



THE MASONRY CONCEPT

A. Brink¹; Olaf C.G Adan²; H.J.P. Brocken³

Abstract

Present masonry is hardly competitive with concrete, wood and steel in terms of constructive applications, but in terms of aesthetical and physical features masonry has many advantages in a wide range of applications. Exploring and developing new constructive possibilities combined with the aesthetical and physical advantages creates a highly competitive building material with high freedom in design.

The Masonry Concept has 2 main objectives:

- a) Drastically improvement of masonry properties (i.e. 5-10 fold bond strength), and guarantees minimum product performance in that respect.
- b) Definitions of integrated performance requirements of the composite product masonry in the form of pre-normative European standards. Such new Standards reflect a fundamental change in the way of thinking in "building in masonry", and create a roadmap for development of new products and applications.

Key Words

The Masonry Concept, SME's, performance, standards

1 Introduction

Masonry is still applied in a traditional way from separately selected and ordered materials, which are combined on the building site to become a composite building product. This tradition hinders new innovations of masonry as a composite building material. As a result the last decades masonry material industries (mainly brick and mortar manufacturers) are faced with a dramatic loss of market share (see figure 1).

If the present situation remains, a further decrease of market share is foreseen and the existence of masonry is threatened. Reinforced concrete, steel and wood have marginalised masonry as a structural material in high-rise respectively low-rise buildings. To take a turn for the better "The Masonry Concept" aims at turning the market attitude from brick laying with specifications for separate materials towards application of masonry (elements) with corresponding assessment of the building product. This change comprises two important issues:

- a) Application related performance definition (and assessment) of the composite product.

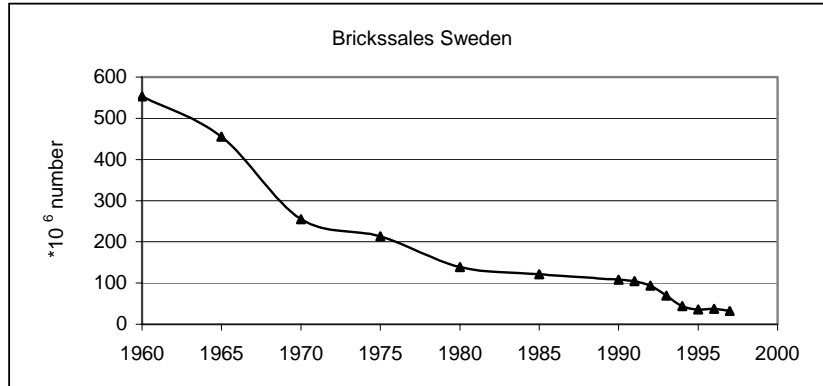
¹ ing. A. Brink, vice president R&D Wall&Ceiling, maxitGroup AB, bert.brink@maxit-group.com.

² Dr.ir. Olaf C.G. Adan, TNO Building and Construction Research, o.adan@bouw.tno.nl

³ Dr. ir. H. J. P. Brocken, TNO Building and Construction Research, h.brocken@bouw.tno.nl

- b) Development of a masonry industry that combines expertise from material manufacturing, design and construction of masonry structures and (full- or semi-automated) brick laying.

Figure 1: Swedish trend for masonry application in last decades of twentieth century.



As a building product, masonry has three distinctive characteristics,

- a) Aesthetical -,
- b) Physical -,
- c) Constructional characteristic.

Masonry becomes a highly competitive building material when these three characteristics are consciously combined. The main principle of "The Masonry Concept" is that masonry property definition starts from the customer side, the designer/customer decides about application type and required/desired performance level. Successively the unified masonry industry provides the market with composite products and corresponding performance guarantees. This paper gives an introduction into such a conceptional approach and describes the principle underlying it.

2 Tradition of masonry

2.1 Masonry Unit production

In large parts of Europe for centuries bricks have been the main building material for houses, churches, public buildings, engineering works etc. Moulding and firing of clay was already known by the Romans, and spread by them through the Roman Empire. After the fall of Rome the know-how was to a large extent lost and reinvented not earlier than the XIth century. In the Middle Ages brick houses were raised in favour of flammable wooden houses, and the first production sites were established near clay excavation sites. To satisfy the growing demand for fired clay bricks, at the end of the nineteenth century the first mechanisation was introduced in clay brick production. In the beginning of the twentieth century the degree of mechanisation increased and from the mid twenties automation was introduced in the mechanised process. From that time the traditional brick fabrication was replaced by a fully automated process that was further improved in its (energy) efficiency during the last decades of the twentieth century.

2.2 Masonry Mortar production

Masonry mortar was mixed on the building site from regionally available components following a local recipe with basic components: sand, lime, puzzolanic material and water according to a traditional recipe. The composition of the mortar was a secret of the mason and it was depending on the local raw materials. A supplier industry for masonry mortar did not exist for centuries. Every building site had its own mortar production. Mortar production was an integrated process on the building side under the responsibility

of the mason. Industrial mortar manufacturing by a separate supplier industry was introduced not earlier than the sixties of the twentieth century.

The masonry mortar industry is a very young industry compare to the clay brick industry and not older then 50 years. This industry is dominated by individual SME's, (Small and medium enterprises). The knowledge of masonry mortar and mortar compositions moved from the building side to the mortar industry.

3 Present situation

In present day building construction, masonry is still applied on site. This way of application can be typified as traditional and empirical. The compatibility of the brick and mortar, the workmanship of the mason and weather circumstances during its realisation and curing, determine the final performance of masonry as building material. Nowadays masonry is considered a low-tech product, hardly being competitive with other constructional materials. The poor understanding of masonry opportunities among architects even decreases competitiveness any further.

Figure 2: Number of sick leave of the Dutch building construction sector according to the Dutch Economic Institute for building construction sector (EIB)

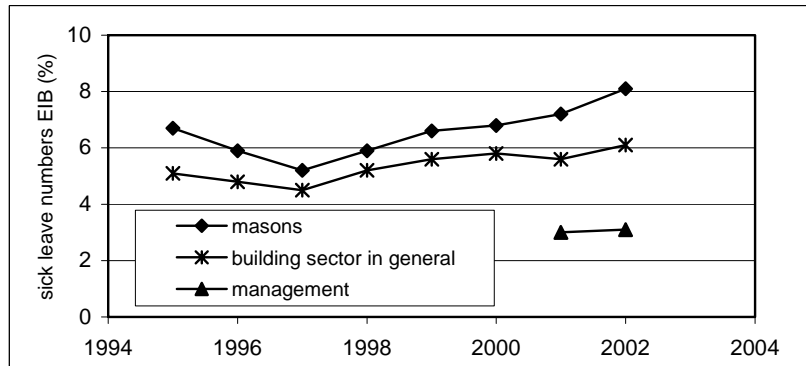
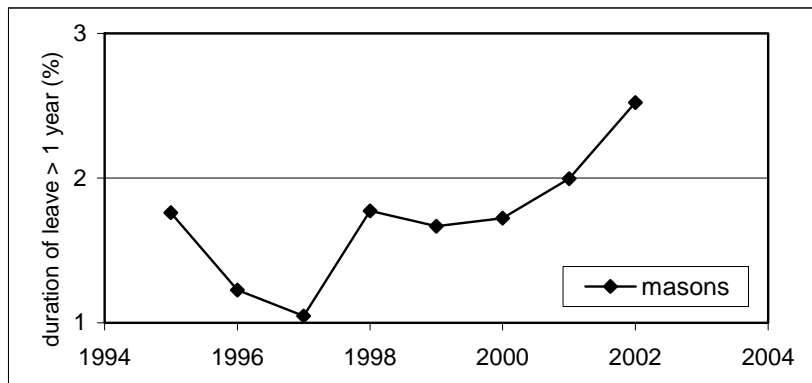


Figure 3: percentage for the duration of sick leave of masons with a duration longer than 1 year. This number is used as indication for disability



Furthermore, the market structure, the separate supplier industries for brick and mortar, and the existing separate product standards and corresponding assessment of specifications for brick and mortar that do not define performances for masonry, create a stand still in innovation towards a higher technological level of the composite material, masonry and development of more potential use of it. Such fragmentation of the supply

industry does not offer a sound perspective of improving competitiveness of the end-product.

Analysis of the building material market shows that masonry is hardly competitive because of high costs, low productivity, typical building process with many parties involved, the relatively high risk for failure costs, the labour intensive job, the relatively high numbers of sick leave and disability of masons .See figure 2 and 3)

Other composite building materials like pre-stressed concrete and outside rendering systems with thermal insulation, etics, do not have these disadvantages and are supplied with guarantees on performance and durability of the applied product. The application of masonry compared with other composite materials is attractive regarding issues that are relevant for the design stage or the actual lifetime of buildings. Masonry prefabrication could reduce a lot of the disadvantages that occur during the realisation stage. It is therefore foreseen as a new technological innovation that is appropriate to make application of masonry competitive again. Masonry prefabrication open new potentialities for application, such as: roofing, bridging and elevated wall elements.

Figure 4: German trend in annual turnover of bricks and stones according to numbers of the 'Industrieverband WerkMörtel e.V.'

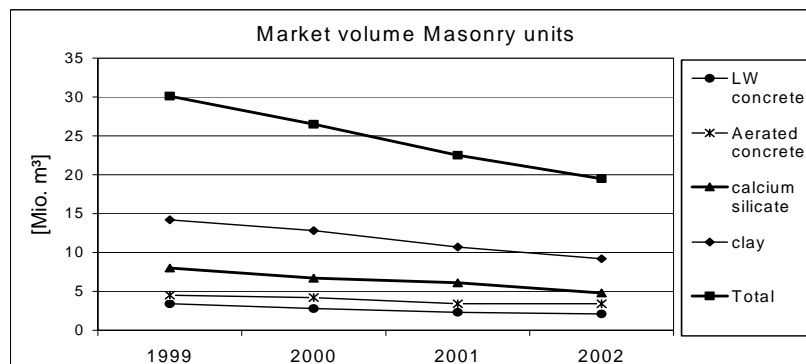
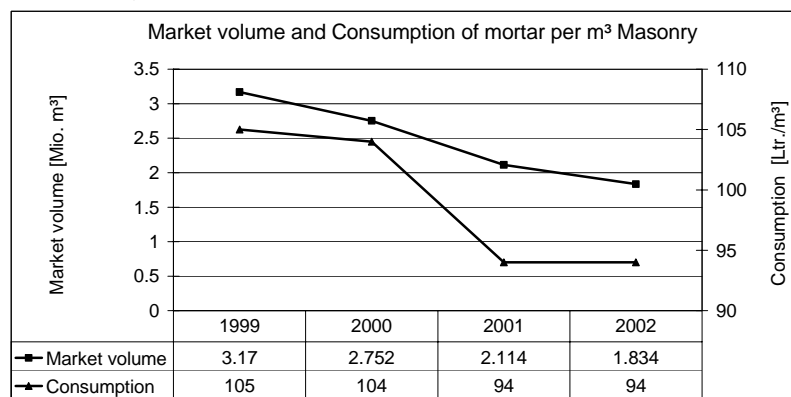


Figure 5: German trend in annual turnover of mortar according to numbers of the 'Industrieverband WerkMörtel e.V.'

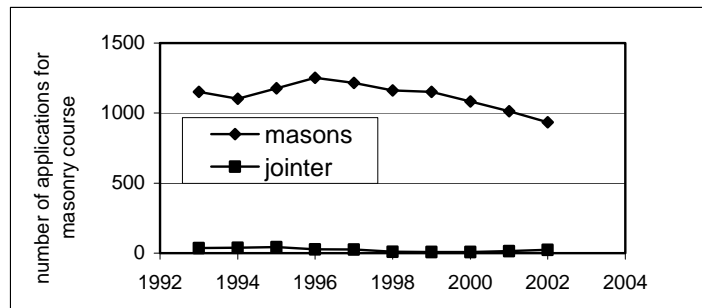


The assessment and qualification of masonry performance as a composite material is essential to make this innovation feasible. The separate product standards for brick and mortar as they are in use now, hamper this development. They are considered to be beneficial for industrial parties that wish to minimize material specifications in favour of customer's interest for definitions and requirement of performance. The lack of

comprehensive masonry material standards based on the description of performance is experienced as a major restriction for masonry innovation.

As a consequence of its reduced competitiveness with other building materials, the application of masonry shows a serious decrease in the last decades (See figure 4 and 5). In addition eagerness of young people to apply for mason jobs is reducing and correspondingly entries for masonry training and education show a decrease. (See figure 6).

Figure 6: Number of applications for Dutch masonry courses according to numbers of the 'Bouwradius Groep'.



Following the market development, the existence of masonry material industries and enterprises in related sectors is threatened. The threat is not only present in the Nordic countries but also in the rest of Europe. In general, when large building and housing projects are concerned, the building company has a predominant vote in the choice of the final building material (see picture group 1). The contractor has a leading interest to minimize building time, building risk, and (short term) realisation costs.

A further and strong decrease in annual masonry turnover as is foreseen, would cause a strong increase in unemployment rates of the corresponding sector, loss of knowledge and experience of the material, increasing effort and costs for the conservation of existing masonry buildings, and a growing volume of a build environment with an industrial image and a low level of regional identification.

The only way to prevent this from happening is to initiate a complete turn in “the thinking of masonry”. Research and development as it is performed nowadays will not initiate the needed change. To turn the situation requires a European effort for introduction of a masonry code, demonstration, training and education in terms of. *“Think global act local.”* If you do not take away restrictive practices at European level, local markets cannot change their attitude towards masonry application.

3.1 Issues for suppliers

The masonry industries experience a decreasing trend in annual turnover of brick and mortar. To stop this market development, disadvantages that result from application on site should be taken away. Application of masonry should become competitive again and new innovative applications should become feasible. To realise this innovation and to increase the technological level of the composite material, restrictive practices – i.e. separate assessment of specifications for brick and mortar – should be taken away at European level.

Picture group 1: Swedish concept of board houses, Contractor concept



3.2 Issues for masonry sector

Due to increasing numbers for sick leave and disability of masons and diminishing eagerness of young people to apply for the job, it becomes difficult to maintain masonry knowledge, experience and workmanship that is needed for realisation of new masonry and for restoration and maintenance of existing masonry. To change this situation, labour circumstances for masonry application should be improved. Furthermore the empirical way of application should be turned towards a level with more technological input. Masonry should become industrial building material, industrially manufactured with clear job level differentiation. If not: masonry application remains traditional and eagerness for new job applications maintains low, with the described consequences.

3.3 Issues for European Communities

With respect to building construction materials the objective to develop and maintain competitive market structures (following EC treaty 85) has been worked out in the European CPD, (Construction Product Directive). In this view the existing separate product standards for brick and mortar are regarded as restrictive. They are poorly related to performances of masonry. The European community is faced with societal consequences of the traditional masonry application:

- a) Increase in numbers for sick leave,
- b) Disability of masons on the short term,
- c) The expected decrease in application on the long term,
- d) Increase of numbers for unemployment in the masonry sector,
- e) Loss of knowledge and experience of the material that represents the major part of existing European building constructions,
- f) Increasing effort and costs for their conservation.

To challenge these societal consequences a new innovation in production and application of masonry is needed and as an instrument to facilitate the innovation, a new

masonry material code should define and assess performances of this composite building construction material.

3.4 Issues for the education institutes

With respect to the other building materials, like concrete, steel and wood the interest for masonry in technical -, higher technical - and university education is very poor. The underlying reason is the lack of insight and models for the complex behaviour of masonry as composite building material. The development of design rules has not kept pace with the development of concrete and steel. This is a consequence of the industrial approach to masonry as an assembly of brick and mortar as modular products. Masonry has not been considered a composite building material.

4 Future masonry

4.1 Harmonised European Standards

In respect to Masonry and masonry products CEN, (Comité Européen de Normalisation), has started, by order of the SCC, (Standing Commission on Construction), of the European Commission, at the end of the eighties of the twentieth century the work on harmonisation of standards in Europe in order to take away all barriers of trade within the European Communities. CEN TC 125, (Technical Commission) have worked for more than 15 years to harmonise the national product standards in the field of Masonry. In this year 2004, the harmonised European product standards are applicable and will be implemented in the Member States and Associated States. By the end of 2005 these standards will be the only existing standards and all conflicting national standards have to be withdrawn.

TC 250 is working on Eurocode 6, (Common unified rules for masonry structures). This standard will harmonise the design rules that exist within in the Member States. When this standard will come into force is not known, but it will be the starting point of an equal language among designers.

4.2 Challenges for the industry

4.2.1 Strategy of the industry

Create a coherent and performance-based approach to masonry as a composite material by bringing together the SME-dominated masonry unit - and masonry mortar industry in Europe.

The knowledge base explores the hidden potential of masonry that shall change the traditional perception of all stakeholders in their way of thinking and application of masonry.

4.2.2 Scientific and technological objectives

To increase masonry competitiveness as a composite product two scientific and technological problem should be addressed:

- a) New constructive features and potentials should be developed for masonry, i.e. present technical capabilities - with a pivotal role of bond strength - should be drastically improved to create a perspective for applications that are competitive with concrete, wood and steel.
- b) Next to the drastic improvement of constructional properties, the profile of masonry can only be created if its many advantages and benefits in aesthetical and physical properties are assimilated in an integrated presentation of the end product. Development of such integrated concept and knowledge base is a prerequisite to accelerate innovation of masonry and increase competitiveness.

At present, the supply industry is highly dominated by SME's, which have only minor R&D capacity, and do not possess the knowledge base to address the above mentioned technological problems individually.

Moreover, the present approach to masonry is merely based on separate mortar and brick approaches; the market is structured and operating accordingly, actually meaning that 'masonry industry' as such does not exist. Bringing together the separate actors, i.e. the brick and mortar industry, is a crucial strategic need to solve the scientific and technological problems the sector is facing, and to explore the real potential of masonry.

4.2.3 Needs and issues

More specifically, the needs and issues of the SME's involved are:

- a) Upgrading the R&D capacity to bring constructive features of the composite product masonry at a level that can compete with steel, concrete and wood. Actually, this involves a drastic (5-10 fold) improvement of the bond strength, but also a guaranteed minimum product performance with an envisaged impact on the production process of masonry and development of new skills.
- b) The envisaged spin-offs lay in new opportunities for design or for new applications of masonry, reducing both labour and transport load, thus improving price/quality ratio.
- c) The creation of a 'platform' or co-operative structure, dealing with R&D issues and strategy collectively on an European level, as a first step towards a real and viable masonry industry. The way towards consensus about developing masonry as a single composite product in a comprehensive concept can only be successful when collective participation of the sector is secured. Such consensus should be reflected in the definition of new prEN Standards, describing performance requirements of the end-product masonry in its intended use. Subsequent large-scale dissemination to the SME community through training of staff, and basic education at universities and technical schools is a prerequisite to implement such performance-based knowledge.

The Masonry Concept is the underlying idea of a sound and sustainable competitive position of the sector. At present, masonry performance is highly determined by other stakeholders in the production chain such as the building contractors. In other words: supply industries have only minor influence on the actual performance of the end product masonry. To reduce this dependency, and to guarantee product performance, SME's in this sector need to upgrade their role in the production chain from single material supplier towards higher added value companies delivering masonry as a guaranteed high quality end product. The definition of comprehensive (pre-) European Standards mentioned above support steps towards such long-term strategic transition. In addition, supply industries should change their position in the production chain and become more added-value organisations that are able to guarantee high performance and user-oriented end products. Such envisaged transition forms the long-term objective or vision. The Masonry Concept's ambition is to facilitate this strategic transition.

4.2.4 Potential impact

The envisaged turn in market attitude with respect to masonry will in general secure and improve market share of the product. More than the reflection of this turn in market share numbers, the change will enforce the masonry industry to innovate their product having a more fundamental impact on the industry itself, related sectors, the European society and education

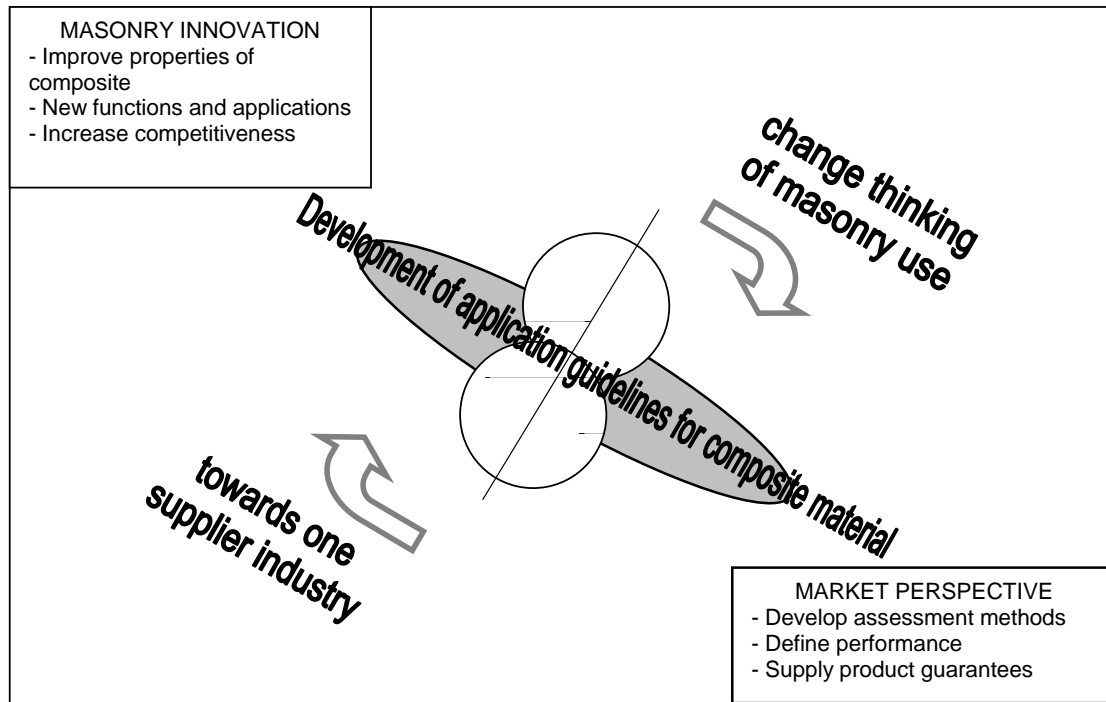
4.2.4.1 Impact for supplier industry

The threat for the masonry material industry as mentioned before is a decreasing trend in annual turnover. To adjust this market development, application of masonry should become competitive again and new innovative applications should become feasible.

The supplier industries for brick and mortar will co-operate more intensively and with executive brick laying contractors. On the short term this unified masonry industry will share the responsibility for the masonry product performance. On the long term the masonry industry will put more focus on the innovation of their product with R&D and engineering input. Correspondingly this will upgrade the technological level of masonry

application. Finally, with regained competitiveness and a high level technological input, new realisation/production methods and new potential uses of masonry will be explored.

Figure7: Illustration of the envisaged changes in the masonry market, and the thinking, innovation and application of masonry as a product



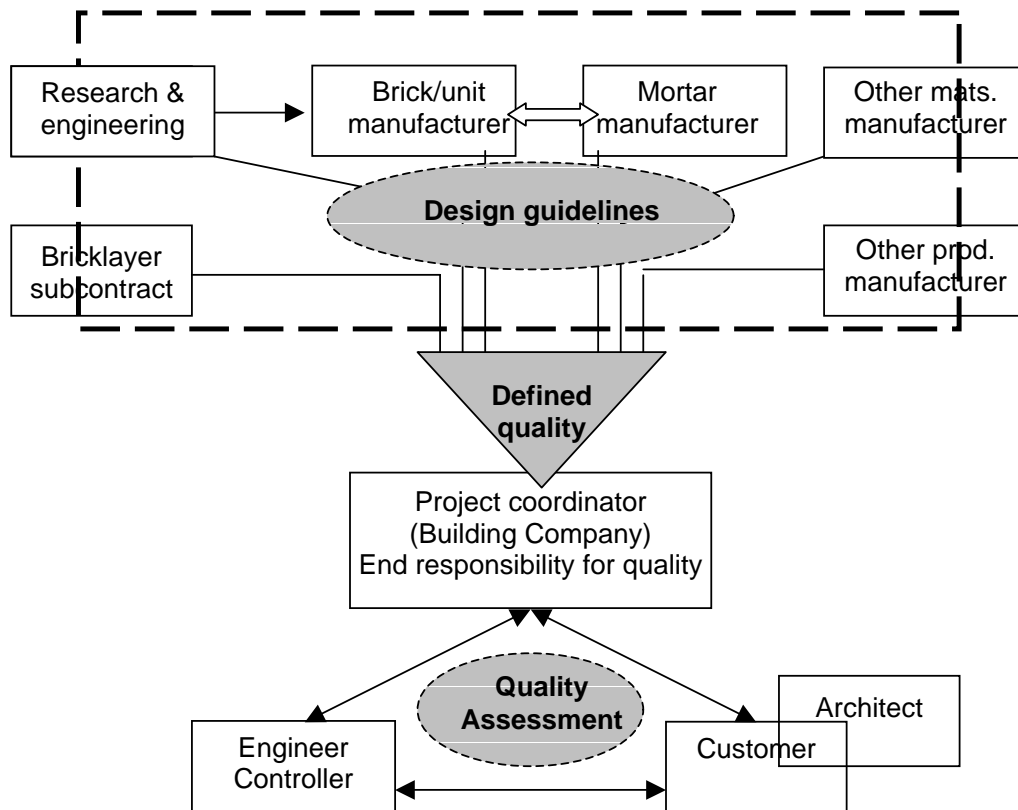
4.2.4.2 Impact for masonry sector

The masonry sector is faced with increasing numbers for sick leave. The eagerness of young people to apply for the job diminishes. In general the empirical way of application will turn towards a level with more technological input of the product on the industry side of the market. This will evolve to a new job level in the masonry industry, either as independent SME partner for the supplier industries or as technical department of these industries. The masonry sector has to make the turn and place masonry as a composite building material in the highlight of the decision makers.

4.2.4.3 Impact for European society

As mentioned before the decrease in masonry application causes an increase in unemployment rates in the masonry sector and other related sectors. Loss of masonry knowledge will on the long-term result in an increase in effort and costs for maintenance and conservation of existing masonry building constructions. It becomes difficult to maintain masonry knowledge, experience and workmanship that are needed for realisation of new masonry and for restoration and maintenance of existing masonry. By regaining market share employment in the masonry sector and related sectors will be assured. Improved knowledge of masonry constructions will reduce and minimize maintenance costs. Note that as a part of performance definition, the masonry industry will take responsibility for long-term maintenance and will accordingly focus their attention. As a more prominent long-term impact new potential applications of masonry with important societal benefits may become available. An old well know building material will remain available for the building society.

Masonry industry: co-operation to develop innovative applications



4.2.4.4 Impact on education

The existing knowledge level in university-, technical high school-, and technical education is based on the existing knowledge concerning characteristics of masonry units and old formulations of masonry mortar, prescribed mortars, not on the performance characteristics of masonry itself. The reason for that is that these characteristics are not known, they are the hidden potentials of the material.

The output of The Masonry Concept can only be anchored in the building society when the principles of this new philosophy will be implemented in the education plans of universities, technical high schools and technical school.

The new generation of architects, design - and building physic engineers will learn how to use the hidden potentials of masonry. The united industry and research institutes will have the task to implement the new knowledge in the education plans.

5 Finally

The merge of national product standards in a harmonised of product standards on European scale has been finalised. These standards will be in force in the coming years, which means that the supply industry has only one document they can use. One European language concerning brick and mortar and a start of one language of masonry for the future is secured.

During the same period the supply industries of masonry products, brick and mortar have merged into larger European groupings. The European Grouping mostly existing of SME's are spread over Europe-25.

The two mergers could be a prerequisite for the success of "The Masonry Concept"

"The Masonry Concept" could place Masonry in the row of the building materials from which decision makers, architects and designer can make their choice.