboration between its Laboratory of Materials and Structures of the Structural Mechanics Department and the TREES lab (with shaking table and reaction wall facilities) at EUCENTRE. At this aim, a formal agreement between UNIPV and EUCENTRE has been signed and is still active, with a duration that goes beyond the duration of the INSYSME project. For this reason, G.M. Calvi and G. Magenes are both professors at UNIPV, but are also Director (G.M. Calvi), and member of the Coordinating Committee and Chief of the Masonry Division of EUCENTRE (G. Magenes). UNIPV and EUCENTRE share the same premises in Pavia.
Besides, the project envisages detailed numerical modelling and analyses, intending also proposing a design software for enclosure masonry walls. The equipment needed to carry out computing can be also found at the RTDPs partners involved in the research and their overall value amount to some hundred thousand Euros. In this task distinct modelling strategies will be followed in order to make clear their potentialities.
It is clear that the equipment owned by the RTDPs, necessary to fulfil the project tasks, have a value which is tremendously higher than the same required EU-funding. The cost for durable equipment by RTDPs, as inferred from Table 2.2c, is thus limited to a minimum (UNIPD and UKASSEL: 20.000; UMINHO: 1.500 €; UNIPV: 6.000 €; NTUA: 22.500 €; METU: 10.000 €), and mainly refers to small laboratory equipment (such as load cells, etc.) that require a constant update, and to dedicated PC or workstation that will be purchased exclusively for the project.

2.2.4 Costs for consumables, computing, and other costs for RTD

The cost for consumables in research activity by RTDPs, as inferred from Table 2.2c (UNIPD: 22.000 €; UMINHO: 35.500 €; UNIPV: 93.100 €; NTUA: 59.000 €; UKASSEL: 15.300 €; METU: 44.500 €), mainly consist in the adjustments of the existing laboratory testing setups, to carry out experimental tests concerning WP5. Indeed, although the equipment already exists, there is always the need of update the structural layout of the testing in order to comply with distinct configuration, boundary conditions and geometries of the specimens. Examples of these expenses are special reaction and/or connection elements to fix the specimens, adjustment of the steel frames through the update of the control systems or the update of data acquisition systems for the online processing of the data. This type of expenses is mainly concentrated in WP5, as a huge amount of consumables is needed in order to test real scale walls and prototype buildings. For the measurement of displacements and deformations also a certain amount of consumables like strain gauges, cables and other laboratorial materials are needed such as other minor sensors and adhesives are required. Hence, expenses for consumables are foreseen for all RTD performers, according to their degree of involvement in WP5.
Minor expenses are related to purchase of materials for trial tests in WP3. The costs claimed under this voice by the SMEs participating in the project (overall 20.500 €) refers to materials used for the production of materials to be delivered to the laboratories and construction of test specimens and trial walls, and include raw materials for the production of units and adjustments in production lines (XALKIS), reinforcements and fastenings (RUREDIL), it refers to software licence maintenance for H.I.STRUCT.
Some of the RTD performers foresee also minor expenses (UNIPD: 5.000 €; UMINHO: 3.000€; NTUA: 7.000 €; UKASSEL: 6.000 €) for the maintenance of the software codes expressly used in the scope of the project (mainly modelling of materials and of masonry walls in WP4 and data acquisition and analysis in WP5). In general, appropriate software licenses are already available at the RTD performers. Due to the amount of modelling involved in the project, besides maintenance

of existing licenses, second licenses will be purchased. Some of the SMEs also foresee minor expenses of travel under the RTD voice (overall 3.500 €), mainly related to travels to/from the RTD premises to discuss product developments and to assist to tests.
Subcontracting under the RTD activity by RTDPs is practically limited to a minimum (UNIPD: 20.000; UMINHO: 15.000) and it is mainly related to invoices to contractors for specimen construction and to arrangements of the test setup that requires specialized workmanship.

2.2.5 Costs for non-RTD activities

The non-RTD activities consist of demonstration activities, management of the consortium and other activities, where dissemination training and exploitation have been taken into account. Estimates of costs for the various activities are presented in Table 2.2d, apart for demonstration activities carried out by the RTDPs that are included in their offer to the SME-AGs and SMEs (Tables 2.2c). These costs are based again on personnel time, plus a provision for the associated travels and subsistence, etc. The non-RTD activity costs can be summarized as follow.
Demonstration activities will cover mainly staff time (45 person-months have been allocated equitable distributed among RTDPs -25,5 PM-, and SME-AGs and SMEs -19,5 PM-). The total cost (226.948 €) mainly covers the personnel costs for finding the site, applying the design rules, making feasibility studies, and for implementation. The case studies (real walls) will be built on real-construction sites, thanks to the established relationship occurring between Associations/single companies and contractors, avoiding any major additional cost (consumable, durable, etc) to the project. Visits to the construction sites and promotional leaflets/video, etc. will be partially covered by expenses for publication in WP2, but will be mainly directly paid by the Associations, as they are related to the exploitation phase following the project.
Management costs have been estimated around 249.122 € based on anticipated staff time. We foresee an expenditure of about 27 person-moths, where 12 person-months are allocated to the project coordinator for the financial and administrative management of the entire project and consortium, the remaining 15 person-months are distributed among the other 15 partners (for the internal administrative and financial management of each partner). Under this voice, the SME-AG that will receive a financial contribution higher than 375.000 € (ANDIL) has also considered the expenses for subcontracting to carry out the financial audit. UNIPD, being the project coordinator, foresees a subcontract of about 3.500 € to a web-designer for the creation and the management of the project web-site. The main cost under the management voice is constituted by travels to/from the project meetings. These have been evaluated at a cost, on average, of 5.500 €, including 7 meetings in different places in Europe. The project coordinator has been accounted for with a higher expenditure as, during project meetings, he will probably need to participate to the meetings with higher number of staff.
Other costs of 472.760 € have been allocated for training and dissemination activities, better described in Section 3.2. These promotional activities are target at different types of audience, hence will be carried out by all the actors of the INSYSME project. For this reason, the overall amount of staff effort foreseen (46 person-months) is equitably distributed among SME-AGs (16,5 PM), RTDPs (18,5 PM), and SMEs (11 PM). Overall, apart from the staff-time, which constitute the major costs of dissemination, the costs will include travel expenses, exhibition stand rentals, marketing and dissemination materials such as leaflets, poster, DVD, etc, costs for organizing training courses etc., and these activities are subdivided among the cost voices of travel, training and consumables, and minor costs of subcontracting (1.500 €). Minor costs are also related to durable equipment (1.500 €), to be specifically purchased for the setting up and organization of the dedicated training course.

Table 2.2b Estimated Cost Breakdown for the INSYSME project.

	RTD		DEMONSTRATION		MANAGEMENT	OTHER ACTIVITIES	TOTAL COSTS	CONTRIBUTION		
	Own Activities	Subcontracting	Own Activities	Subcontracting				MAX EC contribution	Distribution EC contr	Own in-kind contr
1 UNIPD - IT	€ -	€ -	€ -	€ -	€ 57260	€ 40640	€ 97900	€ 97900	€ 21112	-€ 76788
2 TBE - BE	€ 18000	€ -	€ 12000	€ -	€ 10200	€ 27600	€ 67800	€ 57300	€ 13000	-€ 54800
3 ANDIL - IT	€ 14400	€ 579041	€ 33600	€ 46859	€ 18300	€ 42900	€ 735100	€ 546510	€ 647900	-€ 87200
4 ZIEGEL - DE	€ 31752	€ 327880	€ 4536	€ 22400	€ 12268	€ 48672	€ 447508	€ 344132	€ 364280	-€ 83228
5 APICER - PT	€ 4352	€ 288062	€ 2901	€ 52640	€ 12501	€ 16352	€ 376808	€ 275934	€ 351702	-€ 25106
6 TUKDER - TK	€ 6400	€ 307360	€ 3200	€ 5504	€ 15200	€ 11200	€ 348864	€ 266072	€ 322864	-€ 26000
7 UMINHO - PT	€ -	€ -	€ -	€ -	€ 12320	€ 39747	€ 52067	€ 52067	€ 11228	-€ 40839
8 UNIPV - IT	€ -	€ -	€ -	€ -	€ 17600	€ 35200	€ 52800	€ 52800	€ 11386	-€ 41414
9 NTUA - GR	€ -	€ -	€ -	€ -	€ 14400	€ 36800	€ 51200	€ 51200	€ 11041	-€ 40159
10 UKASSEL - DE	€ -	€ -	€ -	€ -	€ 16800	€ 42800	€ 59600	€ 59600	€ 12853	-€ 46747
11 CTCV - PT	€ -	€ -	€ -	€ -	€ 11186	€ 35126	€ 46312	€ 46312	€ 9987	-€ 36325
12 METU - TK	€ -	€ -	€ -	€ -	€ 13504	€ 23008	€ 36512	€ 36512	€ 7874	-€ 28638
13 RUREDIL - IT	€ 25200	€ 148304	€ 10800	€ -	€ 7200	€ 29760	€ 221264	€ 172488	€ 163304	-€ 57960
14 SDA - DE	€ 61200	€ 15000	€ 10800	€ -	€ 12000	€ 21600	€ 120600	€ 96150	€ 30000	-€ 90600
15 XALKIS - GR	€ 39000	€ 352160	€ 5400	€ 9600	€ 10200	€ 15000	€ 431360	€ 326070	€ 376760	-€ 54600
16 H.I.STRUCT - RO	€ 27678	€ -	€ 6708	€ -	€ 8184	€ 6354	€ 48924	€ 38651	€ 15000	-€ 33924
TOTAL	**€ 227982**	**€ 2017807**	**€ 89945**	**€ 137003**	**€ 249122**	**€ 472760**	**€ 3194618**	**€ 2519697**	**€ 2370291**	**-€ 824327**
TOTAL amount of subcontracting, excl. VAT.								**€ 2154810**		
Max EC contribution (110% of Subcontracting to RTD performers)								**€ 2370291**		

Table 2.2c Indicative breakdown of the offer from the RTD performers to the SME-AGs and Other Enterprises.

Name of the RTD performer	No. of Person/month	Personnel Cost	Durable equip.	Consumables	Computing	Overheads	Other costs	TOTAL by RTD	Project Result no.	WP no.
UNIPD	1,0	€ 1.871				€ 1.123		€ 2.994	1	WP3
	1,0	€ 1.871				€ 1.123		€ 2.994	2	WP3
	1,0	€ 1.871		€ 1.000		€ 1.723		€ 4.594	3	WP3
	2,0	€ 5.613				€ 3.368		€ 8.981	5	WP3
	6,0	€ 22.446	€ 4.000	€ 7.000		€ 20.068	€ 5.000,00	€ 58.514	6	WP5
	7,0	€ 26.187	€ 12.000	€ 14.000		€ 31.312	€ 15.000,00	€ 98.499	7	WP5
	4,0	€ 14.964	€ 1.000		€ 2.500	€ 11.078		€ 29.542	9	WP4
	4,5	€ 16.838	€ 1.000		€ 2.500	€ 12.203		€ 32.540	10	WP4
	4,0	€ 14.964	€ 1.000			€ 9.578		€ 25.542	11	WP4
	4,5	€ 16.838	€ 1.000			€ 10.703		€ 28.540	12	WP4
	2,5	€ 9.353				€ 5.612		€ 14.964	13	WP3-WP6
	4,5	€ 16.835				€ 10.101		€ 26.935	14	WP6
	1,0	€ 3.741				€ 2.245		€ 5.986	15	WP7
	7,0	€ 26.187				€ 15.712		€ 41.899	16	WP7
TOTAL RECEIPTS								€ 382.523		

Name of the RTD performer	No. of Person/month	Personnel Cost	Durable equip.	Consumables	Computing	Overheads	Other costs	TOTAL by RTD	Project Result no.	WP no.
UMINHO	1,0	€ 2536				€ 1522		€ 4058	1	WP3
	1,0	€ 2530			€ 1500	€ 2418		€ 6448	2	WP3
	1,0	€ 2258				€ 1355		€ 3613	3	WP3
	2,0	€ 3599				€ 2159		€ 5758	4	WP3
	3,0	€ 5081				€ 3049		€ 8130	5	WP3
	4,0	€ 9616		€ 11000		€ 12370	€ 15000	€ 47986	6	WP5
	7,0	€ 19185		€ 15000		€ 20511		€ 54696	7	WP5
	1,0	€ 4580		€ 4000		€ 5148		€ 13728	8	WP5
	4,0	€ 8002	€ 1500	€ 1500		€ 6601		€ 17603	9	WP4
	7,0	€ 15997		€ 1500	€ 1500	€ 11398		€ 30395	10	WP4
	4,0	€ 11084				€ 6650		€ 17734	11	WP4
	2,0	€ 6501				€ 3901		€ 10402	12	WP4
	3,0	€ 4871		€ 1250		€ 3673		€ 9794	13	WP3-WP6
	3,0	€ 9575		€ 1250		€ 6495		€ 17320	14	WP6
	4,0	€ 13347				€ 8008		€ 21355	15	WP7
	4,0	€ 12894				€ 7736		€ 20630	16	WP7
TOTAL RECEIPTS								€ 289650		

Name of the RTD performer	No. of Person/month	Personnel Cost	Durable equip.	Consumables	Computing	Overheads	Other costs	TOTAL by RTD	Project Result no.	WP no.
UNIPV	1,2	€ 3.720				€ 2.232		€ 5.952	1	WP3
	1,2	€ 3.720				€ 2.232		€ 5.952	2	WP3
	1,2	€ 3.720				€ 2.232		€ 5.952	3	WP3
	1,2	€ 3.720				€ 2.232		€ 5.952	4	WP3
	1,2	€ 3.720				€ 2.232		€ 5.952	5	WP3
	5,0	€ 15.500		€ 3.100		€ 11.160		€ 29.760	7	WP5
	13,0	€ 40.300	€ 3.000	€ 90.000		€ 79.980		€ 213.280	8	WP5
	3,0	€ 9.300	€ 3.000			€ 7.380		€ 19.680	9	WP4
	3,0	€ 9.300				€ 5.580		€ 14.880	10	WP4
	3,0	€ 9.300				€ 5.580		€ 14.880	11	WP4
	3,0	€ 9.300				€ 5.580		€ 14.880	12	WP4
	1,0	€ 3.100				€ 1.860		€ 4.960	13	WP3-WP6
	10,0	€ 31.000				€ 18.600		€ 49.600	16	WP7
TOTAL RECEIPTS								€ 391.680		

Name of the RTD performer	No. of Person/month	Personnel Cost	Durable equip.	Consumables	Computing	Overheads	Other costs	TOTAL by RTD	Project Result no.	WP no.
NTUA	2,5	€ 4.500		€ 1.000	€ 1.000	€ 3.900		€ 10.400	1	WP3
	2,5	€ 4.500		€ 1.000	€ 1.000	€ 3.900		€ 10.400	2	WP3
	1,0	€ 2.500		€ 2.000		€ 2.700		€ 7.200	3	WP3
	3,0	€ 4.000		€ 5.000	€ 1.000	€ 6.000		€ 16.000	5	WP3
	7,0	€ 22.200	€ 5.000	€ 5.000	€ 2.000	€ 20.520		€ 54.720	6	WP5
	2,0	€ 8.000		€ 1.000	€ 2.000	€ 6.600		€ 17.600	7	WP5
	15,0	€ 45.000	€ 15.000	€ 35.000		€ 57.000		€ 152.000	8	WP5
	2,0	€ 8.400		€ 3.000		€ 6.840		€ 18.240	10	WP4
	3,0	€ 7.500	€ 2.500	€ 1.000		€ 6.600		€ 17.600	11	WP4
	1,0	€ 4.000		€ 1.000		€ 3.000		€ 8.000	12	WP4
	3,0	€ 3.000				€ 1.800		€ 4.800	13	WP3-WP6
	1,0	€ 3.000				€ 1.800		€ 4.800	14	WP6
	2,0	€ 6.000		€ 2.000		€ 4.800		€ 12.800	15	WP7
	6,0	€ 15.000		€ 2.000		€ 10.200		€ 27.200	16	WP7
TOTAL RECEIPTS								€ 361.760		

Name of the RTD performer	No. of Person/month	Personnel Cost	Durable equip.	Consumables	Computing	Overheads	Other costs	TOTAL by RTD	Project Result no.	WP no.
UKASSEL										
	2,0	€ 11.000				€ 6.600		€ 17.600	5	WP3
	2,0	€ 11.000	€ 5.000	€ 6.150		€ 13.290		€ 35.440	6	WP5
	11,0	€ 60.500	€ 15.000	€ 6.150		€ 48.990		€ 130.640	7	WP5
	3,0	€ 16.500			€ 2.000	€ 11.100		€ 29.600	9	WP4
	3,0	€ 16.500			€ 2.000	€ 11.100		€ 29.600	10	WP4
	3,0	€ 16.500			€ 2.000	€ 11.100		€ 29.600	11	WP4
	3,0	€ 16.500				€ 9.900		€ 26.400	12	WP4
	1,0	€ 5.500		€ 2.000		€ 4.500		€ 12.000	13	WP3-WP6
	1,0	€ 5.500		€ 1.000		€ 3.900		€ 10.400	14	WP6
	5,0	€ 27.500				€ 16.500		€ 44.000	16	WP7
TOTAL RECEIPTS								€ 365.280		

Name of the RTD performer	No. of Person/month	Personnel Cost	Durable equip.	Consumables	Computing	Overheads	Other costs	TOTAL by RTD	Project Result no.	WP no.
CTCV	0,5	€ 3.069				€ 1.841		€ 4.910	1	WP3
	1,5	€ 9.207				€ 5.524		€ 14.731	2	WP3
	0,5	€ 920				€ 552		€ 1.471	3	WP3
	1,0	€ 1.839				€ 1.103		€ 2.943	4	WP3
	0,5	€ 920				€ 552		€ 1.471	5	WP3
	3,0	€ 14.115				€ 8.469		€ 22.584	13	WP3-WP6
	1,0	€ 1.839				€ 1.103		€ 2.943	14	WP6
TOTAL RECEIPT								€ 51.052		

Table 2.2d Indicative breakdown of costs per partner, per activity type and per cost voice.

RTD ACTIVITIES								
	Personnel	Subcontracting	Travel	Training	Consumables	Equipment	Indirect costs	TOTAL COSTS
2 TBE - BE	€ 15000	€ -	€ -	€ -	€ -	€ -	€ 3000	€ 18000
3 ANDIL - IT	€ 12000	€ 579041	€ -	€ -	€ -	€ -	€ 2400	€ 593441
4 ZIEGEL - DE	€ 26460	€ 327880	€ -	€ -	€ -	€ -	€ 5292	€ 359632
5 APICER - PT	€ 2720	€ 288062	€ -	€ -	€ -	€ -	€ 1632	€ 292414
12 TUKDER - TK	€ 4000	€ 307360	€ -	€ -	€ -	€ -	€ 2400	€ 313760
13 RUREDIL - IT	€ 18000	€ 148304	€ -	€ -	€ 3000	€ -	€ 4200	€ 173504
14 SDA - DE	€ 50000	€ 15000	€ 1000	€ -	€ -	€ -	€ 10200	€ 76200
15 XALKIS - GR	€ 15000	€ 352160	€ 2500	€ -	€ 15000	€ -	€ 6500	€ 391160
16 H.I.STRUCT - RO	€ 19565	€ -	€ -	€ -	€ 2500	€ 1000	€ 4613	€ 27678
TOTAL	**€ 162745**	**€ 2017807**	**€ 3500**	**€ -**	**€ 20500**	**€ 1000**	**€ 40237**	**€ 2245789**

DEMONSTRATION ACTIVITIES								
	Personnel	Subcontracting	Travel	Training	Consumables	Equipment	Indirect costs	TOTAL COSTS
2 TBE - BE	€ 10000	€ -	€ -	€ -	€ -	€ -	€ 2000	€ 12000
3 ANDIL - IT	€ 28000	€ 46859	€ -	€ -	€ -	€ -	€ 5600	€ 80459
4 ZIEGEL - DE	€ 3780	€ 22400	€ -	€ -	€ -	€ -	€ 756	€ 26936
5 APICER - PT	€ 1813	€ 52640	€ -	€ -	€ -	€ -	€ 1088	€ 55541
12 TUKDER - TK	€ 2000	€ 5504	€ -	€ -	€ -	€ -	€ 1200	€ 8704
13 RUREDIL - IT	€ 9000	€ -	€ -	€ -	€ -	€ -	€ 1800	€ 10800
14 SDA - DE	€ 8000	€ -	€ 1000	€ -	€ -	€ -	€ 1800	€ 10800
15 XALKIS - GR	€ 4500	€ 9600	€ -	€ -	€ -	€ -	€ 900	€ 15000
16 H.I.STRUCT - RO	€ 5590	€ -	€ -	€ -	€ -	€ -	€ 1118	€ 6708
TOTAL	**€ 72683**	**€ 137003**	**€ 1000**	**€ -**	**€ -**	**€ -**	**€ 16262**	**€ 226948**

MANAGEMENT ACTIVITIES

	Personnel	Subcontracting	Travel	Training	Consumables	Equipment	Indirect costs	TOTAL COSTS
1 UNIPD - IT	€ 21600	€ 3500	€ 12000	€ -	€ -	€ -	€ 20160	€ 57260
2 TBE - BE	€ 3500	€ -	€ 5000	€ -	€ -	€ -	€ 1700	€ 10200
3 ANDIL - IT	€ 4000	€ 7500	€ 5000	€ -	€ -	€ -	€ 1800	€ 18300
4 ZIEGEL - DE	€ 5723	€ -	€ 4500	€ -	€ -	€ -	€ 2045	€ 12268
5 APICER - PT	€ 1813	€ -	€ 6000	€ -	€ -	€ -	€ 4688	€ 12501
6 TUKDER - TK	€ 2000	€ -	€ 7500	€ -	€ -	€ -	€ 5700	€ 15200
7 UMINHO - PT	€ 1200	€ -	€ 6500	€ -	€ -	€ -	€ 4620	€ 12320
8 UNIPV - IT	€ 5000	€ -	€ 6000	€ -	€ -	€ -	€ 6600	€ 17600
9 NTUA - GR	€ 3000	€ -	€ 6000	€ -	€ -	€ -	€ 5400	€ 14400
10 UKASSEL - DE	€ 5500	€ -	€ 5000	€ -	€ -	€ -	€ 6300	€ 16800
11 CTCV - PT	€ 3991	€ -	€ 3000	€ -	€ -	€ -	€ 4195	€ 11186
12 METU - TK	€ 3440	€ -	€ 5000	€ -	€ -	€ -	€ 5064	€ 13504
13 RUREDIL - IT	€ 3000	€ -	€ 3000	€ -	€ -	€ -	€ 1200	€ 7200
14 SDA - DE	€ 5000	€ -	€ 5000	€ -	€ -	€ -	€ 2000	€ 12000
15 XALKIS - GR	€ 3500	€ -	€ 5000	€ -	€ -	€ -	€ 1700	€ 10200
16 H.I.STRUCT	€ 1820	€ -	€ 5000	€ -	€ -	€ -	€ 1364	€ 8184
TOTAL	**€ 74087**	**€ 11000**	**€ 89500**	**€ -**	**€ -**	**€ -**	**€ 74535**	**€ 249122**

OTHER ACTIVITIES

	Personnel	Subcontracting	Travel	Training	Consumables	Equipment	Indirect costs	TOTAL COSTS
1 UNIPD - IT	€ 11400	€ -	€ 14000	€ -	€ -	€ -	€ 15240	€ 40640
2 TBE - BE	€ 20000	€ -	€ 3000	€ -	€ -	€ -	€ 4600	€ 27600
3 ANDIL - IT	€ 30000	€ 1500	€ 2000	€ 2500	€ -	€ -	€ 6900	€ 42900
4 ZIEGEL - DE	€ 34560	€ -	€ 1500	€ 3000	€ -	€ 1500	€ 8112	€ 48672
5 APICER - PT	€ 2720	€ -	€ 2500	€ -	€ 5000	€ -	€ 6132	€ 16352
6 TUKDER - TK	€ 4000	€ -	€ 3000	€ -	€ -	€ -	€ 4200	€ 11200
7 UMINHO - PT	€ 2342	€ -	€ 10000	€ 2500	€ 10000	€ -	€ 14905	€ 39747
8 UNIPV - IT	€ 10000	€ -	€ 7000	€ 5000	€ -	€ -	€ 13200	€ 35200
9 NTUA - GR	€ 15000	€ -	€ 8000	€ -	€ -	€ -	€ 13800	€ 36800
10 UKASSEL - DE	€ 18750	€ -	€ 5000	€ 3000	€ -	€ -	€ 16050	€ 42800
11 CTCV - PT	€ 15954	€ -	€ 3000	€ -	€ 3000	€ -	€ 13172	€ 35126
12 METU - TK	€ 6880	€ -	€ 7500	€ -	€ -	€ -	€ 8628	€ 23008
13 RUREDIL - IT	€ 16800	€ -	€ 4000	€ 4000	€ -	€ -	€ 4960	€ 29760
14 SDA - DE	€ 17000	€ -	€ 1000	€ -	€ -	€ -	€ 3600	€ 21600
15 XALKIS - GR	€ 7500	€ -	€ 2500	€ 2500	€ -	€ -	€ 2500	€ 15000
16 H.I. STRUCT - RO	€ 2795	€ -	€ 1500	€ 1000	€ -	€ -	€ 1059	€ 6354
TOTAL	**€ 215701**	**€ 1500**	**€ 75500**	**€ 23500**	**€ 18000**	**€ 1500**	**€ 137059**	**€ 472760**

3. Impact. The potential impact through the development, dissemination and use of project results

3.1 Contribution, at the European [and/or international level], to the expected impacts listed in the work programme under the relevant activity

3.1.1 Impact for SME-AGs and their members

For the SME members of the SME-AGs present in the INSYSME consortium, as well as the other enterprises and sectors involved, there are clear and demonstrable benefits to be gained from the successful implementation of the project. The experience of SME associations involved in the project, with the aid of different agents in the process, will ensure that the needs of large communities of SMEs are met. Actually, the research project, being aimed at the development of innovative construction systems, the definition of design procedures and code updating, will offer complete solutions to technological and scientific problems which have a broad-spectrum impact. One of the main output of this project will consist of different innovative industrialized solutions for enclosure masonry walls to be built mainly in rc framed structures, but also in steel ones. It is intended that these solutions will behave adequately under serviceability conditions and, additionally, keep safe if seismic events occur. The developed solutions will facilitate energy savings, increase indoor comfort, being sustainable from environmental, economic, durability and social point of views, thus meeting most of the main priorities of the strategic research agenda of the European Construction Technology Platform (ECTP) [Ref. 73].
From the project results, a larger group of enterprises and end-users across Europe will benefit, effectively replying to the competitive threat of the market and helping in recovering the market share with respect to recently proposed light solutions for partition walls. The development of efficient and complete solutions for enclosure masonry walls will enable the clay unit producers to commercialize the masonry wall systems, instead of the single unit. This will result in increased competitiveness of the SMEs by the diversification of the products offered to the market relatively to the competing enterprises/systems. In a period of deep economic crisis, which is strongly affecting the construction market, the possibility of patenting, marketing or licensing new construction solutions for infill walls on an international basis represents a clear advantage for the SME-AGs members. It should be stressed that the enclosure masonry walls will be provided with full design rules and software (which can also be independently commercialized). This will constitute a great added value and will help achieving competitiveness through innovation.
The project's success will therefore have several positive effects, amongst which focus must be placed on the enhanced possibilities to fight against the loss of market for masonry in building enclosures, to respond with knowledge and technological process to a challenge introduced by the new European regulations, to mitigate environmental impacts, and to solve societal problems in terms of repair costs and loss of lives. Finally, it should be emphasised that the project will represent an important database of results and guidelines that will significantly contribute to further development or improvement of future versions of either the Eurocodes and the national codes. Finally, considering that the uptake for any new product, in the construction sector, is always gradual and that its impact will increase after initial use, it has to be underlined that one of the key project roles of the participating SME-AGs is to inform and educate not only their members, but also the designers, end-users and consumers, in order to maximize the speed of uptake and market penetration.

3.1.1.1 Estimated time to market

It is intended that, once the project is completed, the SME-AGs will continue to drive exploitation of the project results by continuing the program of demonstration to their SME members and, also, by continuing the dissemination actions through promotion of the benefits to designers and general public (publications in technical periodicals, participation in construction fairs, etc), and in particular to the decision makers, contractors, architects, engineers (with workshop, seminars, etc). After the completion of the project, the time-to-market can be estimated in about one year, with project's products being introduced progressively, starting within 12 months following the completion of the project (this time being needed to finalize and implement the industrial production lines developed

and investigated by the project, together with packaging, distribution and marketing). With the aim of demonstrating the technological feasibility of the developed solutions, during the project duration enclosure masonry walls will be constructed in real buildings: this will constitute an important, practical demonstration to the designers and end-users community and is believed to be an important element to reduce time-to-market. Records of feedbacks from all those who took part in the "demonstration" design and construction process will be kept.
An important step for exploitation will consist in the registration of the products and in the inclusion of the developed solutions in the product's catalogues of the SMEs participating in the project. The possibility of patenting the project's outcomes will also be considered, thus resulting in the payment of royalties from other SMEs.
In the current context, in which a lack concerning the design of enclosure systems is found in national and European codes, a fundamental step towards practical and extensive use will consists in providing contractors and designers with clear rules and guidelines for construction and design. This will be accomplished, in a first stage, by resorting to the use of guidelines and software developed during the project that will be made immediately available after the end of the project. Concurrently, during the project duration and afterwards, all the necessary steps to introduce the general design rules into revised version of the current codes will be made. It is recognized that this process, involving the relevant regulatory authorities at national and European level (CEN, UNI, DIN, AENOR, ELOT, etc) will take an average time of at least 1-2 years after the project's end, as the revision processes require several technical approvals; however, given the detailed information gained during the project, it is unlikely that any regulatory problem might arise. Preliminary contacts between the project Consortium and CEN has already been established (see attached CEN letter of support) to establish, in case the project will be accepted by the EC and during the project duration, effective liaisons with relevant standards Committees.

3.1.1.2 Market size and share

From a comprehensive study of the statistics of different European countries, it turns out that the year production of clay products is around 100 million tons, with an non homogeneous distribution across the different member States, with the Mediterranean countries (Portugal, Spain, Italy and Greece) covering the 50% of the total European production. The progressive loss of commercial power has been already tackled in Section 1.1.3 and will be further explained in the following Section 3.1.2. Going to the most recent data, it can be seen that in Turkey (2011 data) the annual turnover of the clay and tile sector, accounting more than 330 clay brick factories, is around 500 M€ and its export is near 6 M€ per year; in Portugal recent data shows sales for 57 M€, in Italy (2011 data) for 920 M€ for 11,23 millions of tons production, and extrapolating the Greek data, around 800 M€ for 178 Mton of sold product can be assumed for Greece. This means that these countries cover around 2,5 billion € of clay products, over the 10,6 billions € of the entire European market. Furthermore, in Germany the 2011 sales were about 255 M€. The products used (units and bricks) for infill and veneer walls represent from 40% of the entire production up to 60%, that means (conservatively taken at 30%) a market of about 800 M€ only in the five main countries of the project.
The analysis of these values indicates the relevance of the masonry units production in several countries in Europe, which can be also extended to rest of Europe, but also point out how innovation in this sector is advisable in order to recover or even increase the purchase of masonry units, for both enclosure walls and for partition walls. Therefore, the competitiveness of all the SME-AGs members will be enhanced thanks to the possibility of patenting new products and extending the market share of construction products. The direct economic impact of the exploitation of the project's outcome on the SME-AGs members can be directly and roughly estimated on the basis of the potential direct economic benefits to the 4-countries SME-AGs and their 334 associated SMEs annual market share (in terms of sales, 1.957 M€ the sector and conservatively 587 M€ for enclosure walls). It is remarkable that the four SME-AGs involved in the project group 334 SMEs and only 25 large Industries. The benefits have been quantified as follows:

- for clay unit producers, in terms of increases in the market by direct sales, taking conservatively into account an increase of 0,3% in their respective national market during the first year, and

then a further increase of 0,3% on an annual base. Both the increases foreseen are very conservative, as the first one means being able to sell the product on 3 construction sites out of 1.000 (which is definitely below the average marketing capacity of the SMEs of the sector) and the latter is underestimated because, after the first introduction in the market, a spin-off effect is foreseen to occur, with increasing values of gained market share; furthermore, no one of the aforesaid increases take into account a market reprise and its consequent increase in the market size;

- for the SME-AGs, in terms of licensing income from non-member SMEs in their own countries and in other EU countries: Europe indeed accounts for about 3.000 SMEs in this sector, and the participation in project of the European Association (TBE), which clusters 25 member associations located in 19 EU member states, with an estimated turnover of 7 Billion Euro, ensures actual transfer of INSYSME results to its member;
- for the SME-AGs, in terms of licensing income from SMEs located in other countries, mainly eastern EU and non-EU countries (Slovenia, Poland, Balkan countries in which new construction is still ascending), where the Turkish association operates and where especially the Italian and German association and companies have strong commercial relationships.

	Year 1 (€ x 1000)	Year 2 (€ x 1000)	Year 3 (€ x 1000)	Year 4 (€ x 1000)	Year 5 (€ x 1000)	Total (€ x 1000)
Producers	€ 1.761	€ 3.522	€ 5.283	€ 7.044	€ 8.805	€ 26.415
EU-Licenses	€ 140	€ 290	€ 420	€ 600	€ 700	€ 2.150
Non EU-Licen	€ 50	€ 100	€ 300	€ 600	€ 800	€ 1.850
	€ 1.951	€ 3.912	€ 6.003	€ 8.244	€ 10.305	€ 30.415

In the narrative above, direct export is not considered as transport cost is a major cost in clay unit sales, hence production is generally local and export is limited to neighbour countries in trans-frontier areas. However, international market can be reached by SME-AGs and SMEs through licensing of their innovative solution, as above explained. As it can be seen by the very conservative estimates carried out, in Year 1 after the project end there will be a return of about 1,9 M€, that means 80% of the EU investment and 60% of the overall consortium investment, but from Year 2 the sales will start covering the full investment and having a rate of return. It has to be stressed once again that the percentages adopted in these estimates are definitely conservative, and a much higher profit, with a positive rate of return, is expected starting from the first year after the project end.

This also applies to the single SMEs directly participating in the project (i.e. clay unit producers like XALKIS, fastener and reinforcement producer RUREDIL, the and software house SDA), which will jointly provide the market with the new masonry walls systems. It has to be stressed that XALKIS has an annual turnover of 16,5 M€ producing clay units and bricks, RUREDIL has an annual turnover of over 28 M€, out of which 9 M€ are represented by fastenings and reinforcements; SDA has an annual turnover of about 265.170 €, mostly related to the sales of specialized software. It can be foreseen that the total number of software licenses distributed by SDA will be increased up to more than 1000 Europe-wide, which will strongly foster an increase of the market share for innovative systems of masonry infill walls.

The uptake of the developed masonry enclosure technologies after the project end will be controlled, besides the rate of technology validation, by the cost, which will be affected by economies of scale. With respect to this issue, only at the final stage of the project a final cost evaluation of the enclosure masonry wall solutions can be made. However, at present, it can be foreseen that the initial price could be slightly higher than the currently available enclosure wall systems but, as demand increases, it will reduce. Furthermore, savings that will accrue throughout the supply chain will offset the small additional cost:

- **lower use** of insulation materials leads to reduction of CO_2 emissions during production; economy in construction site organization; reduction of material disposal and substitution (insulating coating are less durable than masonry);
- **energy savings** in the costs for heating/conditioning, thermal transmittance of masonry has reduced by 55% in the last two decades of innovation [Ref. 51] the corresponding energy requirement with the improved systems can be drastically reduced;

- **lower cost for repair** in serviceability states; today, 25% of the damage reported in civil suits and claimed to insurance companies is related to damage in non-load bearing walls;
- **lower or null cost for repair** in case of frequent, low intensity earthquakes; today, 60-80% of the costs of post-earthquake repairs is related to enclosure and partition walls and related finishing.

If we take into account that energy consumption in buildings account for about 32% of the entire consumption (divided for final use, where transports are 31% and industry is 26,5%, Ref. 99) and that today, the cost for material production, construction and demolishing are in general extremely low, and equivalent to about 4-5 years of building management and maintenance [Ref. 50], it is evident that a small increase in construction cost that can benefit the following maintenance phases leads to a general economy for the owners, and is therefore fully acceptable and affordable.

3.1.1.4 Economic justification of the research

It should be noticed that the economic benefits foreseen, after completion of the project and complete exploitation of the project, clearly overtakes the initial investment in the project according to what is explained in the previous section (market impact estimates, see previous section), and to the estimated budget for the whole duration of the project. This shows that the total investment of 3.194.618 euro in the INSYSME project will be recovered in about 2 years after project completion. Commercial exploitation will be implemented via a number of routes, explained above and also in section 3.2.2.3, and will be amplified, on a larger economic scale, by cost savings for the final customers (owners or users of the buildings adopting the new technologies). Limiting the analysis to the market of the SME-AGs members, a very conservative estimated return of 30.415 million euro is predicted within 5 years, giving an investment ratio of about 10:1. The main beneficiaries of this increase in business volume will be the members of the SME-AGs who can anticipate consequential increases also in employment levels. A greater impact will be achieved taking into account the several categories affected by the new technologies and tools (manufacturers of reinforcement, fasteners, mortar; software houses; and on the medium term, designers and companies of on-site testing), as the new technologies spread across the rest of the European construction industry.

3.1.2 Impact on competitiveness of SMEs and Industry

The construction sector represents one of the largest shares of wealth to Europe's business economy. It accounts for around 10% of gross domestic product (GDP) and 50% gross fixed capital formation (GFCF). Construction is strategically important, providing buildings and infrastructure on which all other industries and public bodies depend [Ref. 71]. In this framework, new constructions represent 57% of the production, where 43% is related to residential and non-residential buildings, and 14% is related to new infrastructures. These percentages are related, in the 19 countries of the Euroconstruct network, to a market that, before the crisis, accounted for more than 1.500 billion euros [Ref. 127]. Fig. 10 shows the percentage of each activity in the construction sector, divided per EU zones. The “natural market” of the project is the full building market, accounting for any type of new construction: housing, schools, industrial, service and commercial buildings, public buildings, warehouses, horizontal silos, etc. This market is dominated by framed structure. The impact of the project results on the competitiveness of SMEs and Industry, considering the size of the market described, is evident. It is also remarkable that clay unit industry, with its 10,6 billion Euros overall turnover, represent almost 1% of the entire construction sector, hence yet a considerable amount of the entire European business, and its prevalence in the Mediterranean European countries, makes it a pillar of those countries economy.

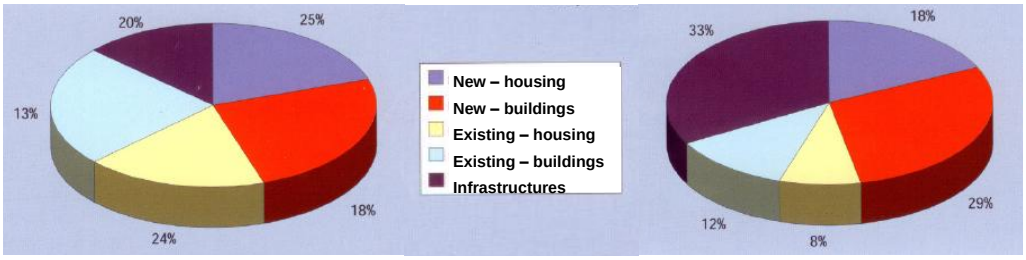


Fig. 10: Structure of Construction Sector (%) in Western (left) and Eastern Europe (right)

However, several shortcomes limits the further development of the Sector and endanger its role for the future. This is particularly true in this period where the economy in general, and the Construction Sector in particular, is facing a deep crisis. From 2008, in fact, the growth of the sector has faced a negative trend. Construction output fell by -8.6% in 2009 and by -3.4% in 2010 in the Euroconstruct area.

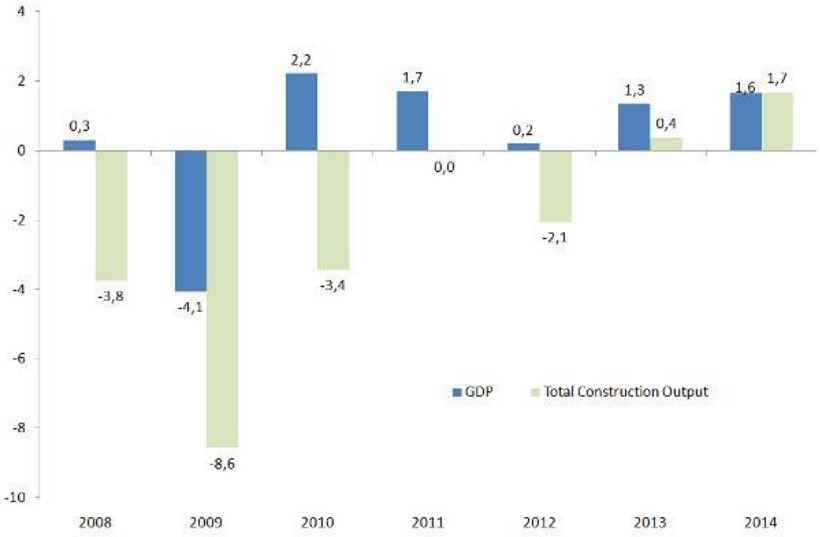


Fig. 11: Construction and economic growth - EC-19 (Source: 73rd EUROCONSTRUCT London, 2012)

Construction forecasts for 2012 downgraded from initially foreseen -0.3% to -2.1. Construction output in the Euroconstruct zone should reach its lowest point in 2012, since the 2013 forecast has remains slightly positive (+0.4%). The biggest downward revisions primarily concern civil engineering sector, followed by non-residential (public) buildings: these two segments are particularly vulnerable to the budgetary austerity plans put in place by the countries most exposed to the debt crisis. Construction will not return to the level of the early 2000s until 2014. Growth in construction in 2013 and 2014 will not be nearly enough for a return to the levels seen just before the crisis, since cumulative growth of about 4% by volume between 2012 and 2014 will be very small by comparison with the cumulative decline of around 17% between 2008 and 2012.

To meet the forecasts of reprise in European countries, it is necessary to boost the sector and make it more competitive. In the case of new constructions, representing almost half of the market, this is even truer, as new constructions are more sensitive, compared to work on existing buildings, to the crisis of the sector. As long as the public awareness rises, the new measure of success in new constructions is the ability to satisfy all of the needs. This means that we should constantly look at ways to make our final buildings safer, easy to be designed, visually attractive, less energy consuming, more sustainable, and capable of increasing the indoor comfort. These are all positive aspects that the envisaged INSYSME solutions will keep, increasing the end-users and, on the long term, public demand for such construction technologies.

Last, it has to be recalled that the overall importance of the construction sector to economic performance and growth is often not fully recognised, also because many of the companies involved are small (sometimes micro) medium enterprises [Ref. 71]. This is true for producers but it is particularly true for service providers such as applicators, consulting engineering firms, etc. The project will provide them with sound design tools, simple rules for application, diagnostic tools for quality assessment, obtained during the various WPs, summarized into the final guidelines of WP7, and disseminated and standardized through the activities described in the following sections. The impact of these results on the increase of knowledge, degree of specialization and thus competitiveness for this type of SMEs, although it is not the main target of the project and has not been taken into account in the previous sections economic estimates, is clear.

3.1.3 Impact on employment and the use/development of skills

The number of people employed in the clay brick sector has gradually decreased from the 60s, even though the year production tends to remain constant, due to reduction of factories and increased productivity [Ref. 7]. However, a dramatic employment loss has been faced in the general construction market in the last four-year period (2007-2011). The overall sector employed 13.5 million workers in 2007 (more than any other industrial sector in Europe, Ref. 71), or 7% of the European total workforce, but more than 1.5 million jobs have been lost since 2007, mostly concentrated in Spain and in Portugal [Ref. 69] alone, but also in Italy and Greece. The contribution of the INSYSME results to the masonry sector is demonstrated in previous section and, of course, it will also help in stopping the negative trend in the European employment in this sector. Obviously, the increase of employment is dependent on the expected increase of production. At this stage a prediction on the increase on the number of employments is based on the estimated increase on productivity. If we take into account a small annual increase of 0,5%, i.e. 1% in two years, and we consider a linear approach, the two-year increase of production in the clay sector would lead to an increase of 100 employees on 10.000. Considering that Italy and Portugal alone have currently about 15,000 employed in this sector, and Europe in overall has 83,000 employed in the clay industry [Ref. 51], the impact on employment, although very roughly and approximately calculated, is clear. Furthermore, emerging recommendations and guidelines, which will also reflects in development of standards and software, will bring new demands to structural engineers and service providers, who will thus have to employ new and more specialized staff.

3.1.4 Impact on safety and quality of life

Earthquakes constitute the natural hazard that yearly causes the highest number of casualties in the world. They cause significant loss also in economic terms, with always increasing trend, as assessed by [Ref. 9]. In European countries, death, injuries, and economic loss related to the modern rc building stocks are often and mostly due to enclosure walls out-of-plane collapse, as seen in Section 1.1.1. The INSYSME project, developing effective technologies for mitigation of earthquake effects on enclosure walls, and reliable design rules, will thus make a vital contribution to Europe's aim of achieving higher quality of life (increased safety), reducing economic costs related to post-earthquake repairing and sustainable economic growth (societies that are constantly coping with the consequences of natural disasters do not achieve sustained growth). The creation of a uniform level of protection of the citizen from injury or loss of livelihood caused by natural disasters is clearly consistent with EU policy objectives, and the impact of the project in this field matches the objectives not only of the ECTP Strategic Research Agenda [Ref. 72], but also of the European Earthquake Agenda [Ref. 70].

The new construction details and the improved mechanical performance of the envisaged enclosure walls will also significantly improve their behaviour under serviceability limit states. This in turn entails an improvement of the indoor comfort, quality of life and health of the occupants. Developing crack-free walls, indeed, means less psychological impact and, mostly, less humidity related problems. In fact, excessive moisture penetrating in enclosure walls due to cracks is the main agent for the creation of mould (a woolly or fluffy growth produced by a fungus due to suitable moisture and temperature conditions), which is unacceptable in housing and in certain cases very harmful to occupants. In addition, the newly produced masonry units will take into account the new EN regulations (EnEV2001) for adequate hydrothermal regulation capacity, the energy efficiency regulations [Ref. 75] and the acoustic regulations (EN ISO 717 series). Enclosure solutions based on the use of thick and specialized clay units alone, when they are enough to satisfy the indoor comfort and acoustic and thermal insulation requirements, will be developed. It is worth noting that the energy required to produce ceramic bricks is 2.8 GJ/t, whereas mortar/concrete requires 8.5 GJ/t and glass wool or foam glass for insulation may raise up to 60 GJ/t. Avoiding using energy consuming, less durable insulating materials, contribute to energy saving and CO_2 emission is also reduced, e.g. by 6% compared to less insulating concrete unit wall solutions [Ref. 51]. Hence, the successful conclusion of the INSYSME project would have positive effects on a wide range of Community societal objectives.

3.1.5 Impact on European norms and standards

The successful completion of the project will contribute to European standardisation and regulation. Research results will constitute “standardised best practices”. Results and guidelines will be made freely available to CEN for use in preparation of structural standards; to this purpose, contacts between the project Consortium and CEN has already been established (see attached CEN letter of support) to establish effective liaisons with relevant standards Committees. The main impact of the project will be on Eurocode 8 (EN1998 for aseismic design of structures, Ref. 19) but the information on masonry infills and veneer walls will be also useful for the series of Eurocode 6 (EN1996 on masonry structures, Ref. 18 e alter), and for Eurocode 2 on concrete, hence also rc frames, structures (EN1992, Ref. 17). The developed materials will give information to be implemented into the corresponding EN series (e.g., EN771 on masonry units, EN845 on fastenings and reinforcement, EN998 on mortars, etc.). The development of design procedures for infill and veneer walls will also have a direct implementation into the various national technical codes, both in the case that they are under development, or under maintenance stage, and will anyway immediately transferred into the commentary of the code. The innovative testing procedures adopted, both at sub-assembly level in laboratory and with non-destructive techniques on-site, can feed pre-normative documents prepared by RILEM and, eventually, can constitute a new EN series. The active participation of the industrial associations participating in the project and of many involved RTD performers into the above mentioned pre-regulatory technical committees (RILEM) and European standardisation committees (CEN), plus their involvement in drafting the National Annexes to the Eurocodes (Eng. A. Di Fusco at ANDIL, Dr. Meyer at ZIEGEL, Prof. Modena at UNIPD, Prof. Magenes at UNIPV, Prof. Fehling at UKASSEL, Prof. Lourenço at UMINHO, Prof. Vintzileou at NTUA), as it results from their CVs reported in the previous Section 2.1.2, will ensure the actual and effective transfer of the project results and contribution to either national and European standards.

3.1.6 Contribution to increase transnational technological cooperation

The project requires a trans-national approach because it aims at solving problems common to most of the European countries. It has to be stressed that, today, rc frame construction is the most commonly used structural system for new buildings. The participation of seven countries includes areas where the seismic risk level is quite different (very high in Greece and Turkey, from moderate to high in Italy and Romania, moderate in Portugal, from low to moderate in Germany, see Fig. 11), and where local building traditions, construction and material types are also dissimilar. Furthermore, in those countries also environmental conditions are different. The diversity within shared problems requires cooperation across Europe and the Mediterranean, in order to work out common approaches, to create new concepts of general use, but also to find a range of individual solutions that can address the needs and can be valid in most European countries, extending the impact of the project well beyond the consortium, and developing rules for design and application that can be used under different conditions.

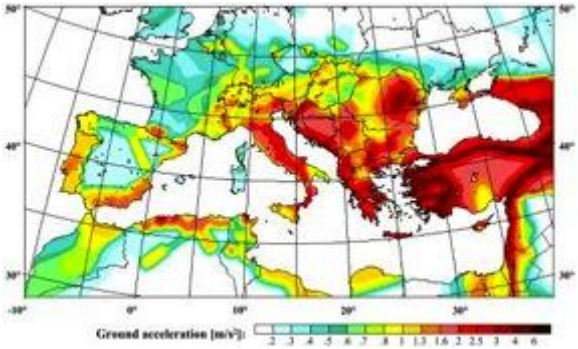


Fig. 11. Seismic risk map of the Mediterranean basin [after Ref. 10]

As far as the latter aspects are concerned, a problem that is shared at European (and World) level is the presence of codes whose design rules and approaches regarding enclosure walls are significantly inhomogeneous or are not tackled at all. The reference here is to Eurocode 8 [Ref. 19]

and to national standards [e.g., Ref. 22]. As a consequence, designers and contractors deal with this topic in very non-homogeneous way throughout the countries. The International dimension of the project, by the standardization at International and local level and by the dissemination of knowledge at local level, will help filling this gap. This is an important added value of the project and will also promote long-term research cooperation.
Inside the consortium, the envisaged research will increase translational technological co-operation and possible interchange of know-how amongst SME-AGs of the same sector (clay unit producer), and among SME-AGs and SMEs from different industrial sectors: brick producers, ties and fasteners manufacturers, software house, but also mortar producers, contractors and others beyond the consortium. It is intended that the INSYSME project is not only a simple relation between SME-AGs and SMEs that support the research and technological activities and RTDs that provide them with results, but that it also will strengthen future collaboration between SME-AGs, SMEs and RTDs both at national and international research projects and protocols.
International co-operation is also crucial because it is hard to find in a single country all the needed resources and knowledge, as high level research is increasingly costly and requires a critical mass. The proposed project brings together expertise and facilities in material behaviour and development, manufacturing, structural testing, structural analysis, on-site testing, modelling and design, that represents a combination of facilities, experience and applications which cannot be found within a single organization or in one country. By doing so, it also strengthens the European Research Potential and improves its competitiveness. At a scientific and technical level, natural hazards research in Europe leads the world in many areas: the impact of this research, building on the most recent knowledge and state of the art and combining high expertise, is to maintain that status, in the face of growing international competition, and bringing it to an increased level.
In addition, the project will improve European social and economic cohesion, in agreement with the 'Region and local development' policy, by promoting less advanced areas of the European Union (South of Italy and several regions in Portugal, Turkey and Greece) through the technological transfer from highly advanced RTD performers to the SME-AGs. Besides, it should be referred that some research centres are located in less favoured areas. Furthermore, this project will promote, inherently, cross-sectorial transnational collaborations among Associations and companies beyond the consortium. Indeed, the project is also already fostering cooperation with neighbouring Countries, following the European Neighbourhood Regional Policy (being Turkey an AC country).

3.2 Appropriateness of measures envisaged for the dissemination and/or exploitation of project results, and management of intellectual property

3.2.1 Project results and management of intellectual property

The exploitable results of the project, on the basis of which regulating intellectual property rights (ownership, licensing, royalties, etc) among the partners, can be grouped in the following items:

1. Abacus of typical typologies of enclosure wall systems and structural frames (WP3);
2. Design requirements for the enclosure wall materials: clay units, mortar, reinforcements and fastenings (WP3);
3. Newly masonry units (WP3);
4. Newly reinforcements and fasteners (WP3);
5. Newly developed constructive systems for enclosure masonry walls (WP3);
6. Physical and mechanical properties of materials and walls (WP5);
7. Definition and assessment of improved quasi-static cyclic testing techniques for combined in-plane/out-of-plane characterization of enclosure wall systems (WP5);
8. Combined dynamic in-plane/out-of-plane behaviour of enclosure masonry walls and frame-to-wall interaction (WP5);
9. Numerical modelling of bare and infilled frames: calibration and parametric analysis (WP4);
10. Numerical modelling of enclosure masonry walls: calibration and parametric analysis (WP4);
11. Influence of global response on the local response and seismic input definition (WP4);
12. Simplified design models of infill walls (formulations and design charts, WP4);
13. Final construction technology and construction of real scale walls (WP3-WP6);
14. NDT on-site testing for validation and development of quality control procedures (WP6);

15. Easy to use software and manual (WP7);
16. Construction and design guidelines (WP7).

Foreground relevant to industrial or commercial application will be protected in an adequate and effective manner in conformity with the relevant legal provisions, having due regard to the legitimate interests of all participants, particularly the commercial interests of the other participants.

3.2.1.1 Ownership of IPR and user rights

The participants in the INSYSME project have agreed to adopt, for most of the project results, the default position regarding intellectual property, namely the SME-AGs will retain full ownership of Foreground Information related to these project results (1 to 8 and 12 to 16, as can be also extrapolated by Table 3.2.2). The Foreground is basically that related to products, construction systems, design rules, etc., i.e., the Foreground which is directly exploitable and transferable by the SME-AGs to their members. The other enterprises participating in the project (SMEs) will retain direct ownership of detailed solutions related to their products. RTDPs will retain the ownership of Foreground Information related to results 9 to 11, which basically are knowledge that can be exploited for further research. A commensurate reduction in the transaction costs is already taken into account as, considering the complexity of the work to be carried out for obtaining those results, it is foreseen that the RTDPs will work more person-months than those presented in the effort Table 1.4d, and justified in terms of cost in Table 2.2c. (see also Section 2.2.2). However, RTDPs will grant royalty-free licenses (for results 9 to 11) to the SME-AGs, in order to give them full access for exploitation purposes, including the right to sub-license them to their members, if necessary. The SME-AGs in the project, having ownership or royalty-free licenses, have full access on all Foreground Information and can benefit from all the results obtained.

As most of the IP, related to Foreground information whose ownership is of the participating SME-AGs and SMEs, will be generated by the RTDPs, they will be fully reimbursed for their costs. These principles will be contractually bound into the Grant Agreement to include the Description of Work (annex I), the rights and obligations of all participants to the Grant Agreement, which will be duly signed by all participants prior to project starting. In particular, the SME-AGs will gain full rights to exploit and disseminate the results among their members, and latterly, their non-member companies. Furthermore, the RTDPs will grant the SME-AGs free access to all their relevant Background Information needed for the implementation of the project or for the use of Foreground, so that exploitation is not impeded. The RTDPs will, however, retain ownership of their own Background Information and will be granted the rights to pursue further R&D. SME-AGs and SMEs will grant the RTDPs free access to all their relevant Background Information needed for the implementation of the project, without any right to sublicense, unless otherwise agreed (under non-disclosure or confidentiality clause). The SME-AGs will therefore be in a position to grant, for most of the project results, (exclusive or non-exclusive) licenses and negotiate royalty payments that will be in the best commercial interests of themselves and their member companies. Regarding IP, the Consortium Agreement will:

- direct the management of the IPR, both Background and Foreground
- specify the Background IP of each partner to be used for the project and the access rights of other partners to it
- detail the arrangements for providing access to the Background for project purposes
- define ownership of the anticipated results
- propose conditions for a fair and equitable agreement on the payment of patenting costs by the SME-AGs and the distribution of downstream revenues
- define the roles of the project participants regarding exploitation and dissemination of the anticipated results.

As one of the objectives of the project is to give contribute to national and European standards, the SME-AGs and RTDPs will make available to third parties the knowledge and know-how needed to act in conformance with the rules of the updated standards.

As one of the objectives of the project is to give contribute to European and most national standards, the SME-AGs and RTDPs will make available to third parties the knowledge and know-how needed to act in conformance with the rules of the updated standards. TBE thanks to its institutional role and mission will collect (on a free of charge basis) those SME-AGs outcomes

having relevance at European level (mainly result n°16 in table 3.2.2) and will take care of promoting within CEN committees thus effectively contributing to standards update process. The Consortium Agreement will regulate the specific access right of TBE.

3.2.1.2 IP management and exploitation

Dr Udo Meyer, Director for Research Exploitation in ZIEGEL, will take on the role of Exploitation & IP Manager for the INSYSME project (Chair of Exploitation Committee). It will be his duty to ensure that the knowledge gained in this project will be exploited and disseminated for the maximum benefit of the SME-AGs. Dr Meyer will manage all knowledge developed within the INSYSME project and will have find strategies and solutions for protecting the Intellectual Property derived.
The role of the Exploitation & IP Manager will be to:

- identify and assess all project results
- regulate the reporting of project results
- prevent unapproved public disclosure of results by the RTDPs
- update the INSYSME Management Board on a regular basis
- instigate recommendations for an appropriate IP protection approach
- follow through once the protection strategy is agreed
- ensure adequate protection is in place prior to exploitation and dissemination

All Foreground Information generated during the project will be documented and reported on at the foreseen meetings of the Management Board. The Board will review these results and ideas and will formulate the most appropriate protection strategy (with direction from the Exploitation & IP Manager). There is full confidence that all IP developed in the project by the RTDPs will be reported to the SME-AGs and SME Participants and a clause to this effect will be incorporated into the Consortium Agreement.
With regard to patenting, it is foreseen that patentable foreground will (mainly) consist of products (units, reinforcement, fastenings) and systems developed in WP3, and the IPR will be of the SME-AGs or SMEs that designed and contributed to the join invention of the product. RTDPs researchers who will contribute to this invention could be named as co-inventors of the patent but, unless otherwise agreed, RTDPs will not have joint ownership. The software to be developed can be easily protected and no patent is required. The SME-AGs or SMEs, under the directorship of the Exploitation & IP Manager, will engage competent European patent agents when necessary to advise on patent issues, draft preliminary patent applications and seek advice on copyright issues as they arise.
RTD performers will have the right of disseminating the Foreground they have generated, compatibly with the protection of IPR, confidentiality obligations and the legitimate interests of the owner(s) of that Foreground, and with clear quotation of the EU project and contract number in the framework of which this information has been gained. The Exploitation & IP Manager will draw up guidelines to ensure that the RTDPs refrain from including any confidential project-related work in activities that may lead to public exposure of the project results prior to their protection. These guidelines will include a condition that any document intended for publication will be circulated in draft form to all project participants involved (in terms of Background or Foreground rights) in the activity described, who will then have 2 weeks in which to convey to the authors any objections they may have to publication. Any other issue related to IPR and rules for dissemination will be secured within the Consortium Agreement.

3.2.1.3 IP registration

At the start of the project, an IP Register will be produced: each participating organization will have the ability to contribute to. Each participant will be required to list in the Register all of its Background IP (patents, know-how etc.) that is relevant to, or could affect the exploitation of, Foreground Information that is generated during the project. Each participant will also be able to place on the Register any ‘external’ IP that they may discover that, similarly, could affect protection of Foreground IP. This will be a ‘living document’ that will be updated, as appropriate, during the course of the project and will support the activities of the Management Board in deciding on the areas and nature of IP protection that will be pursued.

3.2.2 Dissemination and/or exploitation of project results

The project results (listed in section 3.2.1) can be object of distinct means of dissemination and exploitation depending of their nature. Indeed, the results can be roughly divided into two main categories. The first being constituted by the exploitable knowledge, having a potential for developing regulatory requirements, for industrial or commercial application in research activities, or for developing new products or processes or services. The second category comprises the exploitable products and measures, which already constitute final objects, products or instructions that can be used by the end-users. These types of result mainly arise from the phase of the project related to the products and technologies (WP3) development, the final validation (WP6), and the software implementation and guidelines (WP7).
Dissemination of project results (described in WP2 and in Section 3.2.2.2) will also constitute a project result, to which all project participants will contribute. The distinction of exploitable knowledge and exploitable products is made in Table 3.2.2, where a detailed description of project results, type of exploitation and corresponding remuneration is indicated.

3.2.2.1 Dissemination strategy

The main dissemination target groups, means and key objectives are listed in the following:

- dissemination of the results internal to association membership. This will include training activities on the project Background and Foreground, carried out by the RTDPs to the representative of the SME-AGs to a sufficient level that they can then train their member companies; subsequent training activities, through a series of information seminars and demonstration/training workshops, carried out by SME-AGs, to transfer full knowledge of the project results to the SMEs members that are interested in adopting or further developing the new technologies, to assist in the promotion and exploitation of the project results;
- dissemination of the results to architects, engineers, contractors and developers, in EU and worldwide, by means of technical seminars promoted by the SME-AGs, in cooperation with professional boards and association of designer and constructors (see, for example, support letter from ANCE), continuing education courses organized by RTDPs and demonstration activities at pilot sites, presenting the construction systems and compared economic and performance studies, the construction and design guidelines, the case studies, to raise the interest of the possible users/clients and instruct them on the possibilities of the new technologies; newsletters to the relevant associations and boards of professional. The presence, within the project Consortium of partners having a strong background in structural engineering consultancy, thus bringing into the project the design-engineering viewpoint, will ensure that effective dissemination and exploitation to the professionals is ensured;
- training and educational activities carried out for undergraduate and postgraduate students of University courses of Architecture and Engineering, where RTDPs are involved; activity that is of utter importance in order to have a return on investment also on the long term, as a new generation of designers, familiar with the envisaged construction systems and their main technological and design aspects, is formed;
- dissemination of the achievement to the scientific community, by means of presentation at technical conferences (Italian Conference of Earthquake Engineering that will be held by UNIPD-2013; European Conference of Earthquake Eng-2014; IX International Masonry Conference-2014; North-American Masonry Conference-2015; World Conference on Earthquake Eng-2016; etc); publications in technical/peer-reviewed journals of the building sector (Masonry International; Construction and building materials; Ziegelindustrie International-German; Das Mauerwerk and Mauerwerk Kalender in German; Costruire in Laterizio and L'industria del laterizio in Italian; etc.);
- promotion of the results in appropriate standardization and regulatory communities, where a project liaison is already foreseen to be established with CEN, see support letter (other committees are CIB, RILEM, national committees), for incorporation of INSYSME results to norms and codes (in particular, EN1998; EN1992; EN1996), in particular CEN/TC250 for structural Eurocodes, by means of SME-AGs (particularly TBE at CEN level) and RTDPs representatives into standardization bodies (ensured by the numerous Consortium members already involved in this task);

- presentations and seminars at commercial events and national/international fairs of the construction sector (e.g. CONCRETA-Portugal, BAU and DEBAU-Germany, BATIMAT-France, SAIE and MADE-EXPO-Italy, INFACOMA-Greece), to increase public awareness and acceptance;
- use of conventional commercial advertising and of the external (public) part of the Project WEB site (where, in particular, a project presentation and leaflet, plus the final project video, will be posted), to reach a larger community.

Special dissemination activities, in multi-media format or traditional seminar and continuing education workshop format for architects, engineers, contractors and developers, will be set-up for the presentation of the main project results, i.e. the design and construction guidelines.

3.2.2.2 Exploitation strategy

As already mentioned, the exploitable results of the INSYSME project can be divided into two main categories: exploitable knowledge and exploitable products and measures, that are intended to be commercialized by the enterprises and can be fully used by the end users.
The project results included in the first category (knowledge) are: 1-2) Report on the state of the art of rc frames and masonry enclosures with list of design requirements for the materials and the system, information useful to support the product and technological development during the project but also afterwards by RTDPs, SME-AGs, SMEs. 6-7-8) Experimental results on physical and mechanical properties of materials and walls; definition of new combined testing procedures; characterization of the static and dynamic behaviour of enclosure walls. They enlarge the set of available experimental data and thus constitute exploitable knowledge by RTDPs, but also validate the behaviour of the final products and give hints for further development, and are thus exploitable by SME-AGs and SMEs. 9-10-11) The assessment and use of better modelling strategies for enclosure walls is also an important output knowledge for optimizing materials, systems and design procedures, which is essentially exploitable by RTDPs, and of course by SME-AGs as far as they are concerned with validation of the developed enclosure systems and evaluation of new ones. 14) The calibration and application of NDT for on-site testing partially constitute an exploitable knowledge, as it concerns the use of existing technologies in a new application field, which is relevant for RTDPs and for SMEs of the testing sector. The exploitable final products can be grouped in: 3-4-5) where the materials (masonry units, reinforcement, fasteners, mortar) developed for the enclosure masonry wall systems, can be also applied for other uses (e.g.: load-bearing reinforced masonry, etc.) further improving the SMEs and SME-AGs exploitation; the enclosure masonry wall systems, that represent the central outcomes of the project, and will be conceptually exploited by SME-AGs and commercially exploited by the SME-AGs members. From the construction of prototype building, (13) the definition on-site non-destructive testing and development of quality control procedures (14), guidelines for site organization and execution will be provided (16). The guidelines and quality control procedures constitute again a high added value of the main project product, through which SME-AGs and SMEs can support the use of their products, and demonstrate it with the real construction. 12-15-16) The simplified design rules and design charts for enclosure walls, together with design guidelines and software for their implementation, will result in remarkable added-value for the enclosure walls and high quality design projects. This can be exploited at several level: by RTDPs, but mainly by SME-AGs, to promote standardization and correct design of their members products, by SMEs, using software and/or guidelines as part of their commercialization strategy; by end-users or micro enterprises, like engineers and architects who will use enhanced but simple design methods.
Hence, all three types of project participants (SME-AGs, SMEs, RTDPs) will exploit project results. The successful exploitation by SME-AGs members after the project is dependent on the successful dissemination that poses the bases for exploitation, and on the exploitation plan worked out.

- The SME-AGs will use all of the project results to raise awareness and train their members, so that SMEs can improve their productivity and marketing strategies. Further on, SME-AGs will use the project results to demonstrate the technical viability of the masonry materials-construction system to the end users (designers, contractors, etc), via the dissemination tools described in previous section, making the product more appealing for the related added values and instruments that are provided. The SME-AGs will promote commercial exploitation of the products and trans-sectorial industrial cooperation promoting the project results in closer

Associations (other materials, such as mortar, see for instance the letter of support, or constructors) and Professional Boards. Finally, the promotion of the results in standardization committees will allow incorporating the project outcomes into norms and codes (in particular, EN1998; EN1992; EN1996; a project liaison with CEN is already foreseen, see relevant support letter). This will help filling a current code gap, and represent a fundamental exploitation of the project-generated knowledge.

- The SMEs involved in the project (clay unit producer, fasteners reinforcement producer, software house, engineering consultant), but also the SME-AGs of clay industry acting as their members deputy, will carry out the direct commercial exploitation of the results essentially related to the products. After the successful completion of the project, as already mentioned, the time to market should be estimated in about one year, time needed to finalize and implement the industrial production line, together with packaging, distribution via agents and marketing. The software is another important project result (design of masonry walls, including detailed examples and the design charts) and can be also exploited by SMEs, both software houses in their own business, but also product manufactures, that can sell construction system plus calculation package. This can be essential for the effective use of the developed technologies in the construction market and will also leads to the significant improvement of the structural projects for designers.
- The RTD performers in the project team are normally involved in research activities and in contracts concerning not only masonry walls but also different products, on behalf of industry (most of them SMEs), but also contractors, developers, and owners. It will be thus possible to spread the results of the research to other industrial sectors, fostering the collaboration among different sectors (see, for example, the letter of interests to the INSYSME project received by the mortar producer associations and industries), and the further development of the technologies. The RTD performers, deemed granted the property rights of SME-AGs and SMEs, will also exploit the knowledge acquired during the project, in particular that related to numerical modelling strategies adopted/developed, but not only limited to that, for further research developments.

As regard the direct commercial exploitation, the SME-AGs, in cooperation with their members and on their behalf, will develop a marketing strategy for the novel systems (including software) and will follow through with an appropriate marketing/advertising campaign. After the adequate protection of patentable products, promotion of the technological advance on enclosure masonry walls will be also carried out through the participation in construction fairs, technical visits (for engineers and contractors) and advertising of case studies. The SME-AGs and SME partners have ready-made markets for non-load bearing walls, in the sectors of residential, public and industrial buildings. Initial introduction to market will start from all of the three aforesaid sectors, by the already established relationships that most of the SMEs of the masonry sector have with construction companies. As confidence is established, the SMEs will promote commercial agreements with these contractors to make the introduction of the new product in the market easier. The products will also go to market through construction material distribution-authorized dealers networks.

During the project duration, proper actions to attract potential customers and generate expectation towards the project results, in order to prepare its exploitation, will be planned and implemented. Introduction into the construction sector will be on a phased basis and progressive build up will happen in parallel with anticipated end-user acceptance, in particular contractors that will appreciate the system concept and construction guidelines, and designers, who will feel confident with design guidelines and rules. Hence, the SMEs involved in the project benefit from these project results as tools to attract potential buyers of enclosure systems. Both contractors and designers, thanks to industrialization of the construction solution and to the design rules and software, will increase their productivity; the project results will therefore create a form of indirect exploitation also for other industrial categories.

Table 3.2.2. Project Results (including knowledge) to be acquired by the SME-AGs and other SMEs.

		02 - TBE (SME AG)		03 - ANDIL (SME AG)		04 - ZIEGEL (SME AG)		05 - APICER (SME AG)		06 - TUKDER (SME AG)		13 - RUREDIL (SME)		14 - SDA (SME)		15 - XALKIS (SME)	
Project Result no.	**Project result description**	Type of Expl.	Remuneration	Type of Expl.	Remuneration	Type of Expl.	Remuneration	Type of Expl.	Remuneration	Type of Expl.	Remuneration	Type of Expl.	Remuneration	Type of Expl.	Remuneration	Type of Expl.	Remuneration
1	Abacus of typical typologies of enclosure wall systems and structural frames			Own.	€ 8946			Own.	€ 8968	Own.	€ 11008					Own.	€ 10400
2	Design requirements for the enclosure wall materials: clay units, mortar, reinf. and fastenings			Own.	€ 8946			Own.	€ 21179	Own.	€ 12608					Own.	€ 10400
3	Newly masonry units			Patent.	€ 4594			Patent.	€ 5084	Patent.	€ 9856	Patent.	€ 5952			Patent.	€ 7200
4	Newly reinforcements and fasteners							Patent.	€ 8701	Patent.	€ 8256	Patent.	€ 5952				
5	Newly developed constructive systems for enclosure masonry walls			Patent.	€ 14933	Patent.	€ 17600	Patent.	€ 9601	Patent.	€ 35008					Patent.	€ 16000
6	Physical and mechanical properties of materials and walls			Own.	€ 58514	Own.	€ 35440	Own.	€ 47986	Own.	€ 16512					Own.	€ 54720
7	Definition of method and execution of quasi-static cyclic tests for combined in-plane/out-of-plane			Own.	€ 98499	Own.	€ 115640	Own.	€ 54696	Own.	€ 22016	Own.	€ 29760	Own.	€ 15000	Own.	€ 17600
8	Combined dynamic in-plane/out-of-plane behavior of enclosure walls and frame-to-wall interaction			Own.	€ 106640			Own.	€ 13728	Own.	€ 86528	Own.	€ 106640			Own.	€ 152000
9	Numerical modeling of bare and infilled frames; model calibration and parametric analysis			Licenc.	€ 49222	Licenc.	€ 29600	Licenc.	€ 17603	Licenc.	€ 24512						
10	Numerical modeling of enclosure masonry walls; model calibration and parametric analysis			Licenc.	€ 47420	Licenc.	€ 29600	Licenc.	€ 30395	Licenc.	€ 31520					Licenc.	€ 18240
11	Influence of global frame response on the local wall response and seismic input definition			Licenc.	€ 40422	Licenc.	€ 29600	Licenc.	€ 17734	Licenc.	€ 16512					Licenc.	€ 17600
12	Simplified design models of infill walls (formulations and design charts)			Own.	€ 43420	Own.	€ 26400	Own.	€ 10402	Own.	€ 11008					Own.	€ 8000
13	Final construction technology and construction of real scale walls			Own.	€ 19924	Own.	€ 12000	Own.	€ 32377	Own.	€ 5504					Own.	€ 4800
14	NDT on-site testing for validation and development of quality control procedures			Own.	€ 26935	Own.	€ 10400	Own.	€ 20263							Own.	€ 4800
15	Easy to use software and manual			Own.	€ 5986			Own.	€ 21355							Own.	€ 12800
16	Construction and design guidelines	Licenc.	€ 0	Own.	€ 91499	Own.	€ 44000	Own.	€ 20630	Own.	€ 22016					Own.	€ 27200
SUBTOTAL REMUNERATION			€ 0		€ 625900		€ 350280		€ 340702		€ 312864		€ 148304		€ 15000		€ 361760
TOTAL REMUNERATION	**€ 2154810**																

Own.= Ownership; Patent. = Patenting; Licenc. = Licencing.

3.3 Innovation Impacts

Issues relevant to the scientific/technological innovative aspects of the proposed research are extensively treated in section 3.1; therefore in the following, only some of the most relevant items are summarized by focusing on the advantages of the innovative developed solutions.
As previously mentioned, the innovative character of the proposed systems cannot be sought exclusively in the development of thoroughly new materials and construction techniques, but in the smart combination of (i) conventional materials (i.e. clay brick or block masonry units, mortar) and/or innovative materials (e.g. clay masonry units of particular shape, sliding mortar, various steel components), (ii) sophisticated enhancement techniques (e.g. through application of reinforcement, connectors/fasteners, joints, angles, shelves) and (iii) original design methods.
One of the main output of this project will therefore consist of different industrialized solutions for enclosure masonry walls, to be used (mainly) in rc framed structures. The development proposed in this project will constitute a significant step forward with respect to systems currently available on the market, as it will provide sound solutions for improved seismic (and in general, mechanical) resistance, taking concurrently into account in-plane and out-of-plane behaviour, and being, at the same time:

- sustainable from the environmental, economic and social point of views
- respectful of traditional building techniques, which are mainly based on clay units in the largest part of European countries;
- able to preserve/enhance the best habitability/environmental properties that are already typical of masonry solutions (thermal, acoustic, environmental parameters, etc.);
- innovative in combining traditional and advanced materials and construction techniques;
- widely applicable in European building practise ensuring simple and effective methods for design, detailing and execution, thanks to the companion design guidelines and software.

Furthermore, the developed solutions will effectively help in recovering an important market share with respect to competing light solutions for partition walls.
In the INSYSME project, synergic numerical and experimental research studies will be carried out in order to derive an adequate testing methodology, still not existing, concerning reference rc frame, in-plane displacement history, out-of-plane loads application method, quasi-static or dynamic loading procedure. A number of tests will be carried out on a large number of clay unit infill walls, taking into account the various technologies developed in the project framework; tests results will also be used to calibrate numerical models. Besides tests on single bay structures, also dynamic shaking table tests will be carried out on model buildings, with the use of different enclosure systems developed during the project. Dynamic tests on the prototype real buildings will be also executed.
Considering that there is a lack of rules in the design of enclosure systems in either national and European codes, a fundamental step towards practical and extensive use of the project results will be that of providing contractors and designers with clear rules for construction and design. This will be accomplished, in a first stage, by resorting to the use of guidelines and software developed during the project. Concurrently, during the project duration and afterwards, given the pre-normative research issues considered in INSYSME, all the necessary steps to introduce the general design rules into revised version of the current national codes and Eurocodes will be made: public project's results and guidelines will be made freely available to TBE in the project partnership, and further on to CEN, for use in preparation of structural standards, while the innovative testing procedures adopted can feed pre-normative documents prepared by RILEM and, eventually, constitute a new EN series.
The structure of the project management is designed to guarantee, besides an efficient administrative, scientific and technical management, an effective dissemination and exploitation of the project results, for which, in addition to the activities that will be carried out during the project, it has been agreed that, after the project completion, the SME-AGs will continue to drive exploitation of the project results. This will be pursued by continuing the program of demonstration to their SME members and by continuing the dissemination actions started during the project duration through promotion of the benefits to the general public (publications in technical periodicals, participation in construction fairs, etc), and in particular to the decision makers, stakeholders, contractors, architects, engineers. It is worthwhile recalling that the SME-AGs involved in the project, being

representative of almost 400 SMEs active in the sector, can guarantee a successful, long-time promotion of the project outcomes. Trans-sectorial industrial cooperation is expected to be successfully implemented, as the numerous letters of support to the INSYSME project indicate.
RTD partners, in addition to the scientific support in the development of the innovative solutions, will also contribute to training and educational activities for undergraduate and postgraduate students of University courses of Architecture and Engineering. Education has been recognized to be of basic importance to have a return on investment also on the long term, as a new generation of designers that are familiar with the envisaged construction systems and their main technological and design aspects is formed.
European and worldwide construction markets are foreseen to be reached by SME-AGs and SMEs through direct sales and/or licensing of innovative products/systems developed, also thanks to the aforesaid trans-sectorial envisaged cooperation.
As far as time to market is concerned, a detailed analysis has been carried out from which a realistic plan has been deducted. To this regards, by summarizing, it is expected that approximately one year after the completion of the project, the industrialized versions of developed products/systems will be ready to be marketed.

4. Ethics Issues

There are no direct ethical issue implications foreseeable in this project.

ETHICAL ISSUES TABLE

	Research on Human Embryo/ Foetus	YES	Page
*	Does the proposed research involve human Embryos?	NO	
*	Does the proposed research involve human Foetal Tissues/ Cells?	NO	
*	Does the proposed research involve human Embryonic Stem Cells (hESCs)?	NO	
*	Does the proposed research on human Embryonic Stem Cells involve cells in culture?	NO	
*	Does the proposed research on Human Embryonic Stem Cells involve the derivation of cells from Embryos?	NO	
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	YES	

	Research on Humans	YES	Page
*	Does the proposed research involve children?	NO	
*	Does the proposed research involve patients?	NO	
*	Does the proposed research involve persons not able to give consent?	NO	
*	Does the proposed research involve adult healthy volunteers?	NO	
	Does the proposed research involve Human genetic material?	NO	
	Does the proposed research involve Human biological samples?	NO	
	Does the proposed research involve Human data collection?	NO	
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	YES	

	Privacy	YES	Page
	Does the proposed research involve processing of genetic information or personal data (e.g. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	NO	
	Does the proposed research involve tracking the location or observation of people?	NO	
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	YES	

	Research on Animals	YES	Page
	Does the proposed research involve research on animals?	NO	
	Are those animals transgenic small laboratory animals?	NO	
	Are those animals transgenic farm animals?	NO	
*	Are those animals non-human primates?	NO	
	Are those animals cloned farm animals?	NO	
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	YES	

	Research Involving ICP Countries	YES	Page
	Does the research application address and meet the relevant ethics-related EC/International legal standards and the requirements in the country where the research is performed?	NO	
	Is any material used in the research (e.g. personal data, animal and/or human tissue samples, genetic material, live animal, etc?	NO	
	a) Collected in any of the ICP countries?	NO	
	b) Exported to any other country (including ICPC and EU Member States)?	NO	
	Is the proposed research of benefit to local communities (e.g. capacity building, access to healthcare, education, etc)?	NO	
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	YES	

	Dual Use	YES	Page
	Research having direct military use	NO	
	Research having the potential for terrorist abuse	NO	
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	YES	

5. Consideration of gender aspects

The European Union has a long-standing commitment to promoting gender equality, protected in the Treaty since 1957. The promotion of gender equality is an important element to be addressed and it has duly considered during the preparation of this proposal: as a matter of a fact, the proposed project foresees both participation and division of responsibility that ensure a fair equality among the genders. In particular, many women will be involved in the project including management and coordination of several activities.

Gender equality within the project will be implemented by a gender action plan ensuring that equal opportunities are promoted in recruitment at all levels and encouraging women to apply for research positions and positions within SMEs, Industry, and Public Bodies.

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ANNEX I – LETTERS OF SUPPORT

FROM ASSOCIATIONS, SMEs & INDUSTRY

- CEN – European Committee for Standardization
- ALVEOLATER - Consorzio ALVEOLATER®– Italy
- ANCE – Italian Association of Constructors – Italy
- Tassullo S.p.A. – Italy
- CPI – Consorzio POROTON® Italia – Italy
- APFAC - Portuguese Associations of Construction Mortar & ETICS – Portugal
- iiSBE - International Initiative for a Sustainable Built Environment
- H.L.A. – Hellenic Lime Association – Greece
- K. Raikos AE. – Greece
- S&B Industrial Minerals S.A. – Greece
- SPIT - Société de Prospection et d'Inventions Techniques - France

CEN - European Committee for Standardization
CENELEC - European Committee for Electrotechnical Standardization

CEN CENELEC

Prof. Claudio Modena
Università degli Studi di Padova
Via 8 Febbraio, 2
35122 Padova
ITALY

Brussels, 9 November 2012

Subject: CEN interest in the INSYSME Project

Dear Professor Modena,

I have read with interest your proposal entitled INSYSME- innovative systems for earthquake resistant masonry enclosures in RC buildings, which will be submitted to the call FP7-SME-2013.

As the European Committee for Standardization (CEN), we bring together business federations, commercial and consumer organisations, environmental groups and other stakeholders such as the research community. We are actively promoting the links between the research community and the standardization community, mainly through our Research helpdesk[1].
We therefore would like to make our experience and expertise concerning standardization, interface with stakeholders in the field and support to innovation through standards available to the project.

We welcome the opportunity to link with the INSYSME project once accepted through a Project Liaison[2]. This mechanism will allow the project consortium to exchange information throughout the running of the project with the standardization community and contribute to ongoing European standardization work. Furthermore, INSYSME will be able to take into account in the research project current developments in the standardization system, which can enhance the results of the project. If INSYSME is selected, we invite you to contact us

[1] More information about our activities on research and innovation: www.cencenelec.eu/research.

[2] http://www.cencenelec.eu/research/fp7projects/ongoingENwork/Pages/default.aspx

from the early start of the project so that there is real integration between your research activities and our standardization activities.

We wish you success with your project and look forward to working with the project team.

Yours sincerely,

Ashok Ganesh

CEN-CENELEC Innovation Director

Consorzio ALVEOLATER Piazza Strozzi, n. 1 - 50123 Firenze - tel. fax +39.055.3830624 - consorzio@alveolater.com

Florence, 05.11.2012

Object: **Letter of Support to the INSYSME project proposal.**

ALVEOLATER, active since 1986, is an association that groups together about twelve of Italian bricks producers. The association belong to this group have factories all over the nation. Alveolater, that is the owner both of the Alevolater and Perlater trademarks and of the production knowhow, in 2010 has achieved about 750.000 tons of production.
We have been informed by ANDIL (Italian National Association of Clay Bricks and Roofing Tiles Producer) that, together with Small and Medium Enterprises of various sectors and Universities and Research Organizations from various European country, they intend to submit a proposal for a research project responding to the FP7-SME-2013-BSG call, i.e., a research proposal for the Benefit of SME Associations.
Our opinion and support, stated in this letter, is based on the project outline that our member Associations and the project coordinator, Prof. Claudio Modena, at the University of Padova, sent us. The proposed projects aims to develop new technologies for the construction of enclosure walls in RC framed buildings, taking into account the various environmental performance (healthy indoor environment, temperature, noise, moisture, fire, durability, etc.), but also the structural requirements that these systems need to have, particularly for what concern the resistance under earthquake actions. The project results will also include simple rules for design, guidelines and software.
The proposed technologies and the knowledge that will be acquired by means of INSYSME project are relevant for the sector, sustain the enterprises, exploit excellence and increase competitiveness, particularly in this period of crisis. We are willing to externally cooperate to the project consortium, in orienting the technology development, bringing forward the needs of companies from other countries than those forming the consortium, disseminating the public results of the project and using them for the updating and advancement of regulation and standards.

Yours sincerely,

arch. Claudio Piferi

ANCE | ASSOCIAZIONE NAZIONALE
COSTRUTTORI EDILI

VICE PRESIDENTE
TECNOLOGIA ED INNOVAZIONE

Rome, 02/11/2012

Letter of Support to the INSYSME project proposal

ANCE is the National Association of private construction contractors, involved in public works, residential and industrial buildings.
It represents 20 Regional Organizations, 102 Provincial Associations and 20,000 Construction companies whatever the dimension and the operational sector. ANCE is involved with Administrative Authorities in governing the territory, planning investments and designing interventions; it interacts with the Italian government regarding Energy Efficiencies and Renewable Energies legislation and it dialogues with political, social and cultural Institutions at National and European level.

We have been informed by ANDIL (Italian National Association of Clay Bricks and Roofing Tiles Producer) that, together with Small and Medium Enterprises of various sectors and Universities and Research Organisations from various European country, they intend to submit a proposal for a research project responding to the FP7-SME-2013-BSG call, i.e., a research proposal for the Benefit of SME Associations.

Our opinion and support, stated in this letter, is based on the project outline that our member Associations and the project coordinator, Prof. Claudio Modena, at the University of Padova, sent us. The proposed projects aims to develop new technologies for the construction of enclosure walls in RC framed buildings, taking into account the various environmental performance (healthy indoor environment, temperature, noise, moisture, fire, durability, etc.), but also the structural requirements that these systems need to have, particularly for what concern the resistance under earthquake actions. The project results will also include simple rules for design, guidelines and software.

The proposed technologies and the knowledge that will be acquired by means of INSYSME are relevant for the sector, sustain the enterprises, exploit excellence and increase competitiveness, particularly in this period of crisis. We are willing to externally cooperate to the project consortium, in orienting the technology development, bringing forward the needs of companies from other countries than those forming the consortium, disseminating the public results of the project and using them for the updating and advancement of regulation and standards.

Yours sincerely,

Piero Torretta

Via G.A.Guattani, 16-18 - 00161 Roma
Tel. 06 845671 - Fax 06 84567555 - C.F. 80022490587 - info@ance.it - **www.ance.it**

TASSULLO MATERIALI S.p.A.
Via Nazionale, 157 - 38010 Tassullo (TN)
tel. +39-0463-662100 r.a. - fax +39-0463-662143
www.tassullo.com

TASSULLO
TECNICHE E MATERIALI PER COSTRUIRE

Tassullo (TN), 30 ottobre 2012

Letter of Support to the INSYSME project proposal.

TASSULLO MATERIALI S.p.A. was founded in 1909. Since then, it studies, develops, manufactures and commercializes product based on natural hydraulic lime mortars. In this field, Tassullo is a leading industry. Its products are developed in order to reach the highest requirements of transpirability, durability, and compatibility with existing masonry. Tassullo set an internal research department where all the products are developed and design in order to satisfy the demand of the modern building technology, applied to the retrofit of existing structures. The research projects and the material development are carried out independently or in cooperation with universities and research centres, also in the framework of EU funded projects.

Tassullo has been informed about the intention of European Clay Industry Associations, Small and Medium Enterprises of various sectors and Universities and Research Organisations from various European country to submit a proposal for a research project responding to the FP7-SME-2013-BSG call, i.e., a research proposal for the Benefit of SME Associations. Our opinion and support, stated in this letter, is based on the project outline that Prof. Claudio Modena, the project proposal coordinator, sent us.

We are familiar with his research, related to both development of innovative masonry systems and development of intervention techniques for historic masonry. We have participated together within the framework of a previous EU funded project (DISWall, COOP-CT-2005-18120) and developed a special mortar for load-bearing reinforced masonry. The INSYSME project aims to develop new technologies for the construction of enclosure walls in RC framed buildings, taking into account the various environmental enclosure performance (healthy indoor environment, temperature, noise, moisture, fire, durability, etc.), but also the structural requirements that these systems need to have, with introduction of reinforcement and fasteners.

Tassullo fully supports the project proposal and commits itself to provide pre-existing know-how for mortar development. When required, it will supply materials for construction of specimens and testing purposes.

Yours sincerely,

Chief Executive Officer
Stefano Odorizzi

TASSULLO MATERIALI S.p.A.
Via Nazionale - 38010 Tassullo (TN)
C.F. e P.IVA 00217620202

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Verona, 02/11/2012

Letter of Support to the INSYSME project proposal

CPI is the "Consorzio POROTON® Italia" founded in 1972, currently is composed by 17 clay masonry unit producers, with 21 factories, distributed throughout Italy, and is active member of ANDIL (Italian National Association of Clay Bricks and Roofing Tiles Producer). CPI holds the rights of the POROTON® international brand for Italy, which distinguishes a lightweight clay paste with specific technical characteristics and performances. The national market share of the CPI, relating to clay units for masonry walls, is about 35%.
CPI promotes and conducts research studies, contributes significantly to the evolution of national regulations, provides technical assistance to the users and contributes to disseminate the knowledge, with regard to the performance and correct usage of the clay products. CPI directly participated and supported various European funded project (D.RE.MA.B., BREU-CT95-0575; DISWall, COOP-CT-2005-18120) for the development of construction systems aimed to reduce the vulnerability of buildings in seismic prone regions.

We have been informed by University of Padova and ANDIL that, together with European Associations of clay brick/block industry sector, Small and Medium Enterprises of various sectors and Universities and Research Organisations from various European country, they intend to submit a proposal for a research project responding to the FP7-SME-2013-BSG call, i.e., a research proposal for the Benefit of SME Associations.

We are familiar with research and development activities carried out by our Association, by the University of Padova, with whom we have collaborated in the framework of the above-mentioned research projects, related to development of innovative load-bearing masonry systems.

Our opinion and support, stated in this letter, is based on the project outline that our member Associations and the project coordinator, Prof. Claudio Modena, at the University of Padova, sent us. The proposed projects aims to develop new technologies for the construction of enclosure walls in RC framed buildings, taking into account the various environmental performance (healthy indoor environment, temperature, noise, moisture, fire, durability, etc.), but also the structural requirements that these systems need to have, particularly for what concern the resistance under earthquake actions. The project results will also include simple rules for design, guidelines and software.

The proposed technologies and the knowledge that will be acquired by means of INSYSME project are relevant for the sector, sustain the enterprises, exploit excellence and increase competitiveness, particularly in this period of crisis. We are willing to externally cooperate to the project consortium, in orienting the technology development, bringing forward the needs of companies from other countries than those forming the consortium, disseminating the public results of the project and using them for the updating and advancement of regulation and standards.

Yours sincerely,

Consorzio POROTON® Italia
IL PRESIDENTE

APFAC
Associação Portuguesa dos
Fabricantes de Argamassas de Construção

Lisbon, 02/11/2012

Subject: Letter of support to the INSYSME project proposal

APFAC is the Associação Portuguesa dos Fabricantes de Argamassas e ETICS (Portuguese Association of Construction Mortar & ETICS).

APFAC has 14 Associate Members, representing more than 70% of the Mortar and ETICS (External Thermal Insulation Composite Systems) in the Portuguese market.

In our country, we promote standardization, industrial development within our associated SMEs, and research and training activities in cooperation with the major Universities and Research Centres, in the field of Mortars and ETICS.

The President of APFAC is also Vice-President of EMO, European Mortar Industry Organization (http://www.euromortar.com/).

We have been informed about the intention of Associations of masonry unit producers, Small and Medium Enterprises of various sectors and Universities and Research Organisations from various European countries to submit a proposal for a research project responding to the FP7-SME-2013-BSG call, i.e., a research proposal for the Benefit of SME Associations.

Our opinion and support, stated in this letter, is based on the project outline that our corresponding Associations and the Project Coordinator, Prof. Claudio Modena, at the University of Padova, sent us. The proposed projects aims to develop new technologies for the construction of enclosure walls in RC framed buildings, taking into account the various environmental enclosure performance (healthy indoor environment, temperature, noise, moisture, fire, durability, etc.), but also the structural requirements that these systems need to have, particularly for what concern the resistance under earthquake actions. The project results will also include simple rules for design, guidelines and software.

The proposed technologies and the knowledge that will be acquired by means of INSYSME project are relevant for the sector, sustain the enterprises, exploit excellence and increase competitiveness. We are willing to externally cooperate to the project consortium, within our limitations, in orienting the technology development, bringing forward the needs of mortar and ETICS producers, and disseminating the public results of the project among the SMEs that are in contact with our entity for their mutual benefit.

Yours sincerely,

Carlos Duarte

President of APFAC

APFAC
Associação Portuguesa dos Fabricantes de Argamassas de Construção
Praça das Indústrias, Edifício Rosa, Piso 1
1300-307 LISBOA, PORTUGAL
Tel. 213 601 220. Fax 213 601 219

Filiada na EMO – European Mortar Industry Organisation

Iniciativa Internacional para a Sustentabilidade do Ambiente Construído
International Initiative for a Sustainable Built Environment

Delegação Portuguesa *Portuguese Chapter*

02/11/2012

Letter of Support to the INSYSME project proposal

iiSBE (International Initiative for a Sustainable Built Environment) is an international non profit networking organization with a main objective to focus on guiding the international construction industry towards sustainable building practices. The emphasis is on research and policy, with a special focus on building performance and its assessment, and board members from 16 countries.

We have been informed about the intention of Associations of masonry unit producers, Small and Medium Enterprises of various sectors and Universities and Research Organisations from various European countries to submit a proposal for a research project responding to the FP7-SME-2013-BSG call, i.e., a research proposal for the Benefit of SME Associations.

Our opinion and support, stated in this letter, is based on the project outline that our corresponding Associations and the project coordinator, Prof. Claudio Modena, at the University of Padova, sent us. The proposed projects aims to develop new technologies for the construction of enclosure walls in RC framed buildings, taking into account the various environmental enclosure performance (healthy indoor environment, temperature, noise, moisture, fire, durability, etc.), but also the structural requirements that these systems need to have, particularly for what concern the resistance under earthquake actions. The project results will also include simple rules for design, guidelines and software.

The proposed technologies and the knowledge that will be acquired by means of INSYSME are relevant for the sector, sustain the enterprises, exploit excellence and increase competitiveness. We are willing to externally cooperate to the project consortium, within our limitations, in orienting the technology development, bringing forward the needs of sector with a focus on sustainability issues, and disseminating the public results of the project among the SMEs that are in contact with our entity for their mutual benefit.

Yours sincerely,

L. Bragança

Prof. Luís Bragança
Chairman of iiSBE Portugal

Associação iiSBE Portugal Escola de Engenharia DEC Campus de Azurém 4800-058 Guimarães
Website: http://www.iiSBEportugal.org E-mail: info@iisbeportugal.org Telefone/Fax: +351 253 510 499

ΕΛΛΗΝΙΚΟΣ ΣΥΝΔΕΣΜΟΣ ΑΣΒΕΣΤΟΥ
HELLENIC LIME ASSOCIATION

Athens, 5 November 2012

Letter of Support to the INSYSME project proposal

The Hellenic Lime Association (H.L.A.) is the association of lime producers in Greece. It represents 15 quicklime producers and cooperates with more than 100 lime putty and hydrated lime producers. Some of its main goals are to promote industrial development within its associated SMEs and to improve the level of scientific knowledge within its membership, colaborating many times with Greek Universities in order to achieve this.

H.L.A. has been informed about the intention of European Clay Industry Associations, Small and Medium Enterprises of various sectors and Universities and Research Organisations from various European countries to submit a proposal for a research project responding to the FP7-SME-2013-BSG call, i.e., a research proposal for the Benefit of SME Associations.

Our opinion and support, stated in this letter, is based on the project outline that Prof. Claudio Modena, the project proposal coordinator, sent us. We are familiar with his research, related to both development of innovative masonry systems and development of intervention techniques for historic masonry. The proposed INSYSME project aims to develop new technologies for the construction of enclosure walls in RC framed buildings, taking into account the various environmental enclosure performance (healthy indoor environment, temperature, noise, moisture, fire, durability, etc.), but also the structural requirements that these systems need to have, for which enhancement by means of reinforcement is foreseen.

H.L.A. fully supports the project proposal also bearing in mind its wide European perspective and positive impact on construction industry in general and commits itself to provide pre-existing know-how for mortar development. We believe that the project results, including also simple rules for design and guideline, will be of outmost importance for the competitiveness of the sector.

Yours sincerely,

Michalis Raikos
President of the Hellenic Lime Association

Association office address:
Evripidou 6, 10559 Athens / Greece
Tel: +30 2118503910, Fax: +302118503828, e-mail: info@lime-association.gr

K. ΡΑΪΚΟΣ Α.Ε.

HIGH QUALITY LIME

K. Raikos A.E, 6/11/2012

Letter of Support to the INSYSME project proposal

K. Raikos A.E. manufactures and commercializes lime products of high quality, being one of the leading industries of the sector in Greece. Its products are developed in order to reach the highest requirements of the constructions sector.

K. Raikos A.E. has been informed about the intention of European Clay Industry Associations, Small and Medium Enterprises of various sectors and Universities and Research Organisations from various European countries to submit a proposal for a research project responding to the FP7-SME-2013-BSG call, i.e., a research proposal for the Benefit of SME Associations.

Our opinion and support, stated in this letter, is based on the project outline that Prof. Claudio Modena, the project proposal coordinator, sent us. We are familiar with his research, related to both development of innovative masonry systems and development of intervention techniques for historic masonry. The proposed INSYSME project aims to develop new technologies for the construction of enclosure walls in RC framed buildings, taking into account the various environmental enclosure performance (healthy indoor environment, temperature, noise, moisture, fire, durability, etc.), but also the structural requirements that these systems need to have, for which enhancement by means of reinforcement is foreseen.

K. Raikos A.E. fully supports the project proposal also bearing in mind its wide European perspective and positive impact on construction industry in general and commits itself to provide pre-existing know-how for mortar development. When required, it will supply materials for construction of specimens and testing purposes. We believe that the project results, including also simple rules for design and guideline, will be of outmost importance for the competitiveness of the sector.

Yours sincerely,

Michalis Raikos
K. Raikos A.E.

Chr. Smyrnis 6, 151 21, Pefki / Attika / Greece
Tel. : 210 6125428, 29, 30 Fax: 210 8026500

S&B Industrial Minerals S.A. (S&B),
Athens, 6/11/2012

Letter of Support to the INSYSME project proposal

S&B Industrial Minerals S.A. constitutes a Group of companies, with a strong international presence, selling its products in more than 60 countries worldwide. It was established in Greece in 1934 and is listed on the Athens Stock Exchange since 1994. The Group's core activity is the mining, processing and trade of industrial minerals, metallic ores and mineral-bases products. Utilizing the multiple properties of industrial minerals S&B converts natural resources into customized value-adding industrial solutions for a broad range of applications including steel-making, construction and building materials, metallurgy and horticulture.

S&B is currently conducting several research products in the area of special additives and end-products to be used in retrofitting works. Moreover, S&B already supplies European building materials market with mineral-based additives and functional fillers for special mortars, cement mix designs, etc. S&B is also involved in several relevant EU funded projects.

S&B has been informed about the intention of European Clay Industry Associations, Small and Medium Enterprises and Universities and Research Organisations from various European countries to submit a proposal for a research project responding to the FP7-SME-2013-BSG call. Our opinion and support, stated in this letter, is based on the project outline that Prof. Claudio Modena, the project proposal coordinator, has sent us.
We are familiar with his research, related to both development of innovative masonry systems and development of intervention techniques for historic masonry. S&B participates in NIKER, an EU funded project under the title "NEW INTEGRATED KNOWLEDGE BASED APPROACHES TO THE PROTECTION OF CULTURAL HERITAGE FROM EARTHQUAKE-INDUCED RISK". S&B's role in NIKER is the development of innovative mineral-based materials which will be used in Cultural Heritage Buildings and Monuments.

INSYSME project aims to the development of new technologies for the construction of enclosure walls in RC framed buildings, taking into account the various environmental enclosure performance (healthy indoor environment, temperature, noise, moisture, fire, durability, etc.), but also the structural requirements that these systems need to have, with introduction of reinforcement and fasteners.

S&B fully supports the project proposal and commits itself to provide know-how for mortar mix design. Once required, S&B will supply existing and new mineral-based products for the preparation and evaluation specimens of any size.

Yours sincerely,

Anastasios Kladis

Business Development Manager

S&B Industrial Minerals S.A.

Valence, 30/10/2012

Letter of Support to the INSYSME project proposal

SPIT (Societe de Prospection et d'Inventions Techniques), founded in 1951 in Valence (France), has been providing construction industry professionals with its experience in fixing and drilling for over 50 years. Spit is committed to Quality, Innovation, Customer support and On-site Support. SPIT in France covers 4 research and development departments, 3 test laboratories and 5 plants focused on different technologies. With its striking force of technical and commercial staff (more than 500 people in France), and a real policy of industrial investments, SPIT achieved in 2009 sales of over 140 million Euros, exporting more than half of its products to the rest of Europe, the Middle East, Australia and even Asia.

We have been informed about the intention of Clay Industry Associations in Europe, Small and Medium Enterprises of various sectors and Universities and Research Organisations from various European country to submit a proposal for a research project responding to the FP7-SME-2013-BSG call, i.e., a research proposal for the Benefit of SME Associations.

Our opinion and support, stated in this letter, is based on the project outline that the project coordinator, Prof. Claudio Modena, at the University of Padova, sent us. The proposed projects aims to develop new technologies for the construction of enclosure walls in RC framed buildings, taking into account the various environmental enclosure performance (healthy indoor environment, temperature, noise, moisture, fire, durability, etc.), but also the structural requirements that these systems need to have, for which enhancement by means of fastenings and fixings to the frame structure is foreseen.

We support the project proposal, and are interested in being involved for example for supplying fastening products needed for the experimental activities. We support the project proposal also bearing in mind its wide European perspective and positive impact on construction industry in general.

Yours sincerely.

Didier Bourrette

President