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FLOOD RESILIENT CONSTRUCTION

Dr. Geoff Edgell, Head of CERAM Building Technology, gives his thoughts on the Government's report on flood resilient construction

In 2007 the Department of Communities and Local Government issued a report entitled "Improving the Flood Performance of New Buildings: Flood Resilient Construction". This is aimed at providing guidance to developers and designers on how to improve flood resilience of new properties in low or residual flood risk areas. The report defines resilience as 'building in such a way that although flood water may enter a building its impact is reduced' i.e. no permanent damage, structural integrity is maintained and drying and cleaning are facilitated. It also clearly establishes a hierarchy of design to reduce risk, namely avoidance (build elsewhere), resistance (prevent water entry), resilience (controlled consequences) and repairable (repairs simplified). Against this background the report then goes on to give guidance on design and materials selection for different elements of the building. All this is intended to be and, in the most part is, helpful.

In the case of walling at the headline level clay bricks come out of the study fairly well. Based upon test results (subjecting a range of wall constructions to 1m head of water) the following guidance is given.

Flood Resilience Characteristics of Walls (based upon laboratory tests)

Material	Resilience Characteristics		
External face	Water Penetration	Drying Ability	Retention of pre-flood dimensions, integrity
Engineering bricks (classes A and B)	Good	Good	Good
Facing bricks (pressed)	Medium	Medium	Medium

*Resilience characteristics are related to the testing carried out and exclude aspects such as ability to withstand freeze/thaw cycles, cleanability and mould growth

However, the general guidance which is given is based upon the laboratory evidence, expert opinion and experience from the building industry. In relation to water exclusion strategy which is intended to apply to low (<0.3m) flood water levels or higher (<0.6m), where the structural integrity of the building will not be compromised, the guidance says:-

> "Bricks manufactured with perforations should not be used for flood resilient design" and "Do not use highly porous bricks such as hand made bricks."

In the case of greater flood depths a water entry strategy is suggested and in this case the guidance says:-

> "Do not use softer bricks, such as hand made clay bricks, which can easily crumble when subjected to water."

The testing programme referred to above did not cover wall constructions in either hand made bricks or perforated bricks. Indeed perforated bricks were not included in any part of the experimental work. The report does acknowledge that the experimental programme was limited and that there may well be other materials and types of construction which are resilient to flooding, which have not been considered. This does rather imply that the negative comments on perforated and handmade bricks are based upon opinions voiced and not fact.

I would like to put forward a few observations and some information which, when considered, might counter some of the negative comments above.

It is the general case that when brickwork leaks it is through the joints, not necessarily through the body of the mortar, which was shown in the DCLG report as being relatively impermeable, but at very small cracks at the interface of bricks and mortar. This is clearly the case in facing brickwork, in trials where such 'cracks' were made artificially by placing small pieces of polyethylene against the header end of each brick in a wall and removing them when the mortar had cured the resistance to rain penetration was awful. Repointing improved the performance out of all recognition. You may well say that rain penetration, albeit in a flood coat condition as in the above tests is different to a static head of water and it is. However when brickwork has been used for water tanks such as at Howley Park in Yorkshire the leakage at first fill was spectacular. A Dutch boy to put his finger in the dyke was needed! However all this was anticipated, following drain down and some local repairs the performance was fine. The same procedure applies to brickwork manholes; a water test is carried out soon after construction, not to test the basic performance of the material, but to identify local faults that need local repair. Manholes are generally of 215mm thick brickwork and it is important to realise that if the manhole is filled with water the walls may still be absorbing water, i.e. filling the voids, even in 'engineering' brickwork, for 100 hours after the first fill. In relation to the use of perforated bricks it has been shown that manholes built using perforated (3 hole) 'engineering' bricks can perform better than those built in solid engineering bricks in terms of leakage after initial fill and long term steady state leakage rate. Clearly there is evidence to show that the statement that 'perforated bricks should not be used' is questionable. All the more so given their environmental advantages in terms of clay usage, fuel usage in production and transportation, reduced emissions etc.

Consider the humble hand made clay brick. The statement about using highly porous bricks clearly comes from the single experiment on one type of brick and its permeability relative to that of 'engineering' bricks. Granted the brick was more permeable albeit better than aggregate concrete units but is this really a representative view?

Regarding the crumbling of hand made clay bricks in water. We must remember we are talking about new build. Modern hand made bricks may be truly hand made by craftsmen or simulated hand made by machines. Furthermore the firing process may be in a computer controlled kiln. However, even if it is not and a traditional clamp firing is used the bricks are all supplied to BS EN 771-1: 2003 which requires an adequate factory production control scheme to be in place. Perhaps most significant in this context is a mandatory declaration of water absorption following 24 hours immersion in cold water. These bricks do not crumble. Naturally historic bricks fired in uncontrolled ways and exposed to the elements for many years may crumble, primarily due to frost action but this is not relevant to the guidance under consideration. It is also relevant to observe that prior to the adoption of BS EN 771-1: 2003 bricks in the U.K. were manufactured to BS 3921: 1985 which required water absorption to be declared after the bricks had been subjected to boiling water for 5 hours. This test caused the industry no concern. There is no 'crumbling'. These bricks are not Digestive biscuits. There are clear grounds for the statement to be withdrawn.

One final point, in dealing with solid walls, the report tends to concentrate on rendered aircrete. There is however a lot of relevant experience from brickwork manhole construction. Traditionally English Bond has been used, that is alternate courses of headers and stretchers and is known to perform well over many years. It is well known that Collar Jointed walls perform better, i.e. two leaves in stretching bond with a vertical joint between them and hence no through cross joints but instead offset cross joints in the two leaves. Less well known is the bond known as Water or Manhole Bond, which is a Collar Jointed construction where one leaf starts with a course half the normal height. The end result is a wall with offset bed and cross joints in the two leaves and very long hydraulic paths through the mortar leading to much improved resistance to the passage of water. This emphasises the point that it is the joint not the brick that is of significance in relation to leakage.

Conclusion

Overall the report is useful but as with many, inadequate consultation or attention to views offered has led to some poor guidance especially at the detail level. It hoped that any revision of the guidance would take account of the views and information in this article.

FIGURE 1 - BONDING ARRANGEMENTS

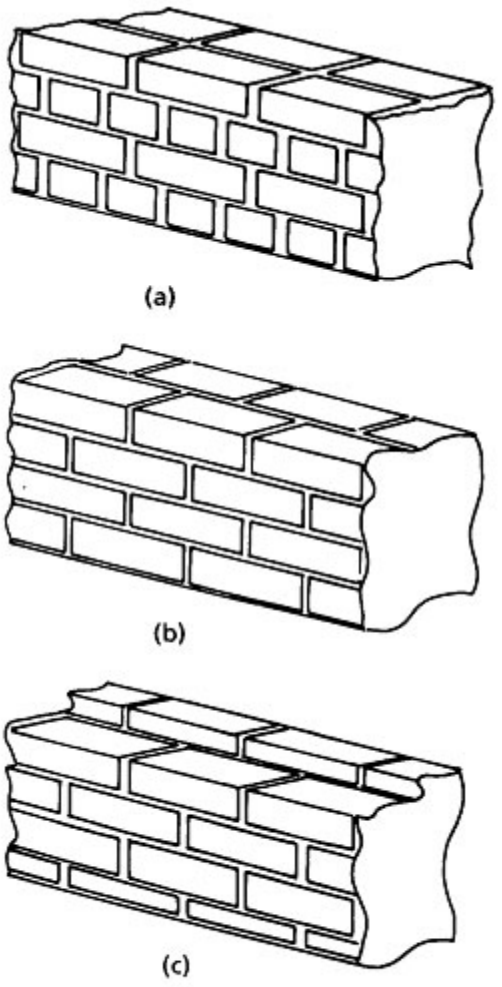

FIGURE 1 - Bonding arrangements: (a) English bond; (b) collar-jointed wall; (c) water bond

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