Pak. j. sci. ind. res., vol. 32,no. 8, August 1989

INVESTIGATIONS ON BUILDING MATERIALS
Part II. Evaluation of Quality of Red Bricks Available in Lahore Region

MIRZA ARSHAD ALI BEG, M. HANIF QURESHI, M. YUSAF, M. AYUB, M. ANWAR KHAN AND NAWAB BEG
PCSIR Laboratories Complex, Lahore-54600

(Received December 31, ; revised July 1, 1989)

Red bricks available in the Lahore region were evaluated for their suitability in construction through determination of properties such as dimentions, crushing strength, porosity, bulk density, water absorption and soluble salts. Most of the bricks available are sub-standard in dimentsions by 24%. 80-90% of them are below the minimum limit of compressive strength and hence load-bearing capacity 65% of them have been found to contain soluble salts in excess of the tolerable limits. The porosity, bulk density and water absorption data also suggest that only 10-15% samples conform to specifications. The substandard quality is attributed to lack of control on raw material, labour and preparation procedures.

Key words: Building materials, Bricks, Clay loam, Soil.

Introduction

Red bricks constitute an important building material in Pakistan. Their use dates back to ancient times of Moenjo-daro days. Abundant evidences for the excellent durability of brick-work are available from many parts of the world, for example 4000 years old brick-work are still intact at quite a few sites in the Middle East and other parts of Asia. Properly made bricks are indeed among the most durable building materials and have properties typical of the ceramics, such as good strength and resistance to rain, sunshine, heat and other vagaries of weather besides excellent resistance to chemicals and to attack by the bacteria and fungi [1].

At least 70 % of the houses in the urban and 25 % in the rural areas utilize these bricks for the construction of internal and external walls [2] and hence it is important that the users are assured of the quality as laid down in Pakistan Standard Specification [3]. A general observation that the bricks available in the market do not conform to standards has prompted the authors to undertake the present survey. This is part of the programme to evaluate the quality of building material in the construction industry. The main objective of survey is to quantify the defects in the quality of the red bricks available in the Lahore and other regions of Punjab where they are being extensively used for construction.

The physico-chemical properties of the surface soils in the vicinity of a few areas of the Indus basin were described in an earlier paper [4]. It was observed that the soil is mostly silty clay loam. It is generally true that the soil which has formed out of sediment, transported by the rivers of Himalayan origin, flowing through Pakistan, India and Bangladesh, are suitable for brick making. This observation is the basis for the establishment of a number of brick making units in the sub-urban areas of these countries [5]. The raw materials for this traditional building component are easily available. This has (1) allowed their manufacture close to the areas where construction activity is going on and (2) helped the growth of the construction activity. Innovation has not been introduced in this industry. The result is that brick makers have continued to use the same soil which they were using in the past. They have not taken much regard of the salinizing of soil in the meantime, as a result of the faulty irrigation practice [4].

It was observed while collecting the samples of bricks from the site of manufacturing that the method of production was mostly based on traditional digging by hand, moulding, drying and firing. Because of a lack of quality control during all these operations, a large number of bricks produced were either substandard or were wasted. In spite of the committment of errors on a massive scale the brick makers pay no attention to rectify the situation by making amendments to the raw material or the process.

Housing construction with red bricks demands that the brick dimension, shape and finish should be adequately guaranteed [6]. It is reasonable to expect consistent properties of bricks to allow the construction of accurate building components for example walls etc. This would minimize the use of mortar between bricks. Furthermore the rendering would require lower mix for a given wall area if the brick facing is accurate and would thus save considerably on the cost of raw material. Unfortunately the brick moulding process in Pakistan is a cottage industry,

mostly hand operated. There is, like all other developing countries, very little information available on the quality control or processing the raw-material for the bricks and operation of the kiln itself, with the result that the bricks have inconsistent properties [7,8]. The data compiled during the present investigation would, besides providing information on the quality of bricks enable the housing sector, in general and the consumer in particular, to arrive at decisions on the appropriate material to be used.

Materials and Methods

Red brick samples from 40 kilns around Lahore (Table 1) were collected and subjected to different investigations. The dimensions of the samples were measured and the bricks were inspected individually for cracks and other defects, if any. For compressive strength determination the compression machine, Consule type, Wydsham Farrance Engineering, U.K. was employed. Crushing strength of the full size bricks was determined using the ASTM method [9]. Total soluble salts in the samples and their water absorption capacity were also determined by using standard methods [10].

Results and Discussion

The properties deterministic of the quality of bricks viz. dimension, compressive strength total soluble salts, porosity, bulk density and water absorption capacity, are listed in Table 1 . For comparison, the standard values have also been noted.

Dimension. It is apparent from Table 1 that most of the bricks available in the market do not possess standard dimensions of 9" x 4.5" x 3 (22.5 cm x 11.2 cm x 7.5 cm) [3,5]. The British standard specification [10] allows only 0.5cm variation in the size of the bricks. Out of the forty bricks samples collected from the region only two were found to have standard dimensions. Quite a few were upto 24 % shorter than required and on the average most of the bricks were 15 % short of the standard volume. Such bricks also had irregular surface and deformed shape. They, therefore, present problems in handling, transport, stacking and rendering and also in consuming larger than required quantities of mortar [5]. It is possible to say from visual observations that the bricks were not well-fired because, as stated earlier the kilns were ill-managed with no control on temperature and the duration of firing.

Compressive strength. The normal range of compressive strength of red bricks for civil engineering construction is 15-60 MN/m^2 [6,11]. Nine out of the forty samples had compressive strength lower than 10 MN/m^2, while the remaining had a compressive strength ranging between 10 and 18 MN/m^2 Table 1, thus, suggests that bricks samples No. 2, 7, 8, 10, 13, 14, 15, 24, 25 and 40 are underfired and should be rated as such. Only samples No. 1, 3, 6, 13, 17, 18, 27, 28, 34 and 35 possess compressive strength higher than 15 MN/m^2 which constitute 25 % of the total that can be accepted. The results clearly show that the higher compressive strength is because of better firing in the kiln while the under-fired bricks have lower compressive strength. It may be noted that there is a great variation in the compressive strength of the red bricks; the variation of quality compares with that observed in East Africa [11].

Water soluble salts. For good quality bricks, soluble salts should not exceed 0.6 % [10]. However, Table 1 shows that out of the investigated samples No. 1, 2, 3, 6, 7, 8, 13, 18, 20, 22, 31, 34, 37, 40, have soluble salts within tolerable limits and the rest of them have higher salt content. If present in the fired bricks, they lead to efflorescence and can spoil brick faces and lead to attack and expansion of cement based mortars. This is a common observation on the construction sites in Lahore and other salinized areas in Pakistan as well as northern India and Iraq. Deleterious effects of these salts may be avoided by either choosing another clay deposit or allowing rain to wash salts out of the clay after it has been dug and piled up or by firing the bricks to a higher temperature.

Water absorption. Hard-fired bricks absorb less water than the under-fired ones. Water absorption at less than 15 % by weight of brick is in general indicative of satisfactory brick strength and durability. Table 1 shows that most of the bricks samples tested have water absorption higher than 15 percent. Only five bricks No. 1, 3, 6, 18, 27 have water absorption less than 15 percent which suggests that only 12 % of the bricks available in the market conform to standards.

Bulk density. Bulk density values of better fired bricks listed in Table 1 also bear out the conclusions based on water absorption. Thus samples No. 1, 3, 6, 18 and 27 have bulk density values around 2.0. Underfired bricks have higher porosity and lower bulk density. Porosity and water absorption values indicate that in well fired bricks the extent of closed-porosity is high. Lower closed-porosity is indicative of underfiring and hence low resistance to erosion by rain, flowing water etc. It is therefore quite apparent that most of the bricks are vulnerable to erosion if not appropriately protected.

Conclusion

The results of survey indicate that excepting two, none of the samples is cast exactly on standard dimensions; they are on an average 15 to 24 % short of the required

TABLE 1. BRICK PROPERTIES.

Sr. No.	Trade Mark	Name of the Proprietor. Co.& Situation	Dimension (cm)	Compressive strength MN/m^2	Total solubles ppm	Porosity %	Bulk density gm/ml	Water absorption %
1.	92	Nazar Abbas, Iqbal Bricks, Chamroopir, Raiwind Road.	22x10.5x7.4	16.41	450	28.2	1.90	14.73
2.	AC	A. Afzal Chatha, High Standard Bricks, Lahore, Janjate, Raiwind Road, Distt. Lahore.	22.5x11x7. 3	10.32	5500	30.05	1.80	17.10
3.	99	Malik Hanif, Arian More, Raiwind Road.	21.7x10.5x6.7	15.73	2420	17.58	2.006	8.76
4.	MN	Mansha & Haji Barkat, Khana Nepal, Raiwind Road, Lahore	22.7x11x7.2	11.79	9750	35.04	1.67	20.92
5.	86	Jia Bagga Railway Crossing, Upside Jia Bagga Railway Station	22.5x10.7x6.9	12.79	–	33.50	1.73	19.30
6.	P	Ch. Said & Muhammad Hussain, Shakan Bricks, Village Atari, Ferozepur Road, Lahore.	22.5x10.5x6.8	16.62	2205	26.10	1.926	13.56
7.	1A1 R	Rabu Sharif, Atari Suroba, near Ferozepur Road, Lahore	22.5x11x7	9.06	2850	33.08	1.75	18.89
8.	1M1 R	Chaudhry Riaz, Riaz Bricks, Atari Saroba, Atari Road.	22.7x10.5x7	8.06	10850	30.68	1.82	16.83
9.	NC1 NSpecial	Haji Muzaffar Khan Niazi, Kumayen near Ferozepur Road, Lahore	22.6x10.5x7	11.03	–	29.01 30.45	1.84 1.71	15.76 20.74
10.	101	Malik Talib, Kumayan, near Ferozepur Road, Lahore.	22.4x10.9 x7		2750	30.38	1.82	16.7
11.	707	Malik Bashir, Keeryanwala	23x10.7x7.6		7200	34.59	1.72	20.05
12.	66	Chaudhry Hafeez, Natha Singh Village	22.1x10.4x7	13.40	–	35.52	1.80	18.08
13.	67	Chaudhry Nazir, Natha Singh Village	22x10.7x7.6	19.38	6650	28.22	1.88	15.20
14.	N60	Tauheed Bricks, Haji Nawab Din, Kumayan Village, Office near Canak Rest House Octori Post Amar Suddu	22.7x10.7x7.2	8.90	3100	33.18	1.79	18.64
15.	H70	Babu Hameed, Kumayan	23x11.3x7.4	6.82	12950	37.60	1.65	17.32
16.	A 1H1	Haji Ashraf, Dev. Kalan	22.5x10.4x6.7	11.66	6800	31.40	1.77	17.60
17.	J	Khawaja Jahangir, Back Glaxo Factory, Ferozepur Road, Lahore	22.5x10.5x7.2	15.42	11500	29.92	1.83	16.35
18.	S.Q	Chaudry Siddique Chandra, Glaxo Factory, Ferozepur Road, Lahore	22.2x10.5x7.2	17.13	4650	18.89	2.08	9.05
19.	R.S	Mian Sardar, Backside Glaxo Factory, Ferozepur Road, Lahore.	22.5x10.8x7.2	12.30	10550	31.24	1.8	17.32
20.	NB Special	Babu Bashir Zafar, Jaggu Matta	22.3x10.7x7.2	11.40	3700	27.47	1.87	14.68

(Continued .....)

(Table 1, continued)

21.	National	Bashir Zafar, National Bricks, Gajju Matta	22.0x10.5x7.2	11.21	–	35.09	1.70	20.58
22.	Z.D.	Ziaud Din, Mian Sardar, Kahna Nau, near Packages	22.0x10.4x7.1	–	5500	29.99	1.80	16.65
23.	M.	Chaudhry Sadiq, Muhammad Amin, Panja near Kahna Nau	–	13.75	8950	28.17	1.87	15.00
24.	M.S.	Chaudhry Barkat, Afzal Bricks Co., Panja, near Kahna (Ground Tiles and Derli small sized bricks also prepaired	22.5x11x7.2	8.33	10850	29.68	1.91	16.19
25.	A.I.	Chaudhry Mohammad Afzal, Panja, near Kahna	22.7x11x6.9	7.04	18350	–	-	–
26.	Extruded without mark.	Sanai Sahib, China Bricks, Chung, Multan Road,	23.4x11.3x7.5	11.77	23000	40.71	1.56	26.08
27.	23 S	Abdul Hamid, Pak Bricks, Chung, Multan Road,	22.0x10.7x7.0 22.5 x 11x7.4	15.08 18.59	6600	24.65 30.70	1.93 1.80	12.72 16.98
28.	N	A. Ullah Khan Niazi, Chung Multan Road	22.7 x 11x7.5	19.36	2750	36.46	1.71	20.74
29.	F.B.	Mian Farooq & Co. Mohlan Wal	–	–	–	43.60	1.68	26.03
30.		Abdul Ghaffar, Saaf Bricks, Mohlan Wal	23x11.3x7.6 22.7x11x7.3	13.42 13.70	9300	35.68 30.67	1.72 1.84	20.76 16.66
31.	Bari	Bari Bricks, Mohlan Wal	22x11x7	10.80	5950	32.2	1.74	19.0
32.	111	Mian Naeem-ur-Rehman, Hasan Bricks, near Sundar.	22.3x10.8x7.1	12.95	7950	33.9	1.74	19.4
33.	599	Mohammad Malik, Imran Bricks, Sundar, Multan Road	22.3x10.7x7.2	12.38	20000	33.78	1.71	19.73
34.	1000	Khaliq Mahmood, United Bricks	22.0x10.6x6.4	16.34	200	32.62	1.76	18.46
35.	B.B.C.	Zafar Bhatti, Bhatti Bricks Co., Sundar, Multan Road.	21x11x7	17.10	8200	30.10	1.81	16.6
36.	005	Ibrahim & Co., Sultanke Road, Sundar	22x11x6.2	12.36	6200	–	–	–
37.	5000	Mr. Sarwar, Sarwar & Co., Sultanke Road, Sundar near Coca Cola Factory, Lahore	22x11x7	10.61	5200	35.55	1.71	20.77
38.	K.B	Yousaf Bricks Corporation, Thokay Wali, Sundar	22x11x6.7	12.40	8650	36.02	1.68	21.37
39.	T.M.	Tariq Mahmood, Tariq Bricks Co., Sultanke	–	–	8800	33.51	1.74	19.22
40.	TOP	Rana Siddique, Rana Bricks Co., Mal Distt. Lahore.	22.6x11.2x7.1	8.90	4650	34.30	1.73	19.70

compressive strength; 35 % have water soluble salts within acceptable limits and only 12 % have the specified water absorption and bulk density values suggesting that 80 % of them are under fired.

They should therefore be appropriately sorted out, if not rejected. However, these are the only ones available in what is called a sellers market and therefore, there is not much that can be done to improve the quality of construction, excepting removal of soluble salts by leaching and liming.

References

1. W. Bender, *The Planning of Brickworks* (Plymouth Macdonald and Evans, 1978), pp. 120.
2. *Environment Statistics of Pakistan* (Federal Burea of Statistics Division, Government of Pakistan, 1986), pp. 208.
3. *Pakistan Standard Specification*, P.S. 208 (1962).
4. M.A.A. Beg, M.H. Qureshi, M. Yusaf, M. Ayub, M.A. Khan and N. Beg, Pak. j. sci. ind. res., **32**, 458 (1989).
5. R.J.S. Spence, An Investigation of the Properties of Rural and Urban Bricks, Paper No. TR9, National Council for Scientific Research, Lusaka (1971).
6. *Handbook for Building Houses of Earth* (Department of Housing and Urban Development, Office of International Affairs, Washington D.C. (undated), pp. 143.
7. United Nations Commission on Human Settlements, Report on Fifth Session, Habitat News, Nairobi, **4**, 10 (1982).
8. J.P.M. Parry, *Brick-making in Developing Countries* (Br. Res. Inst., Garston, Watford, 1979).
9. ASTM Standards, Part-IV (1960).
10. British Standards Institutions, Specifications for Clay Bricks and Blocks, Doc. No. IS No. 3921, London (1974).
11. A.M. Madibbo and M. Richter, *Fired Clay Bricks in the Sudan,* in Building Research Digest (Khartoum National Building Research Station), No. 6 Phase-I, (1970).