EXTERNAL PLASTERS APPLIED TO CONCRETE BLOCKWORK

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The aim of this dissertation is to investigate and analyse different external plasters, available locally, and study how the use of these external plasters may enhance the overall thermal performance of local concrete blockwork. This study provides a practical insight into how the various types of plasters available do improve the U-value of a concrete block wall. Three main types of external plasters were used as the basis of this study. Results demonstrate that the more sophisticated type of plaster helped to greatly improve the U-value of a bare concrete block wall. This enhanced U-value, however, is achieved using more expensive plaster systems. Thus, from this study, the energy conscious designer can see at a glance how, with the help of specific external plasters, a more energy efficient building may be achieved, and how an existing building's thermal efficiency may be improved.

PLASTERS USED FOR EXPERIMENTAL STUDY

A very wide range of products from various companies is available locally. All plasters (except the sand + cement type mixed on site) are imported. The sand + cement type can also be bought in pre-packed form.

Locally, the cement-based plaster is still the more used since it is still the cheapest to buy, and it can be used as a substrate for other systems, for example with another thin silicate or polymer plaster finish applied to it (eg graffiato). Plasters are still considered as just surface finishes and therefore customers try to find the cheapest product (with the greatest visual effect!).

Since there are basic similarities in all the ranges of products offered by the different companies, it was felt that it would not be useful to study similar types of plaster from different companies.

A local company, Attard & Co. Limited, imports Italian made plasters manufactured by 'BUFFA'. These products were used for the tests. This company was interested in the opportunity to carry out experimental studies on their products for the local construction industry. BUFFA Company (Sicilian based) also test their plasters in a climate very similar to ours.

Plaster Descriptions

The choice of BUFFA plasters was based primarily on their widespread local use and secondly because of the insulating properties claimed for their products. (Buffa Brochures). The products used were:

- **INTONACO T-70** – pre-mixed cement base mortar. This is the most popular plaster and, since it is pre-packed, it ensures speed in carrying out the work, guaranteed results and constant quality on site.

  This plaster is usually applied at 6–7mm in thickness. Also, polymer based resin additives may be added to the mix, to achieve different qualities required, such as waterproofing or increased elasticity.

- **MACROCEL** TRASPIRA – this plaster is said to be an *'advanced-technology dehumidifier'* because of its macroporous structure, the plaster also has low thermal conductivity, thus improving the thermal insulation of masonry.

  This plaster can be applied in layers of up to 25mm thickness for maximum insulation efficiency.

- **'CAPPOTTO'** ThermoSystem – this system consists of a smooth finish adhesive, polystyrene foam and fibreglass mesh covered again by the smooth finish adhesive. A final finish coating is applied over this system.
  This thermally insulated façade system can offer many advantages apart from offering a very fast way of thermally insulating a building. As a result, the interior face of the wall does not cool down much, stopping unwanted condensation, dampness and mould.

TEST PREPARATION PROCEDURE

The intention of this study is to carry out comparative experiments on various types of plasters applied to concrete block, whilst still keeping to the guidelines recommended by the Euro-code as specified in EN ISO 8990:2000 (MSA, 2004), but at the same time **achieving results that would really represent what actually happens on site of newly built or renovated buildings**.

It was decided (after analysing many methods) that the best test method in order to minimize all these losses, and to ensure that all the heat (Q) supplied only passed through the test blocks, was to build small concrete block ‘cells’. In doing so, heat losses were minimised and controlled. The whole internal area (A) of the ‘cell ’ was taken into account. This method is based nonetheless on the test procedure given in the Euro-code EN ISO 8990:2000 (MSA, 2004).

The success of the experiments depends on the heat supplied (Q) which flows laterally through the wall area (A) to the outside (cold side). Therefore it was very important to minimize heat loss from any other areas of the experiment set-up by applying thick insulation at the top and bottom of the cells. If heat losses were significant, even through the insulation itself, then the results could be very misleading, or completely wrong. Special care was taken, when designing the test procedure, to ensure that the different tests could be carried out in exactly the same way, so that if some heat losses were unavoidable, this would be a constant throughout all the different tests.

TEST PROCEDURE

Four cells were built from the concrete blocks provided. These measured 1150mm x 920 x 520mm. These were built on insulation panels 120mm thick, and elevated from the ground to ensure a good insulation barrier beneath the cell. The top of the cell was roofed with 300mm thick insulation rockwool to also ensure no heat losses from the top. The internal face of the cell was left bare and the external face was applied with the different types of plasters. In this way, since the top and bottom of the cell were well insulated, heat only flowed laterally through the concrete brick walls and plaster to the outside.

Two 10mm diameter holes were dug through the base insulation, to allow the passage of the thermocouple wires, as well as the wires leading to the resistors and light bulb, from the inside to the outside of the cell. The two holes were dug as distant from one another as possible so the higher voltage passing through the wires leading to the resistors would in no way interfere with the milli-volts passing through the thermocouple wires. A higher voltage passing close to the thermocouple wires, could affect the voltage induced with the wire, and therefore a wrong reading may result or different readings may be read for the same temperature.

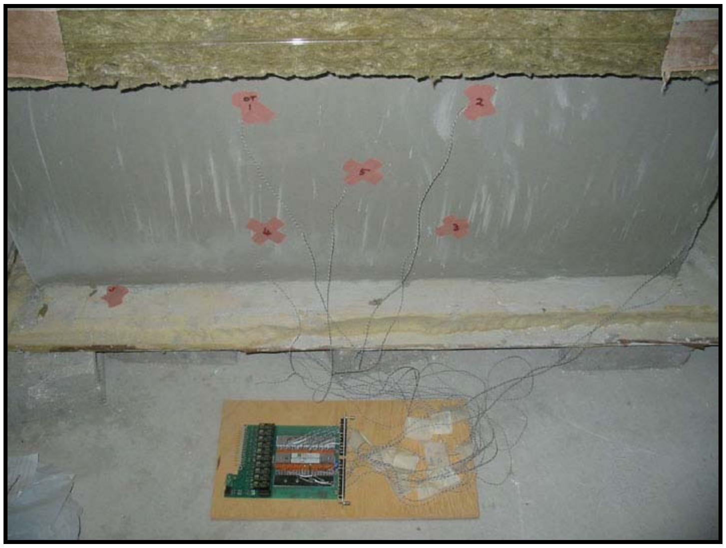

Figure 3-21;
Thermocouples are fixed into position on cold face – outer side 1

Figure 3-22;
Thermocouples are fixed into position on hot face – inner side 1 & 2

Each thermocouple was clearly labelled according to its assigned channel to avoid confusion when moving the sensors from one cell to another. This also easily helped to identify which sensor may be defective in case of abnormal readings.

Figure 3-23;

Thermocouples labelled according to their respective channels, connected to the CA522 card, which is plugged into the datalogger

Insulation Sandwich of Cell

Great care was taken to ensure that heat loss from the inside of the cell was minimal from the top or bottom of the cell. This was to ensure that heat could flow laterally through the concrete block and plaster. The cell was built raised off the ground and on an insulation panel 120mm thick. The insulation panel and the air beneath the panel provided an insulation barrier.

Figure 3-24;
Cell sandwiched between insulation

TESTS AND RESULTS

DURATION AND VALIDATION OF TESTS

Fourteen tests were carried out in total, which comprised of 704 hours of testing time. Three tests were carried out on each cell, but the first test of each set was discarded, because they were presumably too short, and the results achieved, when compared to the results of the subsequent two tests carried out, were not so close. This trend was seen in every set of results. This may have been due to the fact that during the first test run, the cell had a higher moisture content, since the environment in the laboratory was quite damp, and also the bricks may also have been slightly damp from the application of the plasters. Therefore the first test was used to ‘stabilise’ the cells for the following tests. In total eight tests were considered valid, and were in line with EN ISO 8990:2000 (MSA, 2004).

The tests started on 1st April 2005 and ended on 16th May 2005.

A graph was plotted by the computer software throughout the duration of the test, to help verify the time at which the steady-state had been reached. The tests were frequently inspected, to ensure that all was proceeding well, and that the readings made sense. Final readings were taken when at least two successive readings spread over three hours after near-stability had been reached, and agreed within 1% (MSA, 2004).

DIFFICULTIES ENCOUNTERED DURING TESTS

The Euro-Code recommends test conditions to be chosen considering end-use applications and indicates that for building applications, temperature differences of at least 20ºC are common (MSA, 2004). Due to the fact that the laboratory ambient temperature could not be manually controlled, the ‘outside’ temperature was quite high when compared to the ‘inside’ temperatures and therefore temperature differences of 20ºC were very difficult to achieve.

Summary of test results (average U-values):

	W/m^2K
Bare Cell	4.78
'Intonaco-70'-faced Cell applied at 6mm	4.63
'Macrocel'-faced Cell applied at 25mm	3.61
'Cappotto'-faced Cell	2.01

Using the U-value attained for the 'barefaced' cell as the worst case since no plaster was applied to its external face, then it can be seen that the:

- 'Intonaco-70'-faced Cell applied at 6mm decreased the U-value of the concrete blockwork by – **3.14%**

- 'Macrocel'-faced Cell applied at 25mm decreased the U-value of the concrete blockwork by – **24.48%**

- 'Cappotto'-faced Cell decreased the U-value of the concrete blockwork by – **57.95%**

5.2 ANALYSIS OF RESULTS

The critical factor of all thermal conductivity calculations is the Lambda (λ) value. The lower the Lambda value, the higher the resistance and therefore the U-value decreases. The Lambda value is also inversely proportional to the density of the material. Thus, low-density plasters have good thermal resistances.

This can be clearly seen from the above final results. A typical sand-cement mix applied to concrete blockwork has hardly any effect on the overall thermal performance of the cell.

When the less dense plasters were used as the 'Macrocel' type and especially the 'Cappotto' type were polystyrene foam sheets are used, the thermal performance of the cell was enhanced significantly.

There still exists a mentality today that exterior plasters are not seen as possible enhancers to thermal performance, but only as a surface finish. Therefore consumers are not ready to pay any hefty prices for external renders.

The cost of the materials used and including their application are:

- Intonaco-T70 – LM 4 to LM 6 per m^2
- Macrocel – LM 17 to LM 20 per m^2
- Cappotto – LM 25 to LM 30 per m^2

Prices would vary slightly depending on particular site conditions.

Comparing the above costs, one can see how the cost increases dramatically with the more efficient plasters.

Through a quick cost analysis, one could conclude that it may not be financially feasible today to use such expensive (though very efficient) plaster systems especially for small homes. In order for the capital outlay to be recovered with the savings made due to increased energy efficiency would take far too many years. This is because of the cost of electrical energy supplied into our homes is relatively cheap due to government subsidies. Environmental issues are also not considered, including pollution costs etc.

On the other-hand, through a detailed cost benefit analysis, one may find that, especially on large proposed buildings that have high energy heating and cooling costs, using such systems could lead to large financial savings. This would be even more marked, if exterior plasters are used to further enhance an intrinsically energy-efficient building.

Locally, issues related to energy conservation in buildings are being given more prominence. In fact, as from January 2006, new buildings regulations are to be published, where local buildings are to be constructed with a thermal insulation barrier, and given an energy rating. Through these tests on local construction, and thermal insulation systems available, as discussed earlier, the architect can be more accurate in his proposed designs, to achieve the required building energy rating.

The scope of the study was to find out what difference exterior plasters can make to the overall U-value of an exterior wall of local buildings in the most practical way. This is because concrete blockwork is being used more extensively today, and used also on façades where for example, rooms are designed to extend outwards from the façade. Thus, in today’s market where energy costs are constantly on the increase, the public can be made more aware of the benefits that plastering systems can offer to reduce energy consumption, thus saving on energy costs. Today’s trend will have to change to a more energy-conscious environment for development to remain sustainable.