12TH INTERNATIONAL
BRICK/BLOCK
Masonry
CONFERENCE

Ade

MILLENNIUM HOUSE

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ABSTRACT

An analysis is made of masonry materials and their recent applications in order to establish the possible optimization of the same.
Criteria is established for an economizing of materials and energy in line with the demands of society at this the start of the third millennium, and the criteria is applied to the construction of masonry buildings.
The article asserts that it is possible to establish new means of exploiting the strength and hygrothermic qualities of masonry materials when used in cavity walling with insulation.
A standard house is considered in various modular forms which may be combined with traditional masonry and which allow the construction of walls and slabs for the same house and which also allow for the arrangement of installations within the masonry.

Key words: *Universal Unit, Bed Joint Reinforcement, Rib R, Integrala Masonry System.*

1. BACKGROUND

In the final years of the last century masonry underwent a profound evolution for several reasons and this makes it more competitive within the current building market.

Bricklaying consists of manually placing units side by side in successive courses which, therefore, conditions the size and weight of the pieces which can be handled by the bricklayer.

Furthermore our modern and developed society now questions the cost of energy incurred in the manufacture of building materials and demands that energy savings be considered in the design of all buildings.

Together with these tendencies there are, however, other reasons of historic and traditional nature which ensure that traditional masonry materials continue to be used in those place or cities where they have always been employed.

When combining all the modern tendencies which exist in masonry work, there is, however, one area which traditional masonry has not been able, or has not wished, to face in comparison with other more modern constructional materials or techniques. We are referring to the incorporation of steel with all the many advantages that this entails.

Everybody is fully aware that in less than one hundred years, masonry materials, which used to form 90% of all building materials in both architecture and civil engineering, are now only employed in around 30% of cases in the developed world.

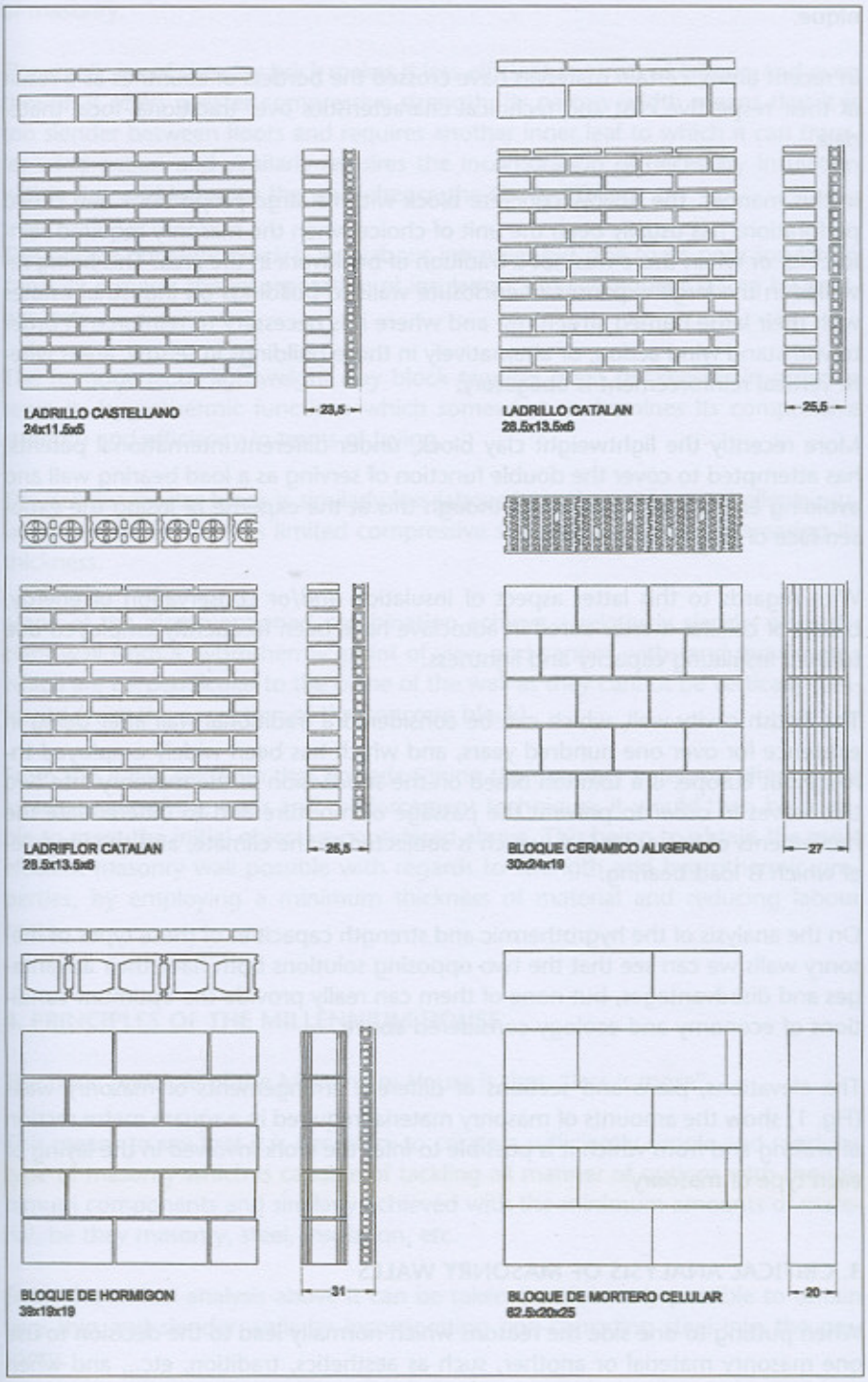
This factor is not only due to the appearance of new materials such as reinforced concrete or steelwork, which are considered to more suited to the industrial and developed world, but largely to the fact that no decisive attempt has been made to incorporate steel within the masonry on the basis that this goes against tradition.

The study in question concentrates on enclosure walls as these are, indeed, the most common types of masonry wall in housing. Here the insulating capacity of correctly arranged masonry has a very important role and which, in non-load bearing structures, is often considered of more importance than the actual load conditions themselves.

2. COMPARATIVE WEIGHTS AND DIMENSIONS OF MASONRY MATERIALS

Every country and even every region has its own specific traditional masonry components which are the product of locally found raw materials.

Figure 1. Diverse arrangements of masonry walls using different materials: 1m² masonry panels, front elevation. section and plan.



This then leads to established traditional values as a result of the long reiterative employment of the same raw materials and even the same bricklaying technique.

In recent times, certain materials have crossed the borders of countries as a result of their respective cost and technical characteristics over traditional local materials.

In this manner, the hollow concrete block with its large proportions and broad perforations has usually been the unit of choice when the masonry required reinforcing, or when there was not a tradition of brickwork in the area. This being revealed in the large expanses of enclosure walls to buildings on industrial estates with their large framed structures, and where it is necessary to reinforce in order to withstand wind action, or alternatively in those buildings in seismic areas where vertical reinforcement is obligatory.

More recently the lightweight clay block, under different international patents, has attempted to cover the double function of serving as a load bearing wall and avoiding energy loss in building, though this at the expense of losing the exposed face of traditional brickwork.

With regards to this latter aspect of insulation and/or conservation of energy, blocks of cellular mortar cured in autoclave have been frequently employed due to their insulating capacity and lightness.

The British cavity wall, which can be considered a traditional wall after being in existence for over one hundred years, and which has been widely employed throughout Europe, is a solution based on the subdivision of the masonry into two tied leaves in order to prevent the passage of moisture and to differentiate the movements of the outer leaf, which is subjected to the climate, and the inner leaf which is load bearing.

On the analysis of the hygrothermic and strength capacities of these types of masonry walls we can see that the two opposing solutions both have their advantages and disadvantages, but none of them can really provide the optimum conditions of economy and ecology considered above.

The elevations, plans and sections of different arrangements of masonry walls (Fig. 1) show the amounts of masonry material required in a square metre section of walling and from which it is possible to infer the work involved in the laying of each type of masonry.

3. CRITICAL ANALYSIS OF MASONRY WALLS

When putting to one side the reasons which normally lead to the decision to use one masonry material or another, such as aesthetics, tradition, etc.., and when

concentrating on the comparison of the labour and amount of masonry material employed, we may then establish a critical analysis of the aforementioned types of masonry.

The small size of the clay brick makes it less efficient in terms of labour, and even though it offers greater compressive strength, its narrow width means that it is too slender between floors and requires another inner leaf to which it can transfer wind action and similarly requires the incorporation of necessary insulation within the void between the walls, hence the Cavity Wall.

The hollow concrete block is less labour intensive but due to its poor insulating capacity requires the incorporation of insulation and subsequent facing by another leaf.

The homogeneous lightweight clay block requires great thicknesses in order to serve its hygrothermic functions which somewhat undermines its compressive strength and efficiency in terms of laying.

The cellular mortar block is similarly less labour intensive and has excellent insulating properties but has limited compressive strength even when increasing its thickness.

None of the aforementioned combination achieve a relatively slender and efficient wall from a hygrothermic point of view and cannot withstand movements which are perpendicular to the plane of the wall as they cannot be vertically reinforced (with the exception of the concrete block).

From this it can be taken that on redesigning the masonry units and altering the arrangement of the walls and reinforcement techniques it would then be possible to meet the initial objective considered above. This being to obtain the most efficient masonry wall possible with regards to strength and hygrothermic properties, by employing a minimum thickness of material and reducing labour costs.

4. PRINCIPLES OF THE MILLENNIUM HOUSE

The basic principle of the Millennium House is that: "less is more".

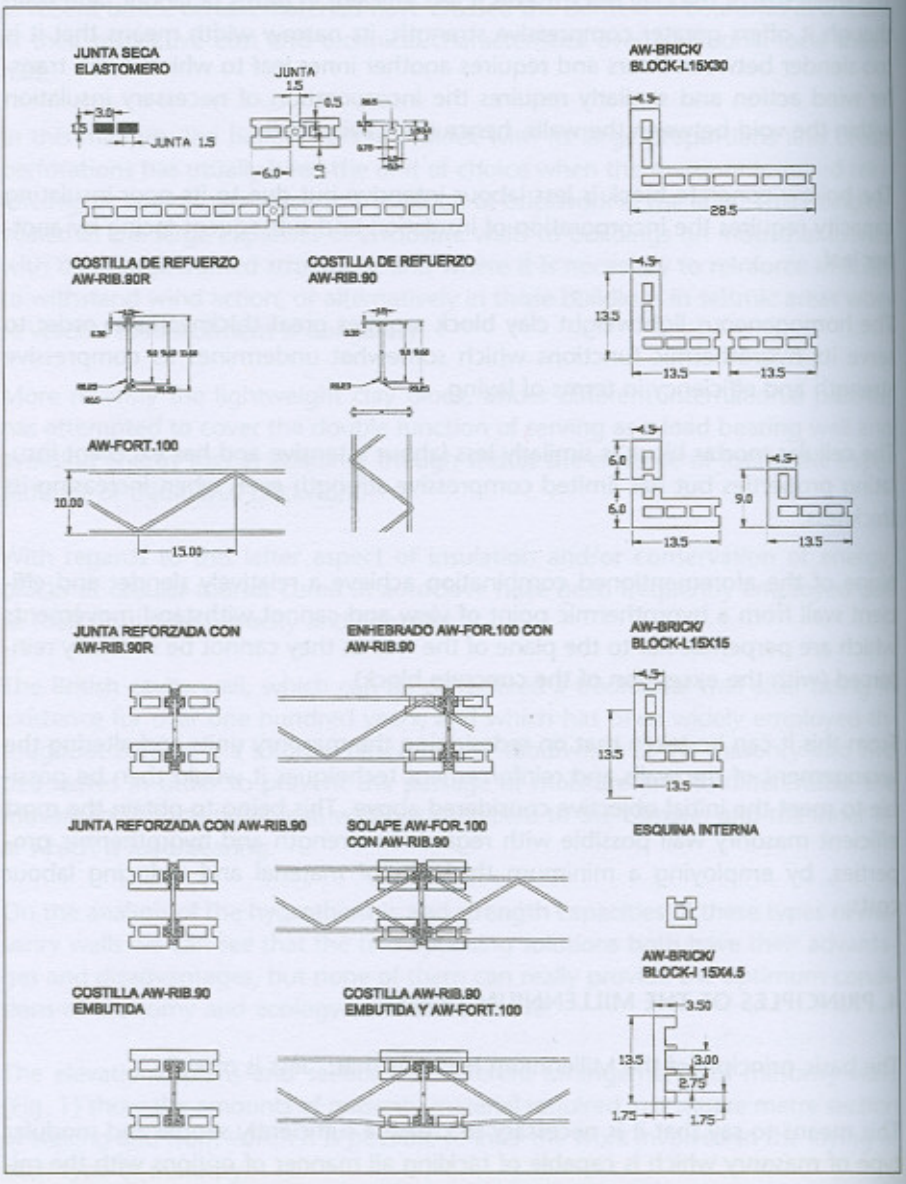
This means to say that it is necessary to create a sufficiently simple and modular type of masonry which is capable of tackling all manner of options with the minimum components and similarly achieved with the minimum amounts of material, be they masonry, steel, insulation, etc.

From the critical analysis above it can be taken that it is only possible to obtain very thin and slender walls by incorporating non-corroding steel into the masonry.

Figure 2. Universal clay units (Flower Brick) combined with panels. Clay masonry units and panels (M-30, M-45, M-90).

Figure 3. Truss type bed joint reinforcement, Rib reinforcement and strengthened rib reinforcement. Connection between clay panels, ribs and truss reinforcement.

Figure 4. Section of outer wall of the Millennium House.



It can also be deduced that the method of broadening the width of the wall in order to ensure the insulating capacity of the masonry, while being of great interest to the manufacturers of these materials, cannot be entirely justified in terms of loss of space and the added expense incurred.

In short, the Millennium House is one that is built in masonry materials with the bricklaying technique of placing one unit next to another in successive courses, but which incorporates steel reinforcement and thereby requires minimum thickness in order to comply with its strength requirements, and which incorporates specific insulation materials in order to ensure this minimum thickness.

With regards to bricklaying technique this should be considered in a manner which suits the reinforcement arrangement rather than the current practice which is to suit the reinforcement to the bricklaying procedure of course work.

That is to say, if we design the reinforcement arrangement with a certain freedom with regards to the building arrangement of the masonry, the ensuing result will be far more efficient, even though it be necessary to redesign the masonry units in order to do so.

Consideration should then be given to the slimming down of the thicknesses of masonry units to the minimum possible in a wall.

5. COMPONENTS OF THE MILLENNIUM HOUSE

Masonry units (Fig. 2)
Prismatic: Universal masonry units
Surfaces: Masonry panels; Slabs; other materials

Steel reinforcement (Fig. 3)
Longitudinal: Twisted bars
Surface: Bed joint reinforcement: meshes
Spatial: Rib reinforcement

Joint materials:
Injected mortars: adhesives; sealants

Insulation: (Fig 4)
Insulating sheets: Sprayed; injected...

Other components:
Connectors; Spacers; Ventilators; Sealants; damp proofing, etc.

6. THE MILLENNIUM HOUSE

The masonry Millennium House arranges the aforementioned basic components in a strict modular form though allowing all manner of modular variations and interchangeable components.

Figure 5. Millennium House with M-30 Modulation.
Figure 6. Millennium House with M-45 Modulation.

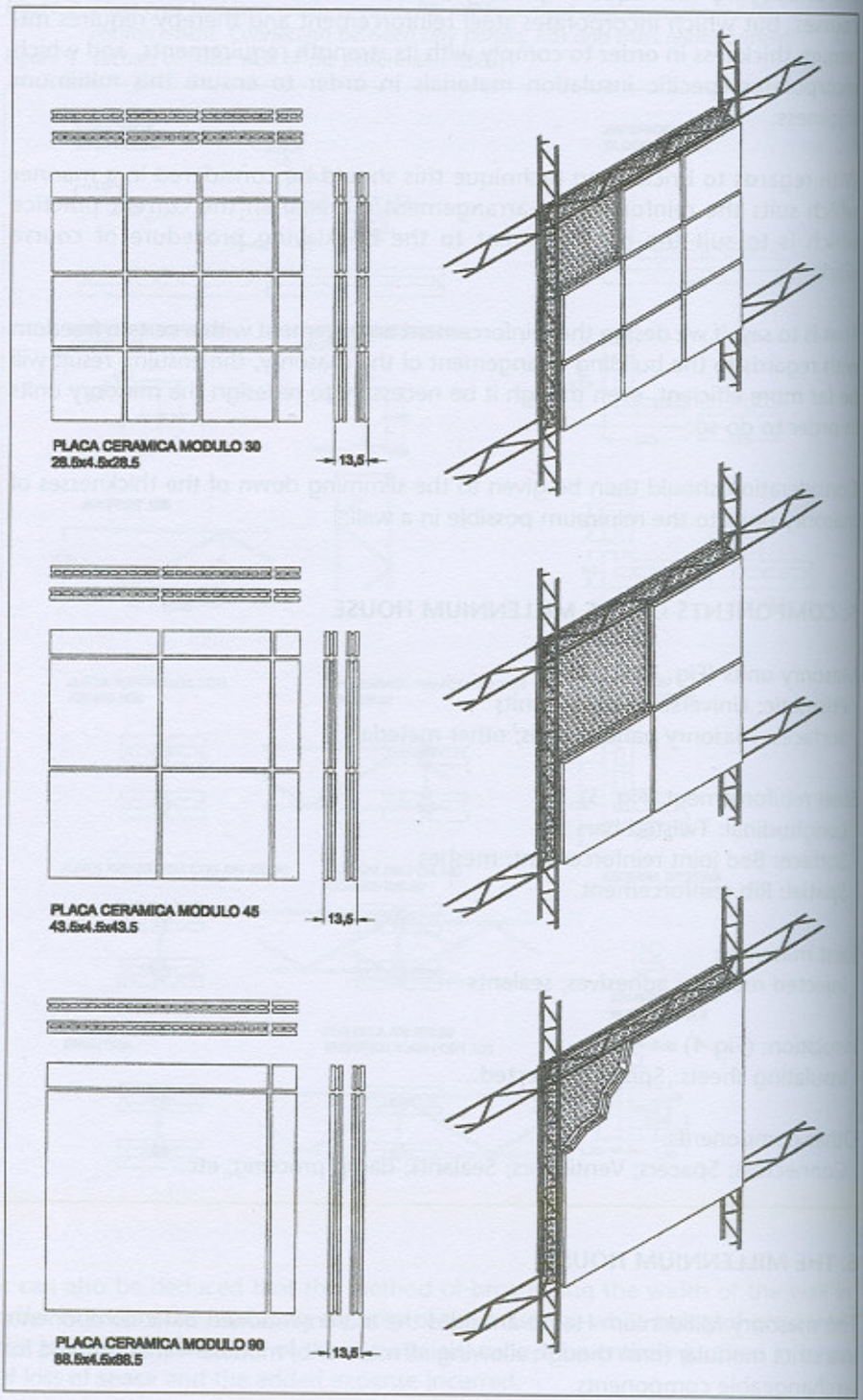
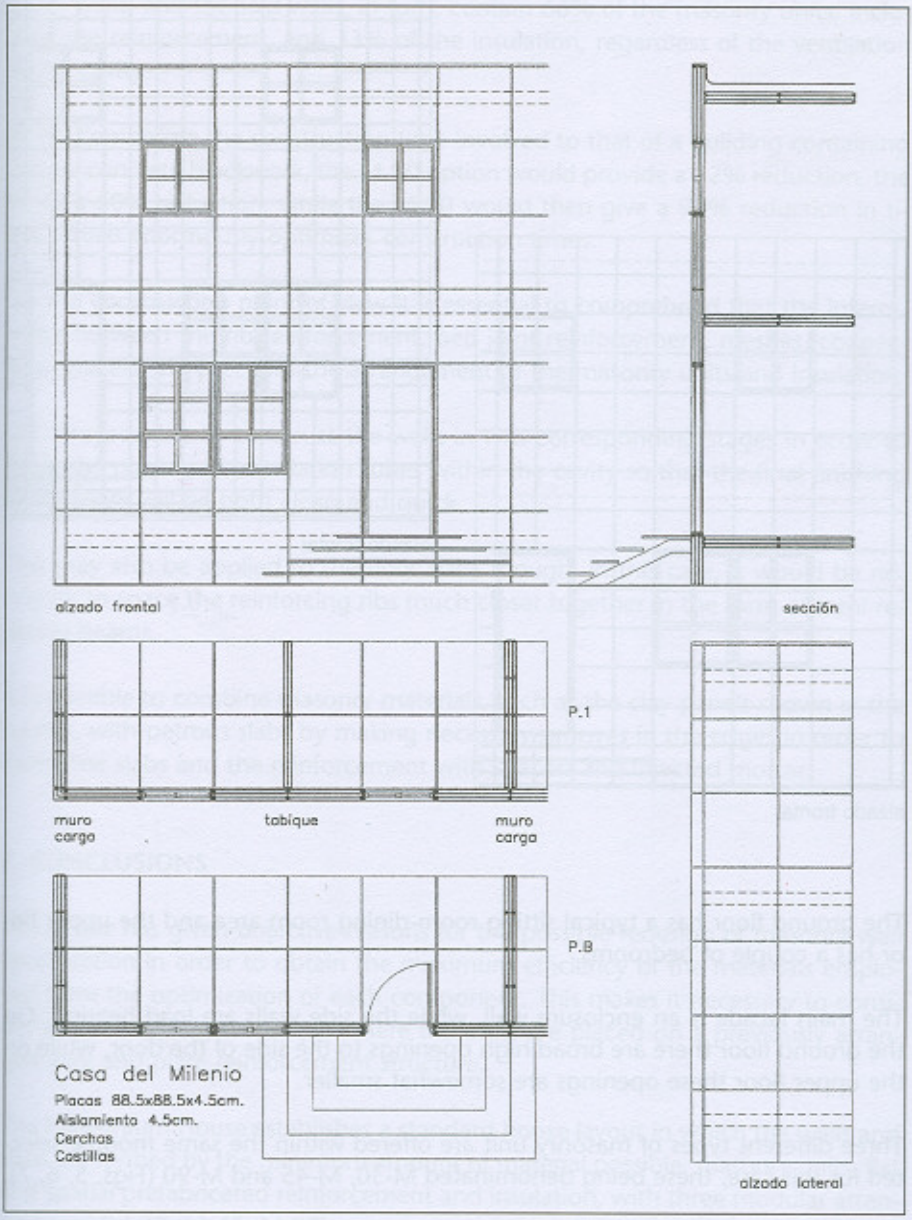
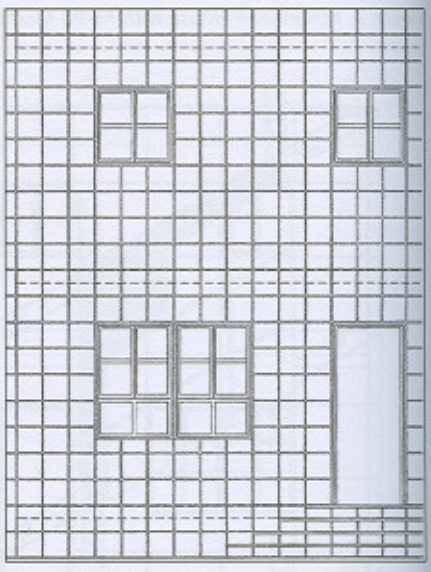


Figure 7. Millennium House with M-90 Modulation.

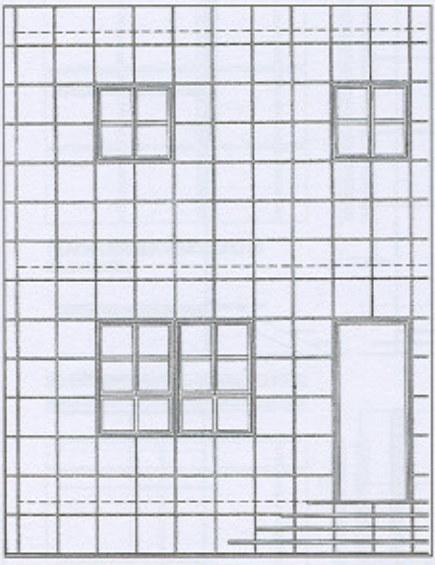


The design of the masonry of the Millennium house may consider both enclosure walls and load-bearing walls as well as floor slabs and roofs if so required.

By way of advancement, we can show the layout of a two-storey house built with load bearing walls, enclosure walls /and/or bracing) and partitions, as well as floor slabs.



alzado frontal



alzado frontal

The ground floor has a typical sitting room-dining room area and the upper floor has a couple of bedrooms.

The main façade is an enclosure wall, while the side walls are load bearing. On the ground floor there are broad high openings to the side of the door, while on the upper floor these openings are somewhat smaller.

Three different types of masonry unit are offered within the same module selected for this case, these being denominated M-30, M-45 and M-90 (Figs. 5, 6, 7).

The walls and slabs respond to their corresponding modulation each case, though the proportion of vertical or horizontal reinforcement remains constant as this depends on the results of calculation.

We have not considered a composite solution in this particular case, though this would be easily obtained by combining modules or sub-modules within the same wall or construction, or even with units of different proportion within the same module.

The walls of the Millennium house are around half the thickness of current masonry walls, and the said walls, in turn, contain 66% of the masonry units, including the reinforcement, and 33% of the insulation, regardless of the ventilation of the cavity.

When comparing the construction time involved to that of a building containing hollow concrete blockwork, the M-30 option would provide a 12% reduction, the M-45 a 60% reduction, while the M-90 would then give a 90% reduction in time, which enormously optimizes construction times.

From a construction point of view it is essential to comprehend that the interrelation between the rib reinforcement, bed joint reinforcement, meshes, connectors, spacers, etc precedes the arrangement of the masonry units and insulation.

It is also possible to construct the walls in two corresponding stages in order to allow the placing of installation tubes within the cavity so that the final finishing of the work will be both clean and quick.

This may also be applied to the floor slabs though, in this case, it would be necessary to space the reinforcing ribs much closer together in the form of semi-resisting beams.

It is possible to combine masonry materials, such as the clay panels shown in the figures, with petrous slabs by making necessary grooves in the edges in order to frame the slabs and the reinforcement with spacers and injected mortar.

7. CONCLUSIONS

The article has given objective reasons for the possible redesign of masonry wall construction in order to obtain the maximum efficiency of the materials employed from the optimization of each component. This makes it necessary to consider a new building technique where the units are placed on a previously arranged wire and plate reinforcement structure.

The Millennium House establishes a standard house layout in which the walls and slabs are formed by the minimum amount of material possible: masonry units, flat and spatial prefabricated reinforcement and insulation, with three modular arrangements (M-30, M-45, M-90).

The Millennium House allows construction time savings over that of a standard hollow concrete block wall in the order of 12%, 60% and 90% in accordance with the corresponding modular units employed.

This arrangement is suitable for D.I.Y building as the component parts are lightweight and manageable and the construction does not require skilled labour.