STANDARDISATION OR NON-STANDARDISATION? THE CASE OF BRICKWORK IN SRI LANKA

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'Standardisation' seeks 'single best' solutions to chaotic problems. However, these solutions are essentially 'static'. Moreover, unimplementable and inappropriate standards undermine their general usefulness and raise doubts as to their efficacy especially in an emerging future. Sri Lankan brickwork is characterised by irregular sizes of bricks, brickwork joints and wall widths. These walls which are plastered on both sides are mainly used as infills and partitions except for walls in single and two storey buildings carrying light loads. Internationally, standard wall widths are associated with standard brick sizes with a unique joint size of 10 mm. However, this study shows that 'standard width' walls may be built not necessarily of standard size bricks with a standard joint size of 10 mm, but with an endless variety of brick and joint sizes. This is made possible by varying the size of the wall joint and by a Sri Lankan practice known as 'chapparu' whereby the spaces created by the shortfall of the length or the breadth of a brick is filled by mortar to make the wall surfaces 'flat as a plate'. As such, this study advocates a paradigm shift from the conventional focus of the *'brick and the joint'* to the *'wall and its width'*. It proposes a methodology for the 'standardisation' of the wall width and decision rules for the 'non-standardisation' of the bed joint, concluding that both approaches are useful. Accordingly, this study calls for a seed change in the mind set of construction managers who specify and manage brickwork operations.

Keywords: Brick, brickwork, chaos, chapparu, complexity, consensus, standardisation.

INTRODUCTION

Standardisation is widely believed to be a preferential approach to rationalised building. It offers many advantages. For example, '... there is now a much wider recognition of standards [the product of standardisation] as a ***means of communicating ideas and technical data, in creating order out of disorder*** and offering ***simplification in place of complexity'*** (Sanders, 1972). Despite these apparent advantages, there is also much criticism of these standards (Kaplinsky, Schilderman; 1992). Furthermore, the fact that brickwork is an age old activity reinforced by custom and practice rather than by a process of scientific explanation (Abeysekera, 1997) one is inclined to raise questions on the adequacy of various Standards related brickwork and to cast doubts on their validity in an emerging future.

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STANDARDS AND STANDARDISATION

Principles of Standardisation

A 'principle' is a basic general truth that underlies a subject (Oxford Advanced Learner's Dictionary, 1989). In social sciences a 'principle' ('law' being synonymous with it) is defined as an universal generalisation of a classes of facts and are important statements about what is so; they are spoken of as being discovered and not created; they do not explain anything, instead they just summarise the way things are (Babbie, 1989). Some of the important principles of standardisation as quoted by Sanders (1972) are indeed useful to understand the underlying truths about it:

- Standardisation is an act of simplification.
- It is a social as well as an economic activity. It should be based on a general consensus.
- Standardisation should result in implementable standards.
- It should be reviewed at regular intervals.

OBJECTIVES OF STANDARDISATION

According to Sanders (1972) the principal objectives of standardisation (as defined by the ISO committee for the Study of the Principles of Standardisation) are the promotion of:

i.. overall economy in terms of human effort, materials, power etc.;

ii. the protection of consumer interest through adequate & consistent quality;

iii. safety, health and protection of life; and

iv. the promotion of expression and of communication amongst interested parties.

Thiard and Plau (1991) adds that objectives of standardisation should also include the promotion of trade, domestic and international, by eliminating technical obstacles by creating a 'common language'. Whilst these objectives appear to persist, they claim that the latter two objectives have assumed considerable importance in recent years, especially in Europe, due to the target of single market, but also throughout the world, due to international trade.

However, a cursory examination shows that these principles and objectives may take different levels of importance depending on the main ***purpose of standardisation***. For example, where safety and health issues are at stake, it is seldom possible to adopt the most economical solution. Furthermore, the greatest economy in labour may preclude the greatest economy in materials, and vice-versa. Still further, the greatest economy in design and manufacture may give rise to a product which is not the most economical in terms of life cycle costs. Thus, it may be necessary to either prioritise the objectives and/or have a compromise solution with all other objectives attaining an optimum (especially when there is interdependency).

REACHING CONSENSUS

One of the main characteristics which needs to be elaborated relates to the methodology adopted for reaching ***consensus*** when developing standards. This consensus is usually obtained within working committees assembling the representatives of all the interested parties. Thereafter the contents of the standards so developed are subjected to the broadest possible public enquiry before it is published.

Reaching a consensus is by no means an easy task. In fact, many of the allegations made on the inappropriateness of standards stem from a lack of attention to this very important characteristic. For example, standards are claimed to be set by middle-or high income policy makers often recognising the well-to-do only, and as such is socially divisive. Standards are also considered to be unaffordable to the masses often failing to reflect people's priorities. Furthermore, standards which are 'imported' are considered not only to destroy local traditions but replace them with inappropriate methods and materials, categorising local practices as sub-standard and illegal. (Schilderman, 1992). Clearly, the development of suitable methodologies for reaching consensus is an area which needs to be investigated in depth. As such, this aspect is reviewed further in section 4.2.

STANDARDISATION AND BRICKWORK

BS 3921 of 1995 and Sri Lanka Standard (SLS) 39 of 1981 (i.e. standards for brunt clay bricks) specify a non-modular single size of 215 x 102.5 x 65 mm and 220 x 105 x 65 mm respectively, with a joint size of 10 mm. Thus, standardisation relates not only to the **size of the brick but also to the size of the joints**. Accordingly, a single brick thick wall would have widths of 215 mm and 220 mm, respectively. Examination of international, regional and national standards for burnt clay bricks show that there is a wide disparity in their contents (Abeysekera, 1997). As such reaching an universal agreement on detail specifications is far from reality. Differences can be seen with respect to many areas including those related to, standard sizes, number of preferred sizes (single or multiple), classification of types adopted, and many more. However, a striking feature in almost all these standards is the **prescription of a 'standard joint size' of 10 mm.** Arguably, there is no reason why all the joints should be of the same size, especially in plastered brickwork where uniformity and consistency are of minor importance (Abeysekera, 1997).

'Conventional' brickwork has two main types of joints, viz. the bed-joint and the perpend-joints. The latter may be classified further depending on whether they are cross- joints or wall-joints. In single brick thick walls in English bond, the header course has only cross-joints whilst the stretcher course has both types of joints, i.e. cross-joints (perpendicular to the wall) and wall-joints (along the wall).

Currently, all these joints are standardised to 10 mm as mentioned before. The size of the joint is useful for identifying the manufacturing size of the masonry unit (i.e. the brick) when buildings are designed using a dimensional framework made up by adding together multiples of a basic 'module'. This form of co-ordination is known as 'dimensional co-ordination'. For example, if the size of this module is taken as 75 mm, the height of the brick would be 75-10 mm (i.e. 65 mm), the length could be 75 mm x 3 modules - 10 mm (i.e. 215 mm) and the width (215 mm - 10 mm)/2 (i.e. 102.5 mm). In fact, the current rule of 'four courses to 300 mm' arise from such a co-ordinated approach to design. This approach is of considerable importance where uniformity and consistency in appearance is paramount - as in exposed brickwork.

However, buildings could also be designed without reference to such a dimensional framework (DoE, 1978). For example, available bricks could be joined together to fit an overall size of a building (or a wall) with comparative ease due to the 'dimensional flexibility' of the brick (Brunton, 1972). There is no need to standardise joints so that bricks fit into a dimensionally co-ordinated framework. For example, any differences in line and level of brick courses for satisfying requirements connected with door and window openings could simply be adjusted by changing the sizes of joints. '... It is worthwhile to bear in mind that dimensional co-ordination is not an end in itself, but a means to [a] better and more efficient building. The possible costs of imposing dimensional restraints should be offset against the likely benefits, and the disciplines only imposed where there are clear overall benefits in doing so.' (Forbes, 1971). Thus for brickwork which is plastered on both sides, carrying light loads, where appearance and consistency is of minor importance, the requirements imposed by dimensional co-ordination could be traded-off with other time/cost advantages. (See section 4.3.)

THE CASE OF SRI LANKAN BRICKWORK

Building with burnt clay bricks is part of Sri Lanka's engineering culture. To date, bricks produced by the island's cottage industry have remained the principal building element in the construction of walls. These walls, plastered on both sides, are used mainly as infills or partitions in reinforced concrete buildings except for walls in single storey and two storey buildings carrying light loads.

Neither bricks nor walls in Sri Lanka confirm with standard sizes and vary widely. Brickwork joints too vary, with significant departures from the norms of other organised construction industries. These variations result in many problems in what can be described as a disordered or chaotic environment. Despite these shortcomings there is a ready demand for hand made burnt clay bricks which are one third to one fourth the price of machine made bricks.

Currently, many different sizes of bricks are being produced in Sri Lanka with much irregularity and diversity. Despite on-going efforts (notwithstanding the efforts made in the past), the status-quo prevails. The SL Standard first published in 1965 and modelled on lines similar to the BS has ceased to be of any regulatory value in this environment. Like the BS, the SLS specifies only one 'standard' size and has unsuccessfully attempted to 'over simplify' this diversity by limiting to one standard size. Oversimplification leads to inefficiency! In contrast, this approach of 'simplification' has been successful in the UK - largely due to the mechanised process of manufacture, the recognition of non-standard sizes (as given in BS 4729), and the use of bricks in exposed brickwork. This is in sharp contrast to the situation in Sri Lanka where bricks are produced mainly by a cottage industry using timber moulds which can literally be changed 'overnight', the non-recognition of non-standard sizes, and the use of bricks in plastered brickwork. Clearly, there is a need to take account of local practices and procedures when localising international standards.

The failure of the standardisation approach in Sri Lanka is not necessarily due to the adoption of an 'unimplementable' standard, but also due to many other reasons; production problems of brick producers, lack of knowledge on basic facts on bricks, vested interests of transporters, inadequate response of related institutions, and poor attitudes of industry professionals are amongst the factors that has contributed to this chaos (Abeysekera, 1997).

Yet, many would perceive that the only solution to this problem is 'standardisation'. No doubt, as explained in section 2.0 it has its advantages in bringing 'order' to this 'disorderly' state and reduce the 'complexity' of dealing with many variations in brick and joint sizes. Not surprisingly, these variations manifest in many management related problems, from design to construction, to the extent that industry appears to be lost in finding directions through this chaos; use of inappropriate norms for estimating, inadequate control of brick and joint sizes, lack of compliance with technical specifications, drawings, Bill of Quantities and the like are symptoms of this problem.

However, despite the apparent advantages, the ***'standardisation' approach of focusing on the 'brick and the joint' has failed*** to take root in Sri Lanka - an approach which rests largely on reaching consensus on many issues (related to bricks) with interested parties diverse in nature. This is not an easy task as mentioned before; it needs the involvement of producers, transporters, architects, engineers, contractors, related institutions, grass root organisations and many more. Could they come together in resolving this chaos and reach consensus? Are there other ways in which to cope with this chaos?

SHIFTING FOCUS

Widths of single brick thick walls in Sri Lanka vary widely (Abeysekera, 1997). Analysis of data from 59 building construction sites revealed a positively skewed distribution (with mean 203.5 mm; std. dev. 15.3 mm; mode interval 190-200 mm; and range 179.4 - 235 mm). A field survey on practices adopted by bricklayers for establishing these wall widths revealed 14 different practices. Conventionally, there is only one way to fix the wall width. For example, in the case of a single brick thick wall, the wall width is fixed by the length of the brick. But, this is not the case in Sri Lanka!

The reason for this is largely due to an ingenious indigenous practice of resorting to what is commonly known in Sri Lanka as ***'chapparu' - a strategy for coping with the irregularity of non-standard bricks***. There are three of types of 'chapparu' in all as shown in Fig. 1. The walls so built appear 'flat as a plate' on both sides. The procedure adopted for building a 'chapparu wall' is to first fix the wall width (as required) by adjusting the bricks in the stretcher course (s/c). Thereafter, the bricks on the header course (h/c) are laid (with or without plumbing and stringing as appropriate) and then filling the gap created by the shortfall in the length of brick (as compared with the wall width) with mortar. (See h/c in Fig. 1.) This is usually attended to after laying the next s/c, similar to the manner in which wall plaster is applied. Thus, it is possible to construct walls of varying widths by adjusting the size of the chapparu (with a corresponding adjustment of the size of the wall joint in the s/c). Similarly, a wall of a given width may be constructed not necessarily out of few discrete sizes of bricks and a standard joint size, but with a variety of bricks and joint sizes. In other words, ***'chapparu' is an effective strategy for coping with irregular brick sizes.***

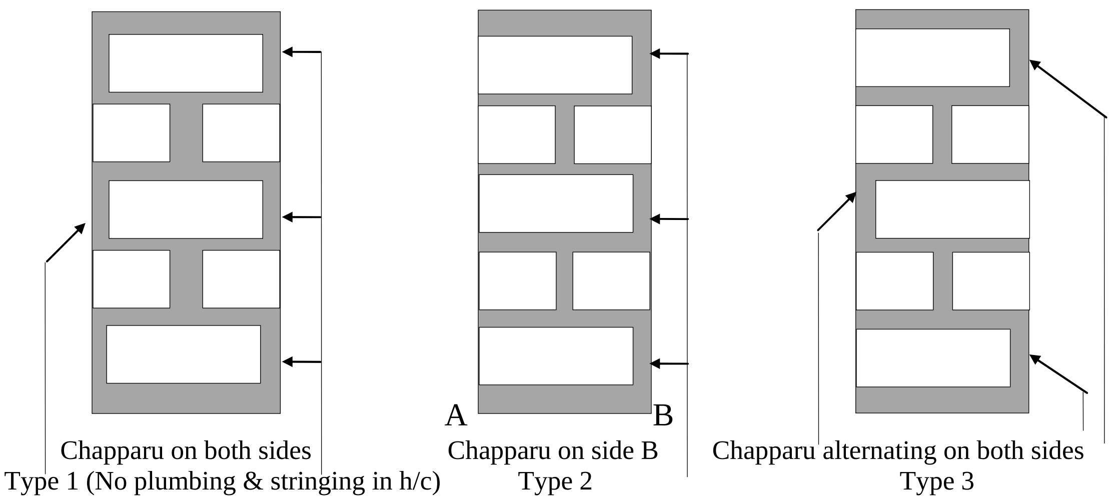

Fig. 1: Elevation of a single brick thick wall in English bond with 'Chapparu'

The 'wall width' is an important parameter from many angles and under no circumstances should it be allowed to vary arbitrarily (as seen often in Sri Lanka). This situation has risen as a result of the focus being on the 'brick' often, the irregularity of the brick size being blamed for the wide variation in wall widths. Moreover, this variation has also resulted in a wide variation in the sizes of accompanying columns and beams which are adjusted/ matched to suit the wall width. <u>This should not be the case, and is unnecessary, as a given wall width can be built with many different sizes of bricks (utilising chapparu).</u> In fact, investigations have shown that the 'chapparu' can be as large as 37.5 mm. This suggests that the width of a single brick thick wall can vary from 2B to 2B+375. mm (where B is the breadth of the brick). Hence, it is absolutely essential to ***shift the focus*** to the ***'wall and the wall width'*** rather than to the ***'brick and the joint*** as the 'wall' is the end product the industry is interested in.

This is a pragmatic shift considering the fact this approach focuses on a process which is carried out at the site (i.e. building a wall) rather than on a process which goes on at a distant locality (i.e. brick manufacturing). But, how could a degree of 'order' be brought about to the wide variation in the wall width? How could consensus be reached given the fact that walls with many different widths could be constructed with a given brick size?

A METHODOLOGY FOR STANDARDISING WALL WIDTH

International Standards on bricks reveal that there is a wide range of standard wall widths (see Table 1). It can be shown that amongst the factors that affect this choice, only strength and dimensional co-ordination are of any importance to a tropical country like Sri Lanka. However, for the types of walls used (as for example, walls which carry light loads and which are plastered on both sides) neither strength nor dimensional co-ordination is of much importance as discussed in sections 3.0 and 4.0.

In Sri Lanka, blockwork is the closest competitor to brickwork. As such , it is useful to examine the preferred wall widths of brick/block walls as prescribed in various standards:

Table 1:

A comparison of standard wall widths of brickwork and blockwork

Width	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Blocks*	75	100	115	125	140	150	175	190	200	215	220	225	250	-
Bricks	Half brick thick walls						Single brick thick walls							
	90	102.5	110	-	140	-	180	190	-	215	220	230	240	290

* Based on SLS 855: Part 1

Clearly, industries the world over have demanded various widths - a demand for greater variability in wall widths. Should widths of brick walls and block walls be different? Of the 14 sizes listed above in Table 1, only four match; There is no logic in such differentiation and arguably, these widths must be matched. Such a process may then be referred to as ‘cross-standardisation’. It assists in rationalising industry processes and importantly promotes competition between two principal types of walling in Sri Lanka (i.e. brickwork and cement blockwork):

What should be done therefore is to narrow down the matching sizes to a ‘demanded range’ (as given in section 4.1). This yields a set of values of 190, 200, 215 and 220 mm, to be used as preferred widths of single brick thick walls. Of the 14 practices quoted by bricklayers, four related to setting of wall widths to 7 1/2”, 8”. 8 1/2” and 9”. Converting these to SI units give values of 190.5 mm, 203.2 mm; 215.9 mm, and 228.6 mm. These values match closely with the values in the selected set except for the disparity in the 220 and 228.6 mm values, which aspect is resolved as discussed next.

A somewhat baffling local practice relates to the adoption of a wall width of 225 (or 9”). In a survey of 44 consulting engineers (comprising 32 chartered engineers) only one specified correctly the standard width of a single brick thick wall (i.e. 220 mm with SLS bricks). Of the balance 43, nine quoted 225 mm whilst 32 quoted 9" when it should have been 215 mm (with BS bricks) or 220 mm (with SLS bricks). These results confirm a strong entrenchment of a *misconceived* practice. Why is it misconceived? The reason for this can be traced back to the ‘nine inch’ brick used during the colonial period of British rule. It was customary then to identify a single brick thick wall as a ‘nine inch wall’ to suit a 9 inch long brick. In the modern context, this is really a ‘misnomer’ as the standard length of a brick size is less than this. This practice has continued to date with reinforced concrete columns and beams designed with dimensions to match 225 mm. However, to give heed to this ‘local practice’ it is not necessary for the brick to be 225 mm long as a brick which is 215 mm can be used with a chapparu of 10 mm to obtain a 225 mm wall width. Thus, this size (i.e. 225 mm) could be incorporated into the set of values of already selected by giving heed to a strong local design practice, giving a set of values with 190, 200, 215 and 225 mm.

The foregoing discussion provides a methodology for arriving at a choice of a set of wall widths which has the potential for meeting industry consensus with the five features of ‘rationalisation’, ‘competitiveness’, ‘demanded range compliance’, ‘bricklayers’ familiarity’ and ‘local design practice’. In effect the ‘continuous’ distribution of the wall width could now be reduced to a ‘discrete’ distribution in order to bring a degree of ‘order’ or ‘simplification’ to the wall width (see principles 1 and 2 in section 2.0). However, is there a need to adopt such an approach with respect to the bed joint as well?

THE RATIONALE FOR THE NON-STANDARDISATION OF BED JOINT

Of all the joints in brickwork, the mortar in the bed joint accounts for the largest portion of mortar; the proportion of bed mortar in a 215 mm wall with BS bricks and a 10 mm bed joint accounts for about 2/3rds of the total volume of mortar. Thus, the bed joint is an important joint from the point of view of mortar consumption. As brickwork is made up of bricks and mortar, manipulation of the bed joint could provide an effective strategy for cost effectiveness.

Similar to the wall width, the bed joint too varies widely. Analysis of data from 59 construction sites revealed a variation of 6.02 - 25.49 mm with a mode interval of 14-20 mm. The mean was 17.11 mm with a std. dev. of 3.67 mm. Examining reasons for this variation it was found that 'ease of construction' provides a good explanation for it. (This lays the foundation for a 'theory on brickwork'). Four categories of bricklayers were identified; all bricklayers did not share a common view on the size of bed joint which was most convenient. Instead they differed with a central tendency similar in shape with a normal distribution. Category 1 preferred small joints, whilst category 2 preferred large joints. Though category 3 preferred a joint size which was neither too small nor too large, category 4 failed to differentiate. The implication to practice is that, if it is necessary to adopt either a small or a large joint, then it would be necessary to exercise control. Interviews with bricklayers also revealed that reference to 'small' and 'large' joints referred to sizes of 12.7 mm (i.e. 1/2") and 25.4 mm (1") respectively.

Studies have shown that when the bed joint size increases the hourly output increases as well (Abeysekera and Thorpe, 1997a). It should be noted that this conclusion has been made with respect to the Sri Lankan method bricklaying. However, if brickwork is sub-contracted to labour only trade contractors who do not differentiate rates based on joint size (Munasinghe, 1996), no direct cost advantages could be expected. A change in the bed joint size affects the bricks to mortar ratio and as such has an impact on costs. Arguably, if the cost density (i.e. cost per unit volume) of brick is greater than the cost density of mortar, the cost of construction can be reduced by using a greater proportion of mortar. One method of achieving this is to increase the size of the bed joint. The reverse is true if the cost density of brick is cheaper than that of mortar. It could be shown that if cost polarity (i.e. cost density of bricks to mortar) is outside the range 0.85 - 1.2 savings not less than 5% can be achieved by changing the bricks to mortar ratio from 5 to 1. For example, with a cost polarity of 2, a saving as much as 18.2% can be achieved (Abeysekera and Thorpe, 1997b). This cost feature of brickwork has been referred to as its 'universality' by Abeysekera (1997) which holds true in any part of the world, either currently or in the future.

Interestingly, it can also be shown that if the cost polarity lies within the range 0.85 - 1.2, no significant cost advantage could be had by controlling the bed joint size though hourly output of brickwork could be increased by increasing the bed joint. Therefore, it can be concluded that by fixing the bed joint size, opportunities for cost/time optimisation may be lost due to variations in cost polarity. What is advocated then is to take a 'dynamic' approach to the bed joint size by taking into account of contextual conditions and the emerging nature of the future environment within which decisions have to be made. Paradoxically, this non-standardisation approach, complies with some of the more important principles and objectives of standardisation outlined in section 2.0 (i.e. economy in costs and human effort).

CONCLUSIONS

This study raised the question whether the ‘standardisation’ or the ‘non-standardisation’ approach is useful for chaotic problems in industry. Paradoxically, both approaches are useful. Accordingly, this study calls for a seed change in the mind set of construction managers who specify and manage brickwork operations.

Brickwork in Sri Lanka is plastered on both sides. They carry light loads and are often non-load bearing. Irregular sizes of bricks and brickwork joints are used with widely varying wall widths. The walls so built appear ‘flat as a plate’ on both sides mainly due to an ingenious indigenous practice of using ‘chapparu’.

The standardisation approach is similar to the ‘single best’ solution to problems - an approach essentially static. Accordingly, this study finds favour in it for rationalising wall widths. Nevertheless, it condemns it for standardising the size of the bed joint in favour of a dynamic approach to bed joint size for especially in an emerging future.

The standardisation approach is embodied with principles such as consensus, simplification, economy, implementability, and the like as explained. However, there is a need to develop suitable methodologies for reaching consensus. Accordingly, the wall widths were standardised by a specific methodology with the potential of reaching industry consensus. It ‘simplified’ the diversity in wall widths. Arguably, this process leads to a scheme which is ‘implementable’.

Strangely, the non-standardisation approach is not necessarily devoid of the afore-mentioned principles. For example, the approach recommended for dealing with the bed joint embodies the principle of ‘economy’ in costs and human effort. However, one may argue that many different bed joint sizes lead to ‘complexity’. This is not true. The discovery of ‘universality’ in brickwork costs makes this ‘apparent’ complexity rather simplistic.

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