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BEYOND NATIONAL MINIMUM STANDARDS: A COMPARISON OF THE TRADITIONAL HCB AND THE AB THERMABLOCK

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ABSTRACT: Since the launch of the Energy Performance of Buildings (EPBD) Directive by the EU Commission, and Malta's membership in the EU in 2004, a number of seminars have been organized in Malta for professionals working in the building industry to raise awareness on the transposition of the EU Directive into National Law, as implemented through Malta's latest building regulations, Part F.

Aware of the ever-increasing demand for energy-efficiency in Malta, one established high-quality manufacturer and building contractor in Malta, Attard Brothers Group, have launched a new product in the building industry. This is an innovative building block for external walls combining two concrete skins and insulation en suite. Hence the name of the new product, the Thermablock. Its thermal performance is almost double the required standards.

Keywords: Thermablock, cavity insulation, thermal performance, energy certification, EPBD.

1 BACKGROUND

"Buildings are at the core of the European Union's prosperity. They are important to achieve the EU's energy savings targets and to combat climate change whilst contributing to energy security…" EU Commission

Synchronised with the latest re-cast of the EPBD (Energy Performance of Buildings Directive, 2002/91 EC), Maltese legislation has been updated through LN 261/08. Malta's energy goals for the year 2020 can only be achieved by curtailing energy in use at the design and construction stage. Energy in use should follow suite.

According to the new regulations, an EPC (Energy Performance Certificate) is now required for practically every building. An EPC, which has a scale of A to G, is similar to energy labels found on domestic electrical appliances. A-rated buildings would be the most energy efficient whereas G-rated buildings would be the least, producing the highest carbon emissions.

The construction industry contributes a generous proportion to the national GDP in Malta. It also constitutes a major part of the national labour force. Therefore any change in the industry is bound to have a direct effect on such national interests. The latest revamp of the building regulations have been tailored to take on board a new section dealing with energy use in buildings, including certification, through Part F. This specifies the minimum requirements for thermal performance; they are prescribed to qualify a building and ensure it attains the national energy certification, now mandatory under EU legislation.

2 ACHIEVING THE MINIMUM STANDARDS

These minimum requirements are achieved by modifying the design of the external building envelope to accommodate an insulation layer in roofs and external walls. This takes much desirable floor space and time in construction. Clients already complain of additional costs due to the cost of construction, especially when considering the alien trade of insulating a wall, originally unheard of in local building construction norms.

Be it externally or internally, many a house or block of apartments will need to be retrofitted or adopted to accommodate the new layer of insulation, especially since the EPC (Energy Performance Certificate) has now become mandatory with every transfer of ownership or tenancy agreement. Updated construction methods are therefore coming into force.

Until the early 1990s, external walls were still being built in two skins of soft stone masonry, originally 2no.x 230mm skins with a 50mm cavity, gradually reduced to two skins of 180 and later to 150mm, with a nominal 12mm or no cavity at all, for want of a lower cost of construction and space considerations. Naturally this demonstrated a blissful, albeit naïve approach towards heat losses and moisture penetration through thermal bridging. Figures 1 and 2 refer.

Today the two skins of soft stone masonry have been replaced by a single wall composed of a single leaf HCB (hollow core blockwork), with its own precast cavity. Its walls are of single or double thickness (with an accompanying increase in concrete density) with the latter affording a greater load-bearing pressure. Such HCB external walls are typically the 'run of the mill' today, practically ousting out soft stone completely. One positive asset is that quarrying has diminished almost completely.


Figure 1: TWO skins of 230mm soft stone with a 50 mm cavity, total 510mm.
Figure 2: TWO skins of 180mm soft stone, typically with NO cavity, total 360mm (+ thermal bridging).

3 WHAT IS THIS NEW THERMABLOCK?

With this in perspective, AB Group has decided to embark on an ambitious project, with a view to launching a novel product on the market. The idea was to develop a new HCB with a 'clamped-on' insulation panel, all cast as one. The novelty of the block is that it retains the same load-bearing properties and is laid as a normal block with the insulation en-suite, thus reducing additional labour on site. This also ensures a consistent quality control of the insulation and simplifies the construction process on site. Moreover the mechanical rigidity and compact robustness of the block also saves on overall wall thickness, thus gaining indoor usable space, figures 3,4 refer.

4 INTRODUCING THE AB THERMABLOCK

Following preliminary empirical calculations, it was established that for optimum thermal performance the block is to be composed of three skins, comprising 73mm solid concrete, followed by a medium density polystyrene insulation board of 50mm in thickness, and another HCB 173mm thick, with two cavity holes. The composite three layers add up to a formidable 296mm overall, thus resulting in a space saving of 114mm internally. It is also lighter and thus faster to construct. Figures 3, 4 refer.

5 PRODUCTION OF THE THERMABLOCK

Building on the company's vast experience of standard HCB production, various trial mixes were made, followed by cube crushing, in order to assess the compressive strength of the new Thermablock with the standard block. It was then established that the size and bonding of the elements of the proposed unit were correct, sustaining adequate bearing pressure for the given cross-sectional area. Towards this end, a new machine was bought by the contractor, as illustrated in figure 5.

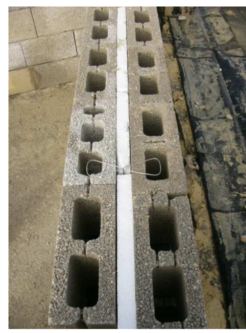


Figure 3: TWO skins of 180mm blockwork, with 50mm insulation, total 410mm.
Figure 4: ONE Thermablock unit laid instead of a double wall+ insulation, 296mm overall.

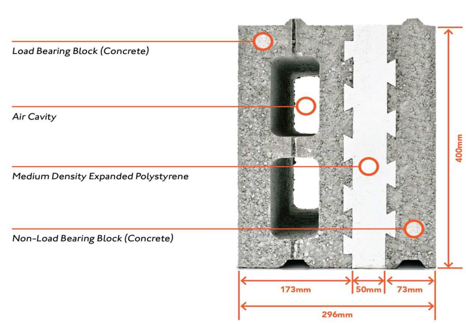

Figure 5: The new precast concrete block machine, RH2000 (HESS Group)
Figure 6: Dimensioned components of the Thermablock.

The principal constituents of the block are essentially locally sourced crushed concrete aggregate, imported Ordinary Portland Cement, medium density Expanded Polystyrene and water. Casting takes place by means of an automatic weighing machine, with a pre-set mix design. The vibration mould is primed with insulation for injection moulding sandwiched between the two skins of concrete. The concrete mix is then cast and adequately vibrated to achieve a dry concrete block. The mould releases four blocks in a row on a continuous string, then moved to an in-house store for natural curing, as shown in figures 7 and 8.

Figure 7, 8: Dry mix compaction & casting of Thermablocks, 4 in a row, stacked for curing.

6 TESTING & CERTIFICATION

The testing of all materials individually is tantamount to producing a high-end quality product. Crushed Coralline Limestone aggregate spalls are tested for strength and grading criteria; OPC cement and water are regularly tested at independent testing Labs; Expanded Polystyrene is certified and guaranteed against a declaration of conformity from the supplier, typically local. The load bearing part can take a standard compressive strength of 7N/mm^2, although higher strengths can be made available on request. The company is certified as compliant with ISO 9001 Quality Assurance Procedures.

One area of concern was the dove-tail bonding of the polystyrene with the two concrete skins. This was however tested by direct tensile tests. Ultimate tensile capacity of the mechanical connection to EPS (Expanded Polystyrene) is 2.5kN/block.

7 SPECIFICATIONS OF ^{AB} THERMABLOCK

The thermal properties of the new units were established after combining with different options for plastering and infill concrete, among other options. These are highlighted as follows, table 1.

Table 1: Thermal Properties of the Thermablock

BLOCK TYPE & DISPOSITION	U-value
Standard Unplastered ^{AB}ThermaBlock:	0.680 W/m^{2}K
Standard Plastered block: (5mm thick plaster on both sides):	0.608 W/m^{2}K
Concrete Filled Unplastered ^{AB}ThermaBlock :	0.730 W/m^{2}K
Concrete Filled Plastered block (5mm thick plaster on both sides)	0.648 W/m^{2}K

When comparing the above U-values with those stipulated in Part F of the latest building regulations, namely a specified U-value of 1.566W/m^{2}K for external walls, it is evident that this new building block exceeds the minimum standards by over 43%.

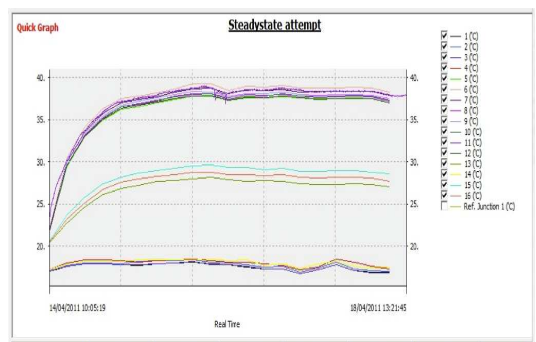

Figure 9: Testing for steady state in a hot box

After building a sample wall in conformity with ISO 8990:2000 and testing for steady state conditions in a guarded hot box, results indicated that although steady state was reached internally, within less than 48 hours, climbing up to 35-38°C, externally the wall remained at a relatively stable temperature of 15-18°C. This indicated that the Thermablock was capable of restraining a change in temperature of circa 20°C.

Samples were later shipped and tested at the IBP (Building Physics) laboratory of the Fraunhofer Institute, in Germany. Very positive results were achieved, where the block (acting as apart of a homogenous wall) was found to be 43% more energy efficient than what is required by the latest Maltese minimum standards, for the issue of an EPC (Energy Performance Certificate).

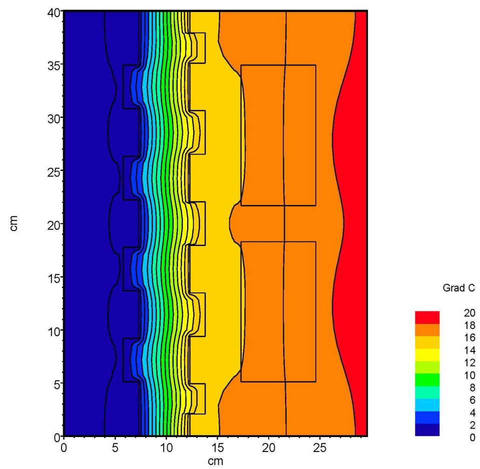

Figure 10: Thermographic imagery when testing in a hot box (courtesy of Fraunhoffer Institute)

At Fraunhoffer labs, thermographic images were taken through a specially fitted infra-red camera. This revealed the transverse heat flow through the block, as demonstrated in figure10. This clearly highlights the nominal (negligible) effect of the cavity holes in the HCB part of the composite block.

8 SPECIFIC PARAMETRIC BENEFITS

Given the experimental results obtained and based on genuine certification, there is an exhaustive list of parametric benefits clearly achievable through the use of the new building module. These include thermal comfort, thermal mass (reduction in temperature fluctuations), sound attenuation, seasonal adaptability, reduced labour cost, faster construction time, indoor space saving, value added to the property, and above all its environment friendly property.

9 CONCLUSION

On reviewing table 1, and comparing the achieved U-values (0.608~0.73 W/m^{2}K) against the prescribed minimum U-value (1.57 W/m^{2}K) for a wall in Part F, it is evident that this new building block exceeds the minimum standards by over 43%. Apart from improving space standards, this goes a long way to prove its effectiveness towards improved energy efficiency in buildings in Malta, as well as to reduce the country’s carbon footprint in the context of global warming.

The authors coordinated the professional testing and certification with IBF, at the Fraunhofer Institute in Germany, an authorised certified body within the EU.

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