



**COLL-CT-2003-500291**

**ESECMaSE**

Enhanced Safety and efficient construction of Masonry Structures in Europe

Collective Research

**Final activity report**

Period covered:  
**from June 10<sup>th</sup>, 2006 to June 9<sup>th</sup>, 2008**

Date of preparation:  
**October 25th 2008**

Start date of project:  
**June 10<sup>th</sup> 2004**

Duration:  
**45 month**

Project coordinator name:  
**Mr. Joachim Kieker**

Project coordinator organisation name:  
**DGfM, Participant N° 1**



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## ESECMaSE – Enhanced Safety and Efficient Construction of Masonry Structures in Europe

### Summary of the project

reporting period: June 10<sup>th</sup> 2004 - June 10<sup>th</sup> 2008

*Within the European research project ESECMaSE static-cyclic and pseudo-dynamic shear wall tests were carried out at Kassel University (Germany), at Pavia University (Italy) and at the technical University of Munich (Germany). Furthermore shaking table tests and pseudodynamic full scale tests were executed at the technical University of Athens (Greece) and the JRC in Ispra (Italy). These tests followed the aim to extend the knowledge about the shear bearing capacity and the deformation capacity of masonry walls made of different kind of units and mortar. For different kinds of masonry walls and for different boundary conditions, a new design model for the shear resistance could be developed and verified by the tests. Finally, a proposal for a new design procedure for the coming European code has been developed including a proposal for realistic behaviour factors for masonry structures.*

The aim of the ESECMaSE project was to develop a better understanding of the stress states in typical masonry structures (Workpackage WP 3), the identification of the relevant material parameters and suitable test methods (WP 5, 6), the improvement of existing design models for shear loaded masonry (WP4), and the optimization of masonry unit properties (WP2). The shear bearing capacity and the deformation capacity of masonry structures was analyzed by static-cyclic and pseudodynamic wall tests (WP 7) as well as in shaking table tests and pseudodynamic full scale tests (WP 8). A proposal for a new design procedure for the coming European code was evaluated in WP 9.

In work package 2, proposals for the optimization of masonry units have been elaborated for both clay and calcium silicate units. Comparative tests showed, that an improvement of the material properties (the material of which the webs and shells consist of) can be achieved using optimised raw materials or admixing selected aggregates.

Apart from the improvement of material properties the work package focussed on the improvement of the perforation pattern of the units.



figure 1: four point bending test arrangement



figure 2 compression test of the optimised clay brick (1<sup>st</sup> optimisation step) in longitudinal direction

In order to model the stress states in typical masonry houses and to identify the expected failure modes, two common cases have been studied.

These are typical terraced houses and multi-storey apartment houses, for which 3D – Finite Element Models have been made (see figure 3). These models consider the most important nonlinearities which have to be expected due to the inelastic behaviour of masonry especially due to combined shear/tension loading (horizontal joint opening). By parametric studies, configurations with different values of the length (in ground plan) of the main shear walls have been investigated. With respect to the relevant current design code provisions (EC 6), the ultimate lateral loads could be determined in dependency of the actual wall length.

As input parameters for the material behaviour for the finite element models, relevant material properties have been defined in WP2.

Actual data for calcium silicate masonry and clay masonry have been determined experimentally in deliverable 3.0.

To begin with, the investigations in WP 4 were focussed on the comparison of different approaches as used by international design codes (Eurocode, DIN, SIA, Canadian Code). There are principal differences, moreover, with respect to the philosophy of using elastic or plastic theory for determining the stress distribution in shear walls and with respect to the safety concepts. Figure 4 visualizes how much the results deviate depending on the model in use.

Based on this existing models and a parametric study using a nonlinear finite element modelling approach, a new design model for the shear resistance was developed in this work package.

For the finite element modelling, a micro-model with a reduced level of detailing was chosen (see Fig. 5), for which the mortar in the joints had been represented by interface-elements with appropriate constitutive models.

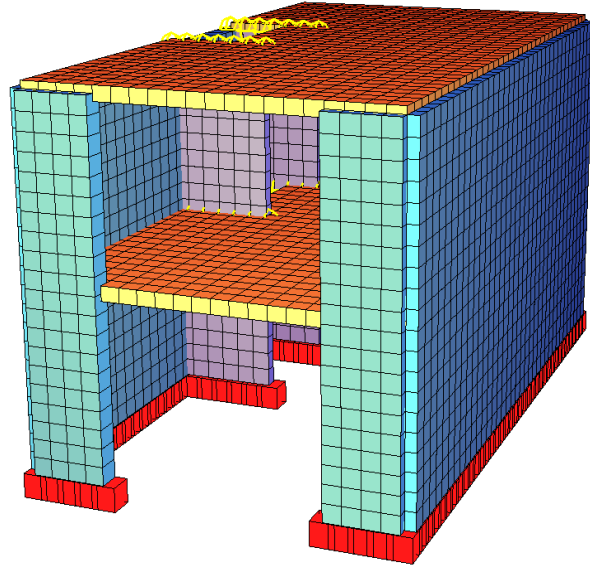


figure 3: finite-element-model of a terraced house

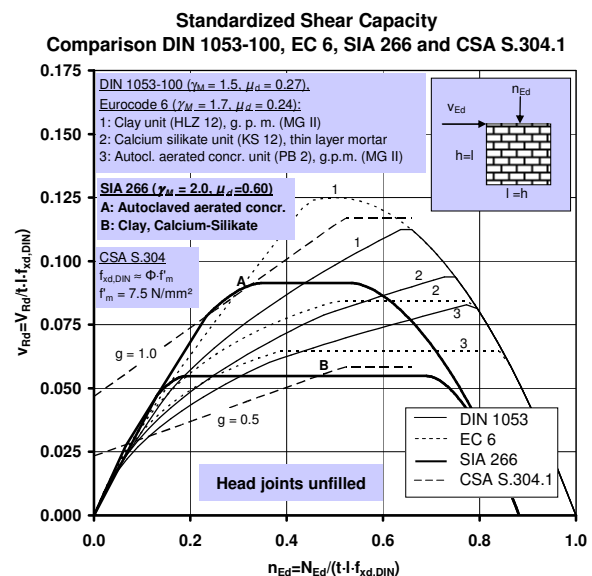


figure 4: comparison of standardized shear capacity according to different design codes

Figure 6 shows the results of the FE-calculations in excerpts. The different types of failure were identified by analysis of the stress- and crack patterns. These are:

- Bending (flexural failure)
- Gaping of the single units in the bed joints
- Diagonal tensile failure of the units
- Sliding in the bed joints

The developed proposal for the calculation of the shear resistance of wall panels has been compared with the maximum horizontal load determined from experimental data including the ESECMaSE tests on storey high masonry panels (WP7). It could be shown that the new integral approach reduced the scatter of the predictions considerably. After calibration of the unit tensile strength specific to the different masonry types, a quite uniform safety level could be reached. Thus, the model could be validated also for the different combinations of loading parameters and geometry as used in the ESECMaSE tests.

Workpackage 5 started with a literature review of existing test methods for tensile strength and bond strength. Several types of tests were analysed and performed on masonry units to evaluate the suitability of the method and the relation of the test result values. The main goal of work package 5 was the development of a simple test method for the determination of the basic material properties related to the shear and tensile strength of masonry. Therefore, several testing methods, 3 standardised and 5 (partly new) non- standardised methods were used in an extensive testing program of small test units (couplets and triplets). These simple tests are able to determine the bond and tensile strength of masonry, simple, suitable, quick and cost-effective.

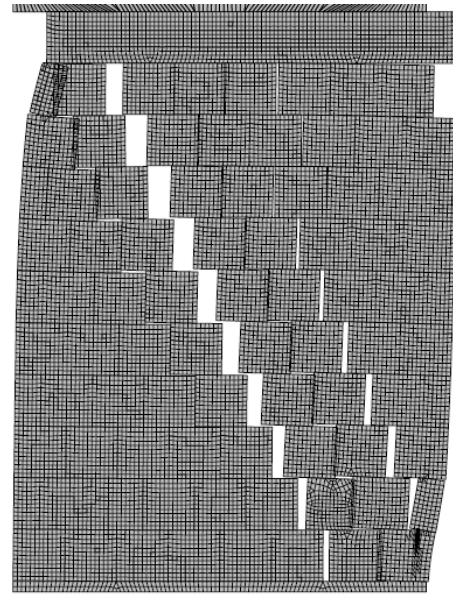


figure 5: crack pattern of the finite-element-model

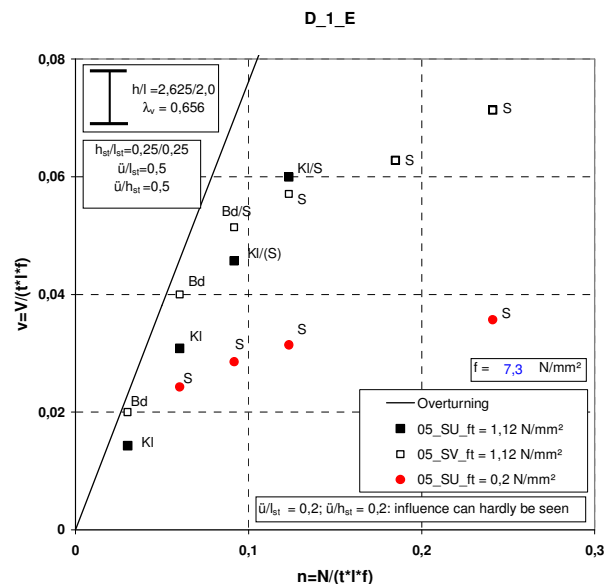


figure 6: results of the FE-calculations



In work package 6, a test set-up for shear tests on masonry walls of realistic dimensions is constructed (see figure 7) and validated by a series of shear tests at the University of Kassel and the Technical University of Munich.

For a realistic test set-up it is inevitable to represent the rotation restraint due to the floor slab in the test. So within the three tests set-ups (TUM, UNIK and UPAVIA) a cap moment of the wall is given by two hydraulic jacks who also apply the vertical load.

In WP 7 static-cyclic tests were carried out at Kassel University, Pavia University (see figure 8) and at the Technical University of Munich. Furthermore, pseudo-dynamic wall tests were arranged at Kassel University and at the Technical University of Munich. For the static-cyclic tests, three slightly differing test set-ups at the three laboratories were established according to WP 6. However, comparative wall tests with the different setups have proven good congruency of the results.

In total, 47 static-cyclic tests on different kinds of masonry were carried out to analyse the influence of different boundary conditions on the shear strength and the deformation capacity of masonry walls.

Eight pseudo-dynamic wall tests were carried out at Kassel University using the same test setup as for the static cyclic tests. The test specimen with a height of 2.5 m represents one of the main walls in the ground floor of a two storey terraced house as tested in full scale at JRC Ispra (see figure 9).

In order to approximately simulate the behaviour of masonry walls in such a building, the pseudo dynamic tests were performed as single degree of freedom tests assuming the distribution of inertia forces from the first vibration mode of the two stories building.

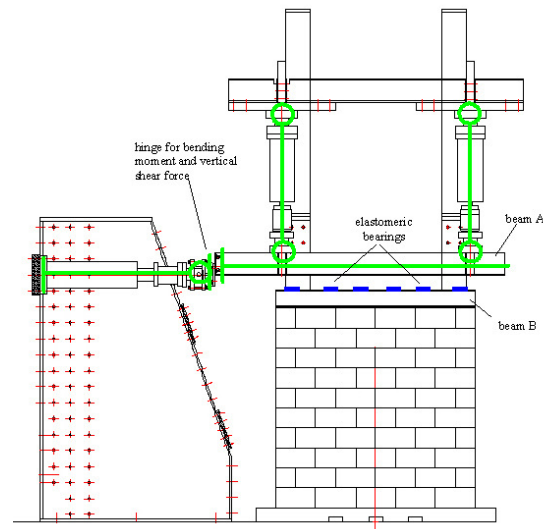


figure 7: static system of the test set-up of UNIK



figure 8: test set-up of Pavia University

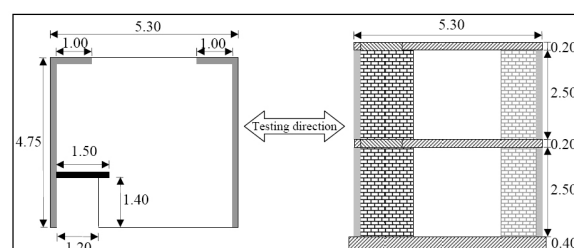


figure 9: ground plan and view of the JRC specimen

At the Technical University of Munich, 12 pseudo-dynamic wall tests were carried out on a 2- resp. 3-storey structure-system. Here the relevant shear wall in the 1<sup>st</sup> storey was investigated experimentally while the rest of the structure was modelled numerically using a finite-element-programme. Figure 10 shows the numerical model of the tests.

To validate the results of the static-cyclic and pseudo-dynamic wall tests under fully dynamic loading conditions, shaking table tests have been performed at NTU Athens. Therefore seven specimens built of clay bricks, calcium silicate units and lightweight aggregate concrete (LAC) units, as shown in figure 11, were tested.

Pseudo-dynamic tests on two full scale two-storey high terraced houses have been carried out at the Joint Research Center (JRC) of the European Union in Ispra (Italy). The houses were constructed with clay unit masonry and calcium silicate unit masonry respectively. Figure 12 gives an overview of the test arrangement (WP 8).

In WP 9 a text proposal for the revision of the EC 6 is given after a brief reflection of the safety concept. The proposal was thereupon compared with the existing experimental results. It could be established, that within the terms of the tested range, an acceptable safety margin can be guaranteed.

Herewith presented proposals give simplified approaches of calculation for masonry structures under seismic loads, which should be implemented in the existing Eurocode EN 1998-1. Furthermore behaviour factors were derived from the pseudo-dynamic tests and by use of the ductility of the static-cyclic wall tests, as shown in figure 10.

In conclusion, the project has shown the complex behaviour of masonry walls under in plane loading. The new approach for a design model could be validated by the great number of tests in this research project.

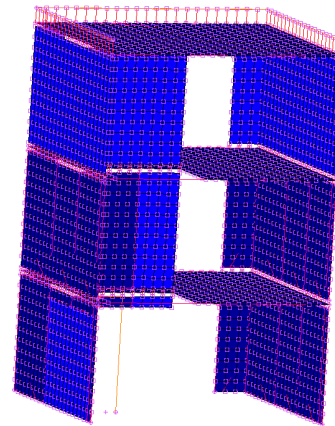


fig. 10: FE-model for tests at TU Munich



fig. 11: view of a dynamic test in Athens

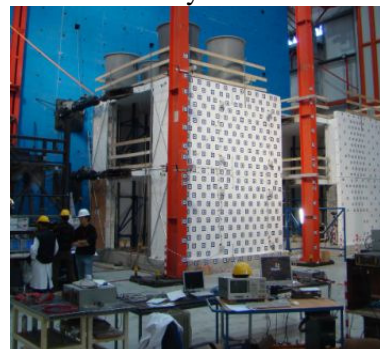


fig. 12: view of the full scale test at JRC Ispra

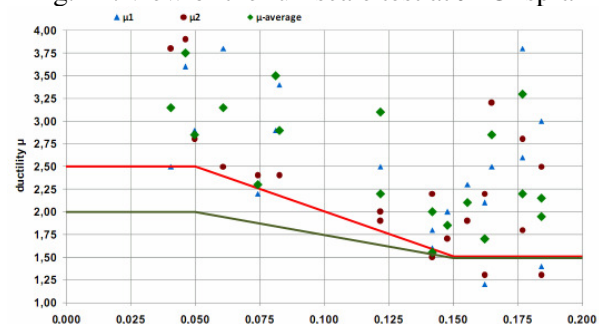


fig. 13: relation of the ductility and vertical load

## **Periodic Activity Report**

### **Section 1**

#### **Project objectives and major achievements of the whole project**

At first, typical material parameters of the tested masonry units had to be investigated and the material characteristics of these units had to be determined. In another step a theoretical study based on the Finite-Element-Method, FEM for optimisation of dimensions and perforation pattern of units was started by RTD performers P21. The theoretical investigations for the optimization were based on the improvement of the compressive strength of the units in the direction parallel to the bedjoints as an indicator for the enhancement of the shear resistance of masonry walls. Also the improvement of ductility was a relevant aspect with regard to the case of seismic loading. Optimised units were fabricated and delivered to the laboratory of the participants which had to perform the shear wall tests

The main objective of WP3 was the identification of critical zones and expected failure modes for both, unreinforced and confined masonry buildings. Also the influence of unit geometry with respect to wall size and the study of load path in case of reversed loading and feedback for material tests were performed.

Within the study, different loading intensities were investigated leading to different sizes of the compression zone. This information is being provided in order to study the influence of the size of masonry units. The performing RTD Partners were P15 and P21.

In WP 4 the essential influences on the calculation of the bearing capacity according to several national and international codes have been analysed. Besides the material properties, geometry and system parameters as well as the design concept play a major role. These influences affect the carrying capacity of a horizontally stressed masonry panel very differently. Therefore a new design model for shear strength was developed. The proposal for the calculation of the in-plane bearing capacity of the shear panels has been compared with the maximum horizontal load determined in tests on storey high masonry panels. Additionally to the aim to recalculate these loads, it was checked, whether the decisive type of failure according to the calculation corresponds to the observed failure modes in the test.

The new integral approach performs very well, especially after calibration. The model works without consideration of the uncertain parameters tensile strength perpendicular to the bed joints and initial shear strength (cohesion). The investigations have also shown, that some of the developed equations are valid for all types of units (bending and gaping), whereas others (friction and tensile) should be modified in terms of the types of units to get better results.

Following the development of a proposal for a new test method for masonry walls with realistic dimensions (WP 6), three test set-ups in each laboratory of the participants TUM, UNIK and UPAVIA had to be constructed. Tests for evaluation and improvement of these test set-ups were performed at the University of Kassel, the Technical University of Munich and the University of Pavia. These tests have shown in general the appropriateness of the proposed testing procedure.



Using the new test setup, static-cyclic and pseudo-dynamic tests on walls of conventional and optimised masonry units were performed to evaluate the effect of the optimization. It has been found out that relating to the different kind of units with the same compressive strength the influence on the load bearing capacity of the wall is rather low. In contrast a higher deformation capacity of the walls built with the optimised clay units in comparison to the walls built with the conventional clay units could be discovered. Further more the influence of the different boundary conditions (length and height of the wall, restraint at the top of the wall, kind of units, kind of mortar and overlapping length) on the shear bearing capacity and on the deformation capacity has been investigated. Based on the enormous data achieved by these wall tests, a first proposal of behaviour factors was given.

To validate the results of the static-cyclic and pseudo-dynamic wall tests under fully dynamic loading conditions, shaking table tests have been performed at NTU Athens. Seven specimens built of clay bricks, calcium silicate units and lightweight aggregate concrete (LAC) units were tested.

The integral behaviour of typical terraced houses with masonry walls was studied in two pseudo dynamic full scale tests at JRC Ispra. Two specimens – each a half of a two story terraced house – made of calcium silicate units and clay bricks were built and tested.

## Section 2

### Workpackage progress of the period

#### Work package 1: Project Management

**Participants:** P1 (DGfM); Reporting Period from: June 10<sup>th</sup> 2006

#### Objectives, progress towards and achievement

- *General coordination*

*The coordinator is the partner which is responsible for the project web site which is running until the end of 2008, and which has to be updated until then.*

*The other details of the general coordination had been explained in the Periodic Reports.*

- *Coordination of the research-related activities*

*The research –related activities had been coordinated mainly by the coordinator and the Project Steering Committee, PSC. The PSC, and the consortium meetings had been convened by the coordinator. Also, several meetings of certain WPs had been necessary in order to progress the research activities and to keep the knowledge flow between the partners involved in certain parts of the project.*

*Directly the coordinator was involved in training and dissemination activities. He presented interim results to masonry experts on the masonry conference in London 2007 and several times on national meetings.*

*As explained in the periodic reports, the consortium decided for several reasons, that the project period should be extended. It was the task of the coordinator, to propose these changes of the workplan and timetable and than to monitor the timeschedule.*

*Therefore, another extension of the project period was necessary and had to be proposed by the coordinator. This included an updated timetable and work plan.*

- *Coordination between RTD performers and SMEs*

*The coordinator takes care, that the coordination between the RTD performers and the SME's involved succeeds. It was a major task to make sure, that RTD Performers were supported by the other partners, to perform the scheduled large scale testing at several testing sites in Europe. This task was performed involving the IAG partners of the relevant industry branches.*

- *Liaison to the Commission Services*

*The coordinator is the contact person to both, the scientific project officer and the financial unit of the Commission. The major task after the 3 reporting periods was the planning and distribution of the 3 tranches of Pre Financing to the project partners. After the termination of the project period, it is still the task of the coordinator to prepare the 3<sup>rd</sup> Periodic Report and this final report and to commit the evaluation of the commission. The last major task is the distribution of the final payment.*

**Deliverables****D1.1**

*Project management, including the organisation of necessary meetings and the provision of status reports for the project partners until month 36 (end of the project).*

**D1.2**

*Organisation of a conference for standardisation experts, before month 33.*

**remark:**     **- all deliverables fulfilled**

**Milestones**

*no milestones defined for WP1.*

### Work package 2: Optimisation of Unit Properties

**Participants:** P3 (AMz), P5 (VÖZ), P7 (Peter), P8 (Zapf), P9 (Cirkel), P10 (Wiest), P11 (Pexider), P12 (RIL), P13 (Lias), P14 (SEPA), P18 (TNO Bouw), P21 (TUM), P24 (FVKS), P25 (IZF)

**WP-Leader :** P21 (TUM)

Starting point: June 10<sup>th</sup> 2004

*For the numerical FE-investigations in WP 3 (Theoretical Investigations on the Stress States of Masonry Structures Subjected to Static and Dynamic Shear Loads) and WP 4 (Design Model for the Resistance of Shear Loaded Masonry Structures) the relevant material properties have been determined (Deliverable 2.1).*

*In the next step, for the improvement of masonry units proposals on the following items were given: Perforation pattern and unit size (Deliverable 2.2-1), material composition of CS-units (Deliverable 2.2-2) and the material composition of clay units (Deliverable 2.2-3).*

*Within the last step, optimized units were produced by the SMEs and the corresponding material properties checked. Here it was found, that an additional optimization step was necessary. The results of the final optimization process can be found in Deliverable 2.3.*

*The optimized units were used for wall elements tested within the full-scale tests in WP 7 and WP8.*

### Section 2

## **Work package 3: Theoretical Investigation on Stress States of Masonry Structures Subjected to Static and Dynamic Shear Loads (Lateral Loads)**

**Participants:** P15 (UNIK), P21 (TUM)

**WP-Leader :** P15 (UNIK)

*An additional deliverable D 3.0 on the stress-strain-behaviour of different kinds of bricks has been included in order to provide a basis for the constitutive models to be used in the finite-element-analyses. A report on this deliverable has been submitted.*

*The analysis of the terraced house (D 3.1) and the analysis of the apartment house (D 3.2) have been submitted behind schedule, because of the delay at the beginning and it took time to find a finite-element-program which is practically applicable for the intended work.*

*Models for typical terraced houses and multi-storey apartment houses were developed, for which 3D – Finite Element Models have been made. These models consider the most important nonlinearities which have to be expected due to the inelastic behaviour of masonry especially due to combined shear/tension loading. By parametric studies, configurations with different values of the length of the main shear walls have been investigated.*

*The outcome of this work package was used for the arrangement of the boundary conditions of the tests.*



### Work package 4: Design Model for the Resistance of Shear Loaded Masonry Structures

**Participants:** P19 (TUD)

**Starting date:** June 10<sup>th</sup> 2004

*In a first step several theoretical models to calculate the in-plane lateral-load capacity of unreinforced masonry shear walls have been analysed. The capacity of horizontally loaded unreinforced masonry panels is influenced by many parameters, mainly the material properties, the dimensions of the units, the geometry of the whole panel, the design concept and the static system. It was shown that the respective parameters and the basic assumptions used in different design approaches affect the shear resistance against horizontal forces significantly.*

*All results are presented and published in the deliverables D4.1 to D4.2.*

*In the next step the outcome of a large number of FE-calculations has been compared with the previously analysed theoretical design procedures. This led to an integral approach, which considers the essential influence parameters on the in-plane lateral-load capacity of URM shear walls. The new approach does not need to consider the parameters tensile strength perpendicular to the bed joints and initial shear strength (cohesion).*

*All results are presented and published in the deliverable D4.3.*

*The comparison with the maximum horizontal loads determined in nearly 100 tests on storey high masonry panels has shown that the new integral approach gives a good approximation of test results.*

*All results are presented and published in the deliverables D4.4.*

*The new integral model and its verification have been presented on the 14<sup>th</sup> IBMAC in Sydney.*

*Simplified design rules have been developed in WP9 (see D9.1 to D9.4) on basis of the new integral model of WP4.*

### Deliverables

D4.1 Report on particular requirements for the optimisation of masonry unit properties

*Has been submitted in schedule (Sep. 10<sup>th</sup> 2004)*

D4.2 Report on specific demands for test methods and required material properties

*Has been submitted three month behind schedule (June. 2<sup>nd</sup> 2005). The reasons for this are explained in section 3 of the activity report.*

D4.3 Report on the integral shear design model for structural masonry members  
*It is planed to submit in schedule (June 10<sup>th</sup> 2006)*

D4.3 report on the integral shear designmodel for structural masonry members

*first discussions and theoretical analyses have been made. The deliverable is due to be finalized after 24 month of the project.*

D4.4 Report on the verification of the design model with test results of WP 6, 7 and 8

*No comment can be given at this time regarding the timetable (foreseen submission is June 10<sup>th</sup> 2007).*

D4.5 Final report on the integral shear model and its verification by experimental results

*No comment can be given at this time regarding the timetable (foreseen submission is June 10<sup>th</sup> 2007).*

### Milestones

- Detailed information about the influence of various material properties to the shear resistance of masonry will allow an optimised product development (WP 2)

*Detailed information about the influence of various material properties have been analysed. The main input parameters for a new shear model had been presented and arranged with the consortium on the meeting May 3<sup>rd</sup> 2005 in Darmstadt. For details see D4.1 and D4.2.*

- Information of necessary material properties for the shear design and realistic models for different failure modes will support the optimisation of test methods (WP 5+6)

*Detailed information about the influence of various material properties have been analysed. The main input parameters for a new shear model had been presented and arranged with the consortium on the meeting May 3<sup>rd</sup> 2005 in Darmstadt. For details see D4.1 and D4.2.*

- The integral model for the realistic shear design of masonry will enable more economic masonry constructions especially for earthquake loading by exploiting the materials potential

*Considering realistic boundary conditions will result in economic constructions. The work therefore is still in progress*

- The verification by experimental results of WP 6-8 will establish the shear design model

*not worked on yet, coming later*

- The shear design model will enable the development of simplified design methods and units/groups and mortar types of EC 6)

*not worked on yet, coming later*

### **Work package 5: Theoretical Investigations an Relevant Material Properties and Test Methods for Material Properties**

**Participants:** P15 (TUD), P21 (TUM)

**WP-Leader :** P18 (TNO-Bouw)

Starting point: June 10<sup>th</sup> 2004

*At the beginning, based on a literature review the material properties of masonry units were determined and given as input parameters for the work-package 3 (found in deliverable 5.1).*

*Following the analysis and evaluation of exiting test methods and the state of the art for the tensile strength of the units and the bond behaviour was made (presented within deliverable 5.2).*

*Based on this information, suitable and cost-effective test methods for the determination of realistic material properties (tensile strength and bond) as a basis for their use in harmonised European standards were developed. The construction of these test set-ups and the proposal can be found in the Deliverables 5.3 resp. 5.4.*

*The material properties achieved from the proposed test-methods were used as input parameters for the work-packages 7 and 8 (experimental investigations on full-scale wall specimens) and for the work-package 4 (design model). The results can be found in Deliverable 5.5.*

### Section 2

## Work package 6: Theoretical Investigation on Shear Test Methods

**Participants:** P15 (UNIK), P18 (TNO), P19 (TUD), P21 (TUM)

**WP-Leader :** P15 (UNIK)

The suitability of existing test methods was studied and a test method for the determination of masonry properties under lateral loads was found.

Three test set-ups for shear tests were constructed at the Technical University of Munich, the University of Kassel and the University of Pavia. For a realistic test set-up it is inevitable to represent the rotation restraint due to the floor slab in the test. So within the three tests set-ups a cap moment of the wall is given by two hydraulic jacks who also apply the vertical load.

A series of validation tests showed good correlations.

Because of these good correlations in the first series, some of the tests of D 6.4 were shifted to deliverable 7.

### Section 2

## Work package 7: Static and Dynamic Shear Tests on Structural Members

**Participants:** P15 (UNIK), P16 (U. Pavia), P17 (LEE-NTUA),  
P21 (TUM)

**WP-Leader:** P17 (LEE-NTUA)

*Tests on masonry walls under static-cyclic loading have been performed at the University of Kassel, the Technical University of Munich and the University of Pavia. All results are presented and published in the deliverables D7.1a to D7.1c.*

*Furthermore, pseudo-dynamic tests on masonry – built of conventional and improved masonry materials - have been performed at the University of Kassel and the Technical University of Munich. Additionally seven selected shaking table tests on specimens built of clay bricks, calcium silicate units and LAC units were carried out at the NTU of Athens. All results are presented and published in the deliverables D7.2a to D7.2c.*

*First interpretations of the tests results of the deliverables D7.1 and D7.2 were carried out and published. They were used for calculating behaviour factors for the shaking table tests and the pseudo-dynamic wall tests. Based on the enormous data achieved from the various tests, a first proposal of behaviour factors is given in deliverable D7.3. A final proposal of behaviour factors will only be possible in addition to the project.*

*The results were used for the verification of the design model of WP 4.*

## **Work package 8: Large Scale Earthquake Test on a building**

**Participants:** P15 (UNIK), P16 (U.Pavia), P17 (LEE-NTUA), P23 (JRC)

**WP-Leader:** P23 (JRC),

*A finite element model of the test specimens has been used in order to design the testing set-up and verify the suitability of the pseudo-dynamic testing procedure (Deliverable D8.1). The model has been used to identify the vibration modes of the specimens (Deliverable D8.2). However, the model was not able to account for all types of damages observed during the high intensity pseudo-dynamic tests. An adequate numerical model is still to be found and, for this purpose, the results of the pseudo-dynamic tests may be used as a benchmark exercise.*

*Two halves of terraced house were constructed with clay unit masonry and calcium silicate unit masonry respectively. The response of the specimens to earthquake of increasing intensities has been obtained and the damage types and locations have been described (Deliverable D8.3).*

*The results of the pseudo-dynamic tests show that the specimens were able to sustain the 0.10g test without suffering relevant damages (serviceability). The first significant damages have been observed during the 0.12g test and have been accentuated by the 0.14g (damage-control). The specimens could sustain further testing until 0.20g for the calcium silicate specimen and 0.22g for the clay specimen (ultimate) although extensive cracking had occurred in the longitudinal and transversal walls.*

*The results of the pseudo-dynamic tests suggest that the type of masonry low-rise structures tested in the project (terraced house) should be safe at least in low seismicity areas.*



### **Work package 9: Development of Design Procedures for Standardisation and Simplified Rules for Application**

**Participants:** P 20 (TU Dresden)  
P 22 (Pech)  
**WP-Leader:** P 20 (TU Dresden)

The intention of this work package was to collect the results from other WP's about the shear behaviour under static, cyclic and pseudo dynamic loading for a proposal for an advanced design model of masonry under lateral loads for the implementation in Eurocode 6-1-1 (EC6) and EN 1998-1. Therefore some introduced or proposed normative regulations are exemplified and then compared with the analytical consideration from work package 4 and the proposed shear design model. The background of this proposal was discussed and the universality is checked.

Because of the major influence of the vertical load situation on the shear load capacity, it also has to be discussed and a proposal for implementation in the code was made.

In addition, the equations have to expand by the safety factors and compared with the collection of test results. Finally, a text proposal for a future update of the Eurocode 6-1-1 is given.

The proposal for a simplified procedure for EC 6 is divided into two versions. For the first version, the design equations without bond strength were used and a further simplification was made by a delimitation of boundary conditions.

For an assessment of standard buildings, a second version of the simplified procedure was created. Now it is possible by comparing the total length of all stiffening walls in a building with a simple reference value to omit the full design procedure.

The primary aim of the proposal D9.4 is the revision of validity of the simplified calculation concerning masonry walls in EN 1998-1, Cap.9 following the here in stated rules for simplified masonry buildings with respect of the required minimum section of shear walls. The check and the eventual adaptation of the simplified rules is only possible on basis of modified descriptions of the resistance of the masonry shear planes (EN 1996-1) and the actions defined in EN 1998-1. Due to this in the proposal as well the design-resistance and the design-actions are discussed.

Based on specific proposals dealing with the examination of the different tests, as well as on the detailed regulations for the design, suggestions for moderate modifications of existing clauses will be presented and used for an enhancement of the simplified rules.

## Work package 10: Dissemination of Knowledge

| Work package number            | WP 10 |     | Start date or starting event: |     |     |     |     |     |     | 1   |     |     |     |
|--------------------------------|-------|-----|-------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Participant id                 | P1    | P2  | P3                            | P4  | P5  | P6  | P7  | P8  | P9  | P10 | P11 | P12 | P13 |
| Person-months per participant: | 9     | 5,5 | 5,5                           | 2   | 3,5 | 3,5 | 0,5 | 0,5 | 0,5 | -   | -   | -   | 0,5 |
| Participant id                 | P14   | P15 | P16                           | P17 | P18 | P19 | P20 | P21 | P22 | P23 | P24 | P25 | P26 |
| Person-months per participant: | 0,5   | 0,5 | 2,5                           | -   | 1   | -   | 1   | 1   | -   | -   | 2   | 0   | 3   |

### Objectives

- Increase of competitiveness through information on masonry products developed within the project and their implementation in the production processes of European SMEs
- Increase of safety level for masonry constructions in Europe through information of architects and structural designers on new (improved) products, improved design methods and expected changes in European standards.
- Increase of competitiveness of the European masonry industry through appropriate design methods and derived simplified rules (rules for construction without further structural calculations) for buildings subjected to lateral loads

### Starting Point of work at Beginning of reporting period

The starting point of Work Package 10 was scheduled for right the project start. Due to the delay in WP 5, 6, and 7 and consequently in WP 4, WP 8 and WP9, which justified a prolongation of the project in total of 12 months, the main dissemination activities (apart from information about the project and its aims) dealing with projects results consequently started with a delay of several months.

### Progress towards Objectives

The main dissemination activities were foreseen right from the beginning to start in the third year of the project's 3 years term. Due to delays in some of the work packages which were to provide the main results and conclusions to be disseminated, the main dissemination activities started with approximately 12 months delay. By the end of the project the following dissemination activities had been performed:

- Information of the SMEs through the IAGs in the participating and other affected countries on the results of material optimisation and the extended possibilities of application of these products in buildings subjected to increased lateral loads.
- Provision of a comprehensive internet platform dealing with the lateral resistance of masonry buildings with special respect to the results of the project (internal and public access).
- Participation in existing national and international information days and conferences for architects and structural designers with information on the developed products and expected changes in European design codes based on the results of the project (presentations by the RTD performers and the IAG's).

Participations in events are, e.g.:

- IBMaC 2004 (International brick and block masonry conference), July 2004, Amsterdam
- International Masonry Conference 2006, London
- European Conference on Earthquake Engineering 2006, Geneva

- IBMAC 2008 (International brick and block masonry conference), February 2008, Sydney
- General Assembly of TBE (European Brick and Tile Producers Association) and ECSPA (European Calcium Silicate Producers Association)
- General Assembly of the participating IAGs
- Würzburger Ziegellehrgang 2006 (information for technical staff of SMEs)
- KS-Meisterseminare (information for technical staff of CS SMEs)

- Publication of the reports resulting from the project on the projects internet platform as well as in relevant journals for civil engineering and construction with masonry.

As the implementation of the project's results and conclusions into European and national standards resp. design codes was still in progress at the end of the project, further dissemination activities are foreseen in the course of 2008 and 2009, to support the adoption of the respective standards and design codes.

#### **Deviations from Project Work Programme and Corrective Actions taken / suggested**

The delay of the overall project had a major effect on the dissemination activities. These delays could not be fully compensated by the 12 month prolongation of the project. Even though considerable dissemination activities were performed during the project, further activities will follow to support the implementation of the projects results in standards, design codes and design tools (e. g. software design tools).

#### **Deliverables**

D10.1 Provision of a plan for using and disseminating knowledge

The plan was provided and updated continuously

D10.2 Internet platform for public and internal information

The platform [www.esecmase.org](http://www.esecmase.org) was provided and updated by the coordinator

D10.3 Information days for the personnel of the SMEs (processing and marketing)

Several activities were carried out in the participating countries, see annexes.

D10.4 Organisation of an European conference for the involved standardisation experts

The project steering committee decided to take advantage of the International Brick and Block masonry conference in February 2008 with 150 top level participant from masonry industry and research as a platform for the presentation of the projects results

D10.5 Provision of draft versions of test standards

A draft version of a test standard for masonry walls was provided and presented at IBMAC and in the periodical "Mauerwerk". The discussion of this draft in CEN/TC 125/WG4 is still to come. Draft versions of test standards for the determination of material properties were not prepared as the test results in this field did not allow for that.

#### D10.6 Provision of draft versions of design procedures for masonry walls under lateral loads

Draft versions were presented in Deliverables D4.3 and 4.4 as well as D9.1 through 9.4 and are under discussion in national and European standardisation committees.

#### D10.7 Project presentation by participation in information days for architects and structural designers

A list of these activities can be found in the annexes.

#### D10.8 Project presentation by information leaflets with special respect to product particularities and regional aspects (e. g. earthquake zones)

This work is still to come as the implementation in the relevant codes is a fundamental requirement for comprehensive brochures for engineers.

### **Milestones and expected results**

M 10.1 Implementation (provision of draft proposals) of the project's results on adequate and realistic test methods for the relevant material properties in design of masonry walls under lateral loads into European test standards.

A proposal for a first European test standard for full scale masonry walls under horizontal loading is available and will be forwarded to CEN TC 125/WG4

M 10.2 Implementation (provision of draft proposals) of the project's results on improved and more realistic design methods for masonry shear walls into European design standards

Proposals for design rules have been provided and are currently under discussion at national and European level.

M 10.3 Increase of safety level and efficiency in the construction of masonry buildings in Europe through application of advanced masonry materials, types of construction and design rules.

This aim can be reached after implementation of the projects results in the relevant standards as the project produced clear results on the loadbearing capacity of unreinforced masonry shear walls.

## **Work Package 11: Training**

Work package leader: P 2

Work package participants: P 2, P 3, P 4, P 5, P 6, P 24, P 26

### **Work package Objectives**

- Increase of competitiveness through training of the SME's technical staff on needed techniques for the production of the improved masonry units developed within the project
- Training of the IAG's technical staff on the project's results in order to enable them to represent their member's interests and communicate the results on a national and European level.
- Training of the SME's consulting staff (advisory staff for architects, designers and constructors) in order to enable them to communicate the outcomes of the project to constructors, architects and structural designers, to enhance safety for masonry constructions in Europe

### **Starting Point of work at Beginning of reporting period**

The starting point of Work Package 11 was scheduled for month 13 after the project start. Due to the delay in WP 5, 6, and 7 and consequently in WP 4 and WP 8, which justified a prolongation of the project in total of 12 months, the main training activities consequently started with a delay of several months.

### **Progress towards Objectives**

The main training activities were foreseen right from the beginning to start in the second year of the project's 3 years term. Due to delays in some of the work packages which were to provide the main results and conclusions to be trained, the main training activities started with approximately 12 months delay. By the end of the project the following training activities had been performed:

- Training of the technical staff the IAG members on the results and conclusions of WP 2 regarding the manufacture of masonry units contributing to an increased shear load bearing capacity of walls.
- Internal training activities of IAG staff aimed at understanding the project's results in order to disseminate these and train member's technical experts as well as architects and structural engineers.
- Training of the IAG's member's (SMEs) technical and marketing experts on the project's results.
- External training activities for architects and structural engineers.

As the implementation of the project's results and conclusions into European and national standards resp. design codes was still in progress at the end of the project, further training activities are foreseen in the course of 2008 and 2009, once the respective standards and design codes have been adopted.

**Deviations from Project Work Programme and Corrective Actions taken / suggested**

The delay of the overall project had a major effect on the training activities. These delays could not be fully compensated by the 12 month prolongation of the project. Even though considerable training activities were performed during the project's duration, further activities will follow once the essential results have been implemented in standards, design codes and design tools (e. g. software design tools).

**List of Deliverables**

| <b>Number</b>                                                                                                                                                                                             | <b>Description</b>                                                                               |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| <b>D 11.1</b>                                                                                                                                                                                             | <b>Training days for SME's technical and consulting staff (processing, design and marketing)</b> |
| The IAG partners performed several training activities for architects and structural designers. Further activities are foreseen in the upcoming months. The specific activities are listed in Annex D 11. |                                                                                                  |
| <b>D 11.2</b>                                                                                                                                                                                             | <b>Training days for IAG's technical staff</b>                                                   |
| The IAG's technical and marketing were trained on several occasions and technical support (brochures) were provided. The specific activities are listed in Annex D 11.                                    |                                                                                                  |

**List of Milestones**

| <b>Number</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Description</b>                                                                                                                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| <b>M 11.1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Ability of the SMEs to provide the market with masonry units meeting the increased requirements of the European load standards.</b> |
| Mile stone 11.1 was achieved within the project's duration. Within WP 2 the partners developed products and improved mixtures which increase the performance of masonry walls subjected to earthquake actions. The improved performance was shown by the results e. g. of WP 7 on walls built from improved units. The results and conclusions achieved within WP 2 were disseminated and trained to the IAG's members, who are now in a position to provide the market with improved products, when needed. However a major finding of the project was, that structural (load bearing) masonry made of common, existing products performs much better under wind and earthquake actions than currently predicted. In most cases its performance is sufficient to withstand wind and earthquake actions which are typical in those areas, where structural masonry is common and traditional. The reasons for this discrepancy were found in the design models, the assumptions and the design rules (codes) which are currently applied. Hence the need to supply specifically optimized masonry units to meet the increased requirements of the European load standards is likely to be restricted to areas with particularly high impacts or to particular buildings for which an increased performance of the structural masonry walls is required. |                                                                                                                                        |
| <b>M 11.2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Increased use of masonry products for buildings in the European earthquake prone areas and areas subjected to high wind loads.</b>  |
| During the project's duration a decreased use of structural masonry was notable e. g. in the south-western part Germany. In particular it was observed that terraced houses, which in the past had been built in structural masonry, were increasingly build in reinforced concrete. By the end of the project this effect could be partially countered by the dissemination and training activities, which were performed by the partners as well as the design tools and brochures which were developed within resp. in parallel to the project. Consequently milestone M 11.2 started to take hold by the end of the project. The foreseen continuation of the afore mentioned activities in the months and years following the end of the project is essential to restore and increase the use of structural                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                        |

masonry and hence to fully achieve milestone M 11.2. The project partners are prepared and determined to continue with these activities and to work towards an implementation of the projects results and conclusions into European and national standards and design codes. The implementation of the results into standards and design codes is already in progress. Some of these standards and design codes are expected for 2008/2009.

|               |                                                                                                                                                                                                  |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>M 11.3</b> | <b>Increase of the safety level and efficiency in the construction of masonry buildings in Europe through application of advanced masonry materials, types of construction and design rules.</b> |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

The results of WP 7 and WP 8 demonstrated impressively that structural masonry performs much better than currently applied design models and codes predict. The observation that the resistance of structural masonry to wind and earthquake loads is much higher than the design resistance already proved, that the current safety provided by structural masonry is much higher than the required safety level. This observation is currently being implemented into design models and codes. With the implementation of the design rules developed within the project in future European and national design codes efficiency of masonry buildings will increase significantly. In addition to the design rules which are under implementation, the project significantly improved the understanding of the behaviour of masonry building subjected to wind and earthquake actions. Unjustified and conservative assumptions regarding the design models and design procedures were disclosed. Towards the end of the project, this knowledge was disseminated and trained to structural designers, thereby increasing the confidence in the established ways of building and in structural masonry as such. The project partners and in particular the participating IAGs are committed to further disseminate and train the results of the project in the following months and years. In addition to these actions, some IAG partners have undertaken and will undertake further investigations and studies to support and back up the conclusions drawn from the project, thereby increasing safety and efficiency of structural masonry.

## Annex D 11.1

### List of Training Activities

The following list gives in extracts an overview of the main training activities performed resp. foreseen by the IAG and RTD partners in the project. Internal training activities of the SMEs, aimed at training their own staff and studying the results and conclusion are not specifically listed.

| Partner      | Training Activity                                                                                                                        | Target Audience                                      | Planned / Actual Dates                 |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|----------------------------------------|
| P1<br>DGfM   | Internal training / Study of results                                                                                                     | IAG staff                                            | throughout the entire project          |
|              | Deep Briefing about consequences for design methods for lateral loading. New standardisation approaches.                                 | German standardisation experts and Industry Partners | 26th, May 2008                         |
|              | Volume 4, Mauerwerk, German masonry journal. Paper about material testing, design methods and practical consequences for masonry design. | Architects, designers and masonry industry           | April 2008                             |
| P2<br>BV KSI | Internal training / Study of results                                                                                                     | IAG staff                                            | throughout the entire project          |
|              | Training of main results and conclusions                                                                                                 | IAG member's marketing and technical staff           | 24.04.2006                             |
|              |                                                                                                                                          |                                                      | 27.07.2006                             |
|              |                                                                                                                                          |                                                      | 24./25.04.2007                         |
|              |                                                                                                                                          |                                                      | 13.09.2007                             |
|              |                                                                                                                                          |                                                      | 08.10.2008                             |
|              | Internal Workshop <sup>1</sup>                                                                                                           | IAG member's technical staff                         | 07.11.2006                             |
|              | Work Shop on Earthquake Design <sup>1</sup>                                                                                              | structural engineers (and architects)                | 26.07.2006                             |
|              |                                                                                                                                          |                                                      | 27.07.2006                             |
|              |                                                                                                                                          |                                                      | 15.03.2007                             |
|              |                                                                                                                                          |                                                      | 19.4.2007                              |
|              |                                                                                                                                          |                                                      | 24.05.2007                             |
|              |                                                                                                                                          |                                                      | 22.07.2008                             |
|              |                                                                                                                                          |                                                      | 23.07.2008                             |
|              |                                                                                                                                          |                                                      | 09.09.2008                             |
|              |                                                                                                                                          |                                                      | 2009                                   |
| P3<br>AMZ    | Internal training / Study of results                                                                                                     | IAG staff                                            | throughout the entire project          |
|              | Internal workshops                                                                                                                       |                                                      |                                        |
|              | Unternehmertag 2006                                                                                                                      | IAG members                                          | 09.11.2006                             |
|              | Mitarbeiterschulung                                                                                                                      | Technical staff of IAG members                       | 15.11.2006<br>21.11.2006<br>29.11.2006 |
|              | Workshop Earthquake design                                                                                                               | Technical staff of IAG members                       | 05.03.2007<br>15.03.2007               |
|              | Workshop University of Applied Sciences                                                                                                  | Engineering                                          | 06.06.2007                             |

<sup>1</sup> organised and held by a regional association linked to Partner P2



| Partner     | Training Activity                                                                                                                                                    | Target Audience                                                                     | Planned / Actual Dates                               |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------------|
|             | Cologne                                                                                                                                                              | students                                                                            | 04.06.2008                                           |
|             | Workshop Earthquake design<br>Friedrichshafen/Reutlingen/Rheinfelden/Ulm<br>(organized by a SME member)                                                              | Structural engineers                                                                | 04.07.2007<br>05.07.2007<br>11.07.2007<br>19.07.2007 |
| P4<br>VÖB   | Internal training / Study of results                                                                                                                                 | IAG staff                                                                           | throughout the entire project                        |
|             | “Arch+Ing Akademie”<br><b>Four</b> symposiums about results, in Vienna (2 symposiums), Graz and Salzburg<br><br>(joint activity with partner P5 and P22)             | Building professionals (Producers, Civil Engineers, Architects, public authorities) | 05/06 2008                                           |
|             | Austrian “Betonkolloquium”                                                                                                                                           | Producers, key clients, construction industry, research, schools, universities      | 07.11.2007                                           |
| P5<br>VÖZ   | Internal training / Study of results                                                                                                                                 | IAG staff                                                                           | throughout the entire project                        |
|             | “Arch+Ing Akademie”<br><b>Four</b> symposiums about results, in Vienna (2 symposiums), Graz and Salzburg<br><br>(joint activity with partner P4 and P22)             | Building professionals (Producers, Civil Engineers, Architects, public authorities) | 05/06 2008                                           |
| P6<br>ANDIL | Internal training / Study of results                                                                                                                                 | IAG staff                                                                           | throughout the entire project                        |
|             | Training course about Wall design software                                                                                                                           | SME's technical staff and structural masonry designers                              | 13.10.2006                                           |
|             |                                                                                                                                                                      |                                                                                     | 18-19.01.2007                                        |
|             |                                                                                                                                                                      |                                                                                     | 04.04.2007                                           |
|             |                                                                                                                                                                      |                                                                                     | 25.6.2007                                            |
|             |                                                                                                                                                                      |                                                                                     | 26.06.2007                                           |
|             |                                                                                                                                                                      |                                                                                     | 27.06.2007                                           |
|             |                                                                                                                                                                      |                                                                                     | 10.2007 (Saie)                                       |
|             | Title "Corso sulle costruzioni in muratura, per la valutazione della sicurezza e il progetto degli interventi, alla luce di nuove Norme tecniche per le costruzioni" | structural engineers (and architects)                                               | 24.01.2008                                           |
|             | University Seminars of ANDIL:<br>"Progettare la muratura" and "Innovazione nel settore dei laterizi"                                                                 | Formative training for university students                                          | 13.11.2007                                           |
|             |                                                                                                                                                                      |                                                                                     | 8.01.2008                                            |
|             |                                                                                                                                                                      |                                                                                     | 6.03.2008                                            |
|             |                                                                                                                                                                      |                                                                                     | 7.03.2008                                            |
|             |                                                                                                                                                                      |                                                                                     | 28.03.2008                                           |
|             |                                                                                                                                                                      |                                                                                     | 3.04.2008                                            |
|             |                                                                                                                                                                      |                                                                                     | 10.04.2008                                           |

| Partner            | Training Activity                                                                                                                                       | Target Audience                                                                     | Planned / Actual Dates |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------|
|                    |                                                                                                                                                         |                                                                                     | 9.05.2008              |
|                    |                                                                                                                                                         |                                                                                     | 28.05.2008             |
| P 15<br>UNIK       | Lectures on Earthquake design of masonry buildings taking into account the ESECMaSE results                                                             | Students                                                                            | continuous activity    |
| P 16<br>U. Pavia   | Lectures on Earthquake design of masonry buildings taking into account the ESECMaSE results                                                             | Students                                                                            | continuous activity    |
| P 17<br>LEE-NTUA   | Lectures on Earthquake design of masonry buildings taking into account the ESECMaSE results                                                             | Students                                                                            | continuous activity    |
| P 19<br>TUD        | Lectures on Earthquake design of masonry buildings taking into account the ESECMaSE results                                                             | Students                                                                            | continuous activity    |
|                    | Organisation of the “Deutscher Mauerwerkskongress 2005“                                                                                                 | structural engineers (and architects)                                               | 29.09.2005             |
|                    | Work Shop on Earthquake Design in co-operation with P3 in Stuttgart                                                                                     | structural engineers (and architects)                                               | 27.09.2007             |
| P 20<br>TU Dresden | Lectures on Earthquake design of masonry buildings taking into account the ESECMaSE results                                                             | Students                                                                            | continuous activity    |
| P 21<br>TU München | Lectures on Earthquake design of masonry buildings taking into account the ESECMaSE results                                                             | Students                                                                            | continuous activity    |
| P 22<br>Pech       | “Arch+Ing Akademie”<br><b>Four</b> symposiums about results, in Vienna (2 symposiums), Graz and Salzburg<br><br>(joint activity with partner P4 and P5) | Building professionals (Producers, Civil Engineers, Architects, public authorities) | 05/06 2008             |
|                    | Austrian “Betonkolloquium”<br><br>(joint activity with partner P4)                                                                                      | Producers, key clients, construction industry, research, schools, universities      | 07.11.2007             |
| P 24<br>FVKS       | Seminar for Master Craftsmen                                                                                                                            | IAG member’s craftsmen (technical stuff involved in the production)                 | 09./10.11.2007         |
|                    |                                                                                                                                                         |                                                                                     | 23./24.11.2007         |
|                    |                                                                                                                                                         |                                                                                     | 30.11/01.12.2007       |
|                    |                                                                                                                                                         |                                                                                     | 14./15.12.2007         |
|                    | “Sand Seminar”<br>(specific seminar on aggregates, i. a. on the influence of gradation on unit properties)                                              |                                                                                     | 20./21.11.2008         |
|                    |                                                                                                                                                         |                                                                                     | 04./05.12.2008         |
|                    |                                                                                                                                                         |                                                                                     | 15./16.01.2009         |
|                    |                                                                                                                                                         |                                                                                     | 05./06.02.2009         |
|                    |                                                                                                                                                         |                                                                                     | 19./20.02.2009         |
|                    |                                                                                                                                                         |                                                                                     | 12./13.03.2009         |
| P 26               | Internal training / Study of results                                                                                                                    | IAG staff                                                                           | throughout the         |

| Partner    | Training Activity | Target Audience | Planned / Actual Dates |
|------------|-------------------|-----------------|------------------------|
| E.A.A.C.A. |                   |                 | entire project         |

## Deliverables list

| Del. N° <sup>1</sup> | Deliverable name                                                                                                                                                                          | WP N°. | Lead participant | Status remark               | Nature <sup>2</sup> | Dissemination level <sup>3</sup> | Delivery date <sup>4</sup><br>(proj.-month) |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------------|-----------------------------|---------------------|----------------------------------|---------------------------------------------|
| D1.1                 | Project management, including the organisation of necessary meetings and the provision of status reports for the project partners                                                         | WP 1   | P1<br>DGfM       | still active                | O                   | PP                               | 48                                          |
| D1.2                 | Organisation of a conference for standardisation experts                                                                                                                                  | WP 1   | P1<br>DGfM       | fulfilled                   | O                   | PU                               | 46                                          |
| D2.1                 | Definition of the relevant material properties for the initial FEM investigations in WP 3 and 4.                                                                                          | WP 2   | P21<br>TUM       | fulfilled,<br>see<br>report | R                   | PP                               | 3                                           |
| D2.2                 | Proposals for the improvement of masonry units (Three reports, P21 (perforation pattern and unit size), P24 (material composition of CS-units), P25 (material composition of clay units)) | WP 2   | P21<br>TUM       | fulfilled,<br>see<br>report | R                   | PP                               | 8                                           |

<sup>1</sup> Deliverable numbers in order of delivery dates: D1 – Dn

<sup>2</sup> Please indicate the nature of the deliverable using one of the following codes:

**R** = Report

**P** = Prototype

**D** = Demonstrator

**O** = Other

<sup>3</sup> Please indicate the dissemination level using one of the following codes:

**PU** = Public

**PP** = Restricted to other programme participants (including the Commission Services).

**RE** = Restricted to a group specified by the consortium (including the Commission Services).

**CO** = Confidential, only for members of the consortium (including the Commission Services).

<sup>4</sup> Month in which the deliverables will be available. Month 1 marking the start of the project, and all delivery dates being relative to this start date. Numbers in brackets show estimated delivery dates after agreed corrections of the group of WP leaders in March 2006.

| Del. N <sup>o1</sup> | Deliverable name                                                                                         | WP N <sup>o</sup> . | Lead participant | Status remark               | Nature <sup>2</sup> | Dissemination level <sup>3</sup> | Delivery date <sup>4</sup> (proj.-month) |
|----------------------|----------------------------------------------------------------------------------------------------------|---------------------|------------------|-----------------------------|---------------------|----------------------------------|------------------------------------------|
| D2.3                 | Production of improved masonry units to be tested in the further steps in WP 7 and 8 of the programme    | WP 2                | P21<br>TUM       | fulfilled,<br>see<br>report | P                   | PP                               | 12                                       |
| D3.01                | Investigations about stress-strain relationship under compression                                        | WP 3                | P15<br>UNIK      | fulfilled,<br>see<br>report | R                   | PU                               | 12                                       |
| D3.02                | Stress-strain-relation of perforated bricks (4-brick-specimen)                                           | WP 3                | P15<br>UNIK      | fulfilled,<br>see<br>report | R                   | PU                               | 12                                       |
| D3.03                | Stress-strain-relation of perforated bricks (RILEM-Specimen)                                             | WP3                 | P15<br>UNIK      | fulfilled,<br>see<br>report |                     |                                  | 18                                       |
| D3.1                 | Analysis of Terraced House (TH, unreinforced as well as confined masonry, few short shear walls) by P 15 | WP 3                | P15<br>UNIK      | fulfilled,<br>see<br>report | R                   | PU                               | 6                                        |
| D3.2                 | Analysis of Apartment House (AH, unreinforced as well as confined masonry, long shear walls) by P 21     | WP 3                | P15<br>UNIK      | fulfilled,<br>see<br>report | R                   | PU                               | 6                                        |
| D4.1                 | Report on particular requirements for the optimisation of masonry unit properties                        | WP 4                | P19<br>TUD       | fulfilled,<br>see<br>report | R                   | PP                               | 3                                        |
| D4.2                 | Report on specific demands for test methods and required material properties                             | WP 4                | P19<br>TUD       | fulfilled,<br>see<br>report | R                   | PP                               | 6/9                                      |
| D4.3                 | Report on the integral shear design model for structural masonry members                                 | WP 4                | P19<br>TUD       | fulfilled,<br>see<br>report | R                   | PP                               | 29                                       |
| D4.4                 | Report on the verification of the design model with test results of WP 6, 7 and 8                        | WP 4                | P19<br>TUD       | fulfilled,<br>see<br>report | R                   | PP                               | 45                                       |
| D4.5                 | Final report on the integral shear model and its verification by experimental results                    | WP 4                | P19<br>TUD       | fulfilled,<br>see<br>report | R                   | PU                               | 45                                       |

| Del. N <sup>o</sup> 1 | Deliverable name                                                                                                                                                                                                                         | WP N <sup>o</sup> . | Lead participant                         | Status remark             | Nature <sup>2</sup> | Dissemination level <sup>3</sup> | Delivery date <sup>4</sup><br>(proj.-month) |
|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------------------------------------|---------------------------|---------------------|----------------------------------|---------------------------------------------|
| D5.1                  | material parameters as input for WP 3                                                                                                                                                                                                    | WP 5                | P18<br>TNO-Bouw                          | fulfilled,<br>see report  | R                   | PP                               | 3                                           |
| D5.2 A<br><br>D5.2 B  | analysis and evaluation of test methods for tensile strength<br>analysis and evaluation of test methods for bond strength                                                                                                                | WP 5                | P21<br>TUM<br>P18<br>TNO-Bouw            | fulfilled,<br>see reports | R                   | PP                               | 12<br><br>38                                |
| D5.3 A<br><br>D5.3 B  | construction of suitable test set-ups for tensile strength<br>Construction of suitable test set ups for bond strength                                                                                                                    | WP 5                | P21<br>TUM<br>P18<br>TNO-Bouw            | fulfilled,<br>see reports | P                   | PP                               | 18<br><br>38                                |
| D5.4 A<br>and B       | Proposal of suitable and cost-effective test methods for the determination of the tensile strength of units and bond strength between unit and mortar                                                                                    | WP 5                | P18<br>TNO-Bouw,<br>P21<br>TUM           | fulfilled,<br>see reports | R                   | PU                               | 38                                          |
| D5.5 A<br><br>D5.5 B  | Material properties of masonry units for the tests in WP 7 and 8 and the verification of the design model of WP 4<br>Material properties of masonry mortars for the tests in WP 7 and 8 and the verification of the design model of WP 4 | WP 5                | P21<br>TUM<br><br>P18<br>TNO-Bouw<br>P24 | fulfilled,<br>see reports | R                   | PP                               | 21<br><br>38                                |
| D6.1                  | Study on suitability of existing test methods                                                                                                                                                                                            | WP 6                | P15<br>UNIK<br>P18<br>TNO-Bouw           | fulfilled,<br>see report  | R                   | PU                               | 3                                           |
| D6.2                  | Development of test methods for the determination of masonry properties under                                                                                                                                                            | WP 6                | P15<br>UNIK                              | fulfilled,<br>see         | R                   | PU                               | 15                                          |

| Del. N <sup>o</sup> 1 | Deliverable name                                                                                                                         | WP N <sup>o</sup> . | Lead participant    | Status remark               | Nature <sup>2</sup> | Dissemination level <sup>3</sup> | Delivery date <sup>4</sup> (proj.-month) |
|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------|-----------------------------|---------------------|----------------------------------|------------------------------------------|
|                       | lateral loads in WP 7, incl. test methods for European standardisation                                                                   |                     |                     | report                      |                     |                                  |                                          |
| D6.3                  | Construction of test set-up for shear tests for validation of proposed method                                                            | WP 6                | P15<br>UNIK         | fulfilled.<br>see<br>report | P                   | PP                               | 12                                       |
| D6.4                  | Series of shear tests for validation                                                                                                     | WP 6                | P15<br>UNIK         | fulfilled.<br>see<br>report | R                   | PU                               | 15                                       |
| D7.1                  | Test results on the behaviour of masonry under static (monotonic and cyclic) in plane lateral loads                                      | WP 7                | P17<br>LEE-NTUA     | fulfilled.<br>see<br>report | R                   | PU                               | 38                                       |
| 7.1a                  | University of Kassel                                                                                                                     |                     |                     | fulfilled                   | R                   | PU                               | 45                                       |
| 7.1b                  | Tech.University of Munich                                                                                                                |                     |                     | fulfilled                   | R                   | PU                               | 48                                       |
| 7.1c                  | University of Pavia                                                                                                                      |                     |                     | fulfilled                   | R                   | PU                               | 45                                       |
|                       | Test results on the earthquake resistance on improved masonry materials by pseudodynamic and shaking table tests<br>Pseudodynamic Tests: | WP7                 | UNIK<br>P17<br>UNIK | ?                           | R                   | PU                               | 45<br>40                                 |
| 7.2a                  | University Kassel                                                                                                                        |                     |                     | fulfilled                   | R                   | PU                               | 45                                       |
| 7.2b                  | Tech.University of Munich                                                                                                                |                     |                     | fulfilled                   | R                   | PU                               | 48                                       |
| 7.2c                  | Shaking table Tests: NTU Athens                                                                                                          |                     |                     | fulfilled                   | R                   | PU                               | 40                                       |
| D7.3                  | Identification of suitable behaviour factors for masonry members under earthquake loads                                                  | WP 7                | P17<br>UNIK         | fulfilled                   | R                   | PU                               | 48                                       |
| D8.1                  | Report on definition and design of test specimen                                                                                         | WP 8                | P23<br>JRC          | fulfilled.<br>see<br>report | R                   | PP                               | 40                                       |

| Del. N° <sup>1</sup> | Deliverable name                                                                                                                    | WP N°. | Lead participant  | Status remark                      | Nature <sup>2</sup> | Dissemination level <sup>3</sup> | Delivery date <sup>4</sup><br>(proj.-month) |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------|--------|-------------------|------------------------------------|---------------------|----------------------------------|---------------------------------------------|
| D8.2                 | Report on preliminary tests and dynamic identification of test specimen                                                             | WP 8   | P23<br>JRC        | fulfilled.<br>see<br>report        | R                   | PP                               | 41                                          |
| D8.3                 | Final report on earthquake tests and analysis of the experimental results (e.g. behaviour factors)                                  | WP 8   | P23<br>JRC        | fulfilled.<br>see<br>report        | R                   | PU                               | 45                                          |
| D9.1                 | proposals for an advanced design model of masonry under lateral loads for the implementation in Eurocode 6-1-1                      | WP 9   | P20<br>TU Dresden | fulfilled.<br>see<br>report        | R                   | PU                               | 41                                          |
| D9.2                 | proposals for simplified rules for masonry buildings subjected to lateral loads                                                     | WP 9   | P20<br>TU Dresden | fulfilled.<br>see<br>report        | R                   | PU                               | 45                                          |
| D9.3                 | proposals for design procedures for masonry in Eurocode 8                                                                           | WP 9   | P20<br>TU Dresden | fulfilled.<br>see<br>report        | R                   | PU                               | 41                                          |
| D9.4                 | proposals for simplified methods for masonry structures in Eurocode 8                                                               | WP 9   | P20<br>TU Dresden | fulfilled.<br>see<br>report        | R                   | PU                               | 45                                          |
| D10.1                | Project presentation and plan for using and disseminating knowledge                                                                 | WP 10  | P3<br>AMz         | still active                       | R                   | PU                               | 8                                           |
| D10.2                | Internet platform for public and internal information                                                                               | WP 10  | P3<br>AMz         | still active                       | O                   | PU/PP                            | 6                                           |
| D10.3                | Information days for the personnel of the SMEs (technical and consulting staff)                                                     | WP 10  | P3<br>AMz         | fulfilled.<br>still active         | O                   | PU                               | 48                                          |
| D10.4                | Organisation of an European conference for the involved standardisation experts (Project presentation and dissemination of results) | WP 10  | P3<br>AMz         | fulfilled                          | O                   | PU                               | 45                                          |
| D10.5                | Provision of draft versions of test standards                                                                                       | WP 10  | P3<br>AMz         | fulfilled.<br>see paper<br>masonry | O                   | PU                               | 48                                          |



| Del.<br>N <sup>o</sup> 1 | Deliverable name                                                                                                              | WP<br>N <sup>o</sup> . | Lead<br>parti-<br>cipant | Status<br>remark                                    | Nature <sup>2</sup> | Dissemination<br>level <sup>3</sup> | Delivery<br>date <sup>4</sup><br>(proj.-<br>month) |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------|------------------------|--------------------------|-----------------------------------------------------|---------------------|-------------------------------------|----------------------------------------------------|
|                          |                                                                                                                               |                        |                          | journal                                             |                     |                                     |                                                    |
| D10.6                    | Provision of draft versions of design procedures for masonry walls under lateral loads                                        | WP 10                  | P3<br>AMz                | fulfilled,<br>discussion<br>in SC6,<br>still active | O                   | PU                                  | 48                                                 |
| D10.7                    | Participation on information days for architects and structural designers (Project presentation and dissemination of results) | WP 10                  | P3<br>AMz                | fulfilled,<br>still active                          | O                   | PU                                  | 48                                                 |
| D11.1                    | Training days for SME's technical and consulting staff (processing, design and marketing)                                     | WP 11                  | P2<br>BVKSI              | fulfilled,<br>still active                          | O                   | PU                                  | 48                                                 |
| D11.2                    | Training days for IAG's technical staff                                                                                       | WP 11                  | P2<br>BVKSI              | fulfilled,<br>still active                          | O                   | PU                                  | 48                                                 |

**Table 2**

| <b>Milestones List</b> |                                                                                                                                                 |                        |                 |                                      |                                                   |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------|--------------------------------------|---------------------------------------------------|
| <b>Milestone no.</b>   | <b>Milestone name</b>                                                                                                                           | <b>Workpackage no.</b> | <b>Date due</b> | <b>Actual/Forecast delivery date</b> | <b>Lead contractor</b>                            |
| 1                      | Identification of the relevant material properties for masonry under shear loads.                                                               | WP2                    | Dec 04          | May05                                | P21, TUM                                          |
| 2                      | Optimization of masonry unit properties based on these results.                                                                                 | WP4                    | July 05         | Sep 05                               | P19, TUD                                          |
| 3                      | Development of suitable test methods for these properties.                                                                                      | WP5                    | Oct 05          | Sep 05                               | P18, TNO-Bouw                                     |
| 4                      | Provision of drafts for harmonized European test standards for the determination of these properties.                                           | WP6                    | Dec 05          | Dec 06                               | P15, UNIK                                         |
| 5                      | Development of a suitable harmonized European test standard for masonry walls under shear loads. Provision of a draft standard for this method. | WP6                    | Dec 05          | Dec 06                               | P15, UNIK                                         |
| 6                      | Implementation of these drafts in the relevant CEN Committees by the members of the consortium.                                                 | WP5                    | Dec 06          | March 08                             | P18, TNO-Bouw<br>P1, DGfM<br>P2, BVKSI<br>P3, AMz |
| 7                      | Identification of the realistic shear resistance of masonry walls with these developed test methods.                                            | WP4                    | Dec 06          | Sep07                                | P19, TUD                                          |
| 8                      | Provision of a design model, taking into account all results derived so far.                                                                    | WP9                    | Feb 07          | Dec 07                               | P20, TU Dresden                                   |

|  |                                                                                                                                                                                                                                              |     |        |          |                                                     |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|--------|----------|-----------------------------------------------------|
|  | Provision of recommendations for the improvement of the relevant European design standards for masonry under static and dynamic loads. Implementation of theses proposals in the relating standards, mainly by the members of the consortium | WP9 | Aug 06 | March 08 | P20, TU Dresden<br>P1, DGfM<br>P2, BVKSI<br>P3, AMz |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|--------|----------|-----------------------------------------------------|

## **Section 3**

### **Consortium management**

#### **Leading participant: Project Coordinator, P1 DGfM**

The Consortium is managed by the Coordinator (P1) and the Project Steering committee (PSC) which is comprised of the Technical Manager (P15), both Exploitation Managers (P2,P3), one SME representative (P10) and the Coordinator.

The first important task of the last reporting period of the project was to prepare the second periodic report and its reviewing process. After its acceptance the commission's financial services made the third pre-financing payment of € 256.911,- which is equal to about 12% of the total grant requested from the EC. It was the task of the Coordinator and the PSC to distribute this money appropriately to the individual participants regarding the eligible costs of the first and the second reporting period and the activities planned for the next period. This process finished until July 2007. In total, the Pre Financing amounted to 75% of the total grant requested.

In addition to cost management, the other major task of the project coordination is monitoring progress. In the ESECMaSE project the research work is monitored by the PSC and the group of the WP Leaders. Several meetings of these groups were convened during the reporting period (see Section 2, WP 1 for more information).

As mentioned in Section 2, WP1 the WP leaders and the PSC saw the necessity to propose another extension of the project period.

The reasons for this were as follows:

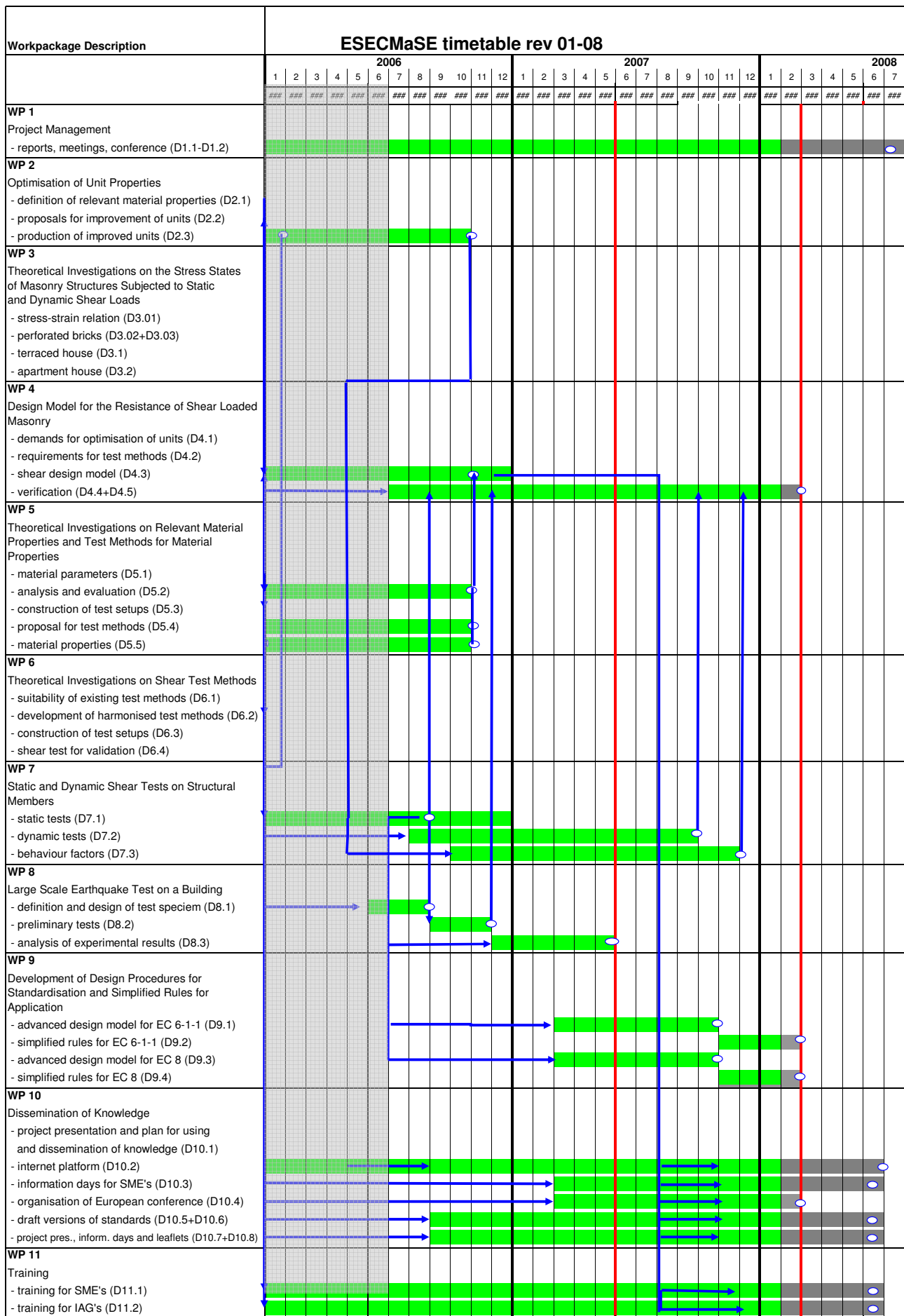
- Several important tests (especially the full scale pseudo-dynamic test on a masonry structure at JRC Ispra) were delayed and the test reports were not available in time to guarantee an efficient training and dissemination before the foreseen Project deadline of March 9<sup>th</sup>, 2008.
- The Consortium suggested to commit the foreseen dissemination activities when the final results were available instead of presenting more or less intermediate results before the deadline of March 9<sup>th</sup>, 2008.

The Consortium therefore asked for an extension of the project duration for dissemination and training activities of 3 months until June 9<sup>th</sup> 2008.

Regarding the tasks of WP 10, dissemination of knowledge, the major project results had been presented to the European experts of masonry design at the 8<sup>th</sup> IMC, the International Masonry Conference, which was held in February 2008 in Sydney, Australia. This ensures, that the results can also be taken into account by relevant European standardisation committees.

The coordinator had to propose the extension of the Project Period, including an updated time table and work programme.

It will now be the task of the coordinator to go through the acceptance process for the third and the final reporting and to make final financial contributions.



**Appendix 1 - Plan for using and disseminating the knowledge****Section 1: Exploitable knowledge and its use**

The main results will be test and design procedures to be incorporated in the next generation of European Standards. If these procedures are available, the earthquake design of masonry will become more appropriate and the safety in new buildings in earthquake regions will increase.

In addition, material optimization might lead to more sophisticated products. These products will be put in the market as soon as they are available to provide a higher safety level and extend the areas of application of masonry.

Some exploitable results (products, standards) are given in **table 1**.

**Overview table 1**

| <b>Exploitable Knowledge (description)</b>                                                | <b>Exploitable product(s) or measure(s)</b> | <b>Sector(s) of application</b> | <b>Timetable for commercial use</b> | <b>Patents or other IPR protection</b> | <b>Owner &amp; Other Partner(s) involved</b> |
|-------------------------------------------------------------------------------------------|---------------------------------------------|---------------------------------|-------------------------------------|----------------------------------------|----------------------------------------------|
| Optimisation of perforated Clay units towards an enhanced earthquake resistance           | Clay units                                  | Building                        | 2009                                | Not applicable                         | AMz, ANDIL, Bellenberg, RIL, Pexider         |
| Optimisation of Calcium silicate units towards an enhanced earthquake resistance          | Calcium silicate units                      | Building                        | 2007                                | Not applicable                         | BVKSI, FVKS                                  |
| Test method for the determination of the relevant tensile strength of masonry units       | Test standard                               | Building                        | 2008/2009                           | Not applicable                         | TUM, All                                     |
| Test method for the determination of the relevant bond strength of masonry units in shear | Test standard                               | Building                        | 2008/2009                           | Not applicable                         | TNO Delft, All                               |
| Test method for the determination of the relevant shear strength of masonry               | Test standard                               | Building                        | 2008/2009                           | Not applicable                         | TUM, UNIK, All                               |

| Exploitable Knowledge (description)   | Exploitable product(s) or measure(s) | Sector(s) of application | Timetable for commercial use | Patents or other IPR protection | Owner & Other Partner(s) involved |
|---------------------------------------|--------------------------------------|--------------------------|------------------------------|---------------------------------|-----------------------------------|
| Design method for masonry shear walls | Design standard                      | Building                 | 2010/2012                    | Not applicable                  | TUD, TUDD, Pech                   |

## Section 2 - Dissemination of knowledge

The projects results are published on the ESECMaSE website and in a variety of periodicals throughout the participating countries. Results have been and will be presented on all major international masonry and earthquake engineering conferences during and after the project. The overview table gives an updated selection of dissemination measures carried out and still foreseen in Germany and Austria. For the Italian activities see appendix 2.

**Overview table 2**

| Planned/ actual dates | Type                                                                                           | Type of audience                                                   | Countries addressed | Size of audience | Partner responsible / involved |
|-----------------------|------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|---------------------|------------------|--------------------------------|
| 2004-2008             | Information of the technical committee of the Austrian brick industry - 4 times per year       | Austrian brick manufacturers                                       | Austria             | 8-10             | VÖZ                            |
| 2004-2008             | Information to the members of the Austrian brick industry (general assembly) - 1 time per year | Austrian brick manufacturers                                       | Austria             | 25               | VÖZ                            |
| 07.2004               | Presentation at conference IBMaC 2004, Amsterdam                                               | Research, Industry                                                 | worldwide           | 150              | DGfM, AMz, BVKSI               |
| 01.2005               | Website                                                                                        | all                                                                | Europe              |                  | DGfM, all                      |
| 02.2005               | Publication, Mauerwerk 2/2005                                                                  | Research, higher education                                         | Germany, Austria    | 4500             | BVKSI                          |
| 11.2005               | Publication Mauerwerk 6/2005                                                                   | Research, higher education                                         | Germany, Austria    | 4500             | AMz, all                       |
| 05.2006               | Presentation at E.C.S.P.A. TC meeting                                                          | European Senior Technical Experts of the Calcium Silicate Industry | Europe              | 12               | BVKSI                          |
| 07.2006               | Presentation at                                                                                | Structural                                                         | Germany             | rd. 120          | BVKSI                          |

|            |                                                                                    |                                                                    |                               |            |               |
|------------|------------------------------------------------------------------------------------|--------------------------------------------------------------------|-------------------------------|------------|---------------|
|            | a workshop on earthquake design                                                    | Designers and Architects                                           |                               |            |               |
| 09.2006    | Presentation at building materials conference Ibausil 2006, Weimar                 | Research, Industry                                                 | European                      | 150        | AMz           |
| 09.2006    | Presentation Annual conference of the Austrian Clay Industry                       | Industry                                                           | Austria                       | 100        | Pech, VÖZ     |
| 09.2006    | Presentation of the project and the preliminary results at CEN TC 250/SC 6 meeting | Standardisation Experts                                            | Europe                        | rd. 50     | BVKSI         |
| 10.2006    | Publication VÖZ Newsletter                                                         | Architects, Civil engineers, key clients                           | Austria                       | 1000       | VÖZ           |
| 11.2006    | Presentation at conference Würzburger Ziegellehrgang 2006                          | Industry (manufacturing staff)                                     | Germany, Austria, Switzerland | 300        | AMz, IZF, TUM |
| 11.2006    | Presentation at conference IMC London                                              | Research, industry                                                 | UK, Europe                    | 70 approx. | DGfM, All     |
| 01/02.2007 | Presentation at "KS Bauseminar"                                                    | Structural designers, architects                                   | Germany                       | rd. 250    | BVKSI         |
| 03.2007    | Dissemination Meeting                                                              | Research, Industry                                                 | Europe                        | rd. 30     | BVKSI, all    |
| 03.2007    | Presentation at E.C.S.P.A. TC meeting                                              | European Senior Technical Experts of the Calcium Silicate Industry | Europe                        | 12         | BVKSI         |
| 03.2007    | 2 Seminars for the consulting staff of the German clay industry                    | Industry                                                           | Germany                       | 30         | AMz, UNIK     |
| 06.2007    | Presentation at the General Assembly of BV KSI                                     | manufactures                                                       | Germany                       | rd. 100    | BVKSI         |
| 09.2007    | Presentation at                                                                    | Industry                                                           | Europe                        | 30         | AMz           |



|         |                                                                                                        |                                                                               |                  |         |                    |
|---------|--------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|------------------|---------|--------------------|
|         | the Joint Product Group meeting of the European Brick and Tile Producers (TBE)                         |                                                                               |                  |         |                    |
| 09.2007 | Presentation "ESECMASE and earthquake design for masonry"                                              | Association of Consulting Engineers                                           | Germany          | 35      | AMz, UNIK          |
| 11.2007 | Publication of results in "ZI-Jahrbuch 2008" (Yearbook of the brick and tile industry, German/English) | Industry,                                                                     | Germany, Europe  |         | AMz                |
| 11.2007 | Publication of results in "Mauewerk-kalender 2008"                                                     | Research, Higher Education, Structural Designers                              | Germany          | ???     | AMz, BVKSI         |
| 02.2008 | Publication / Presentation at 14. IBBMaC                                                               | Research, Higher Education                                                    | Europe / World   | 150     | all                |
| 02.2008 | Presentation at "KS Bauseminar"                                                                        | Structural designers, architects                                              | Germany          | rd. 250 | BVKSI              |
| 03.2008 | Presentation at "Tag des Mauerwerk-kalenders"                                                          | Higher Education, Civil Engineers                                             | Germany          | rd. 90  | ECSPA <sup>1</sup> |
| 03.2008 | Publication "A3 Bau"                                                                                   | Key clients, construction sector                                              | Austria          |         | VÖZ, VÖB           |
| 04.2008 | Presentations                                                                                          | Belgian Clay Brick Association, Hochtief AG, German building authorities DIBt | Germany, Belgium | Rd. 30  | AMz                |
| 04.2008 | Publication "Konstruktiv"                                                                              | Architects, civil engineers, building authorities                             | Austria          |         | VÖZ, VÖB           |
| 05.2008 | Presentation at "ECSPA Earth Quake Work Shop"                                                          | European Senior Technical Experts of the                                      | Europe           | rd. 15  | ECPSA <sup>1</sup> |

<sup>1</sup> European Calcium Silicate Producers Association, on behalf of BVKSI

|                 |                                                                                                        |                                         |                                  |         |                                                      |
|-----------------|--------------------------------------------------------------------------------------------------------|-----------------------------------------|----------------------------------|---------|------------------------------------------------------|
|                 |                                                                                                        | Calcium Silicate Industry               |                                  |         |                                                      |
| 05.2008         | Publication website<br>www.ziegel.at                                                                   | All                                     | Austria                          |         | VÖZ                                                  |
| 05.2008/06.2008 | 4 Symposiums (Arch + Ing Akademie)                                                                     | Building professionals                  | Austria (Vienna, Salzburg, Graz) | Rd. 140 | VÖZ, VÖB                                             |
| 05.2008         | Presentation "ESECMASE workshop for German researchers in Masonry"                                     | Research staff from German universities | Germany                          | Rd. 20  | DGfM, AMz, BVKSI                                     |
| 06.2008         | Publication "Wettbewerbe"                                                                              | Architects, civil engineers             | Austria                          |         | VÖZ, VÖB                                             |
| 08.2008         | Publication, Mauerwerk 4/2008                                                                          | Research, higher education              | Germany, Austria                 | 4500    | AMz, ECPSA <sup>1</sup> , TUD, TU Dresten, TUM, UNIK |
| 06.2008         | Newsletter                                                                                             | Building professionals                  | Austria                          | 1500    | VÖZ                                                  |
| 08.2008         | Publication of results in "ZI-Jahrbuch 2009" (Yearbook of the brick and tile industry, German/English) | Industry,                               | Germany, Europe                  |         | AMz                                                  |
| 09.2008         | Publication of results in "Mauerwerksbau Praxis 2009"                                                  | Research, Industry                      | Germany                          |         | AMz                                                  |
| 01.2009         | Publication of results in "Masonry International"                                                      | Research, Industry                      | UK, Europe                       |         | AMz, BVKSI                                           |
| 06.2009         | Presentation "Canadian Masonry Symposium"                                                              | Research, Industry                      | Worldwide, Canada, USA           | 100     | AMz                                                  |