भारतीय मानक

(Reaffirmed 1997)

भवन निर्माण हेतु हस्त-निर्मित पक्की ईंटों के बनाने की मार्गदर्शिका

(तीसरा पुनरीक्षण)

Indian Standard

GUIDE FOR MANUFACTURE OF HAND-MADE COMMON BURNT-CLAY BUILDING BRICKS

(Third Revision)

UDC 691·421

BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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Price Group 7

FOREWORD

This Indian Standard (Third Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Clay Products for Buildings Sectional Committee had been approved by the Civil Engineering Division Council.

Different practices for the manufacture of hand-made common bricks are adopted in different regions of the country. It will be advantageous to give the existing knowledge and experience so far gained in the form of guide in order to specify the minimum requirements for various manufacturing operations.

In brick industry all operations, such as preparation of clay, moulding, drying and firing are carried out in the open. The kiln most commonly used is the bull's trench. The design and construction of such a kiln of optimum capacity has been covered in IS 4805 : 1978. This standard has been prepared to furnish general guidance in the selection of raw materials and the processes of manufacture of hand-moulded bricks (from clay-alluvial and black cotton).

Bricks may be made from a mixture of plastic clays and fly ash from thermal power stations. However, as the composition of these material varies over a wide range it is necessary to determine a suitable batch composition after laboratory tests. Two materials may be mixed wet either manually or in a machine. The processes of moulding, drying and firing are similar to those described in this standard.

This standard was first published in 1963 and revised in 1967 and 1975. This revision has been prepared to include such of the data which have been established since it was last revised, like manufacturing bricks with various additives like fly ash, sandy loam, rice husk ash, basalt stone dust and details of firing process besides making other contents up to date.

Indian Standard

GUIDE FOR MANUFACTURE OF HAND-MADE COMMON BURNT-CLAY BUILDING BRICKS

(Third Revision)

1 SCOPE

The standard covers the selection of site, raw materials, method of moulding and burning of hand-made common burnt-clay building bricks.

2 REFERENCES

The Indian Standard listed in Annex A are necessary adjuncts to this standard.

3 TERMNOLOGY

For the purpose of this standard, definitions given in IS 2248 : 1981 shall apply.

4 SELECTION OF SITE FOR THE MANUFACTURE OF HAND-MADE COMMON BURNT-CLAY BUILDING BRICKS

4.1 The site should be selected after giving due consideration to the suitability of soil and the location of water-table.

NOTE — It is a good practice to select a site where the water-table during burning season remains at least about 2 metres below kiln floor.

4.2 The site should be located in conformity with the prevailing town planning regulations or other bye-laws of similar nature, particularly in view of the smoke of the kiln which may prove a nuisance.

4.3 The availability of suitable clay conforming to the requirements laid down in **5**, within an economical distance, will be an important factor influencing the location of the kiln; greater consideration shall, however, be given to the distance of the distribution centre of the finished bricks rather than only to availability of the raw materials from the source, as otherwise it may prove more costly to arrange the distribution and despatch of finished bricks.

4.4 The nearness to a rail head or transport facilities through road or water shall be important considerations in the final selection of a kiln.

5 SELECTION OF RAW MATERIALS

5.1 Selection of Clay

5.1.1 The clay or mixture of clays selected should preferably conform to the following mechanical composition:

Clay	20 to 30 percent by mass
Silt	20 to 35 percent by mass
Sand	35 to 50 percent by mass

5.1.2 The total content of clay and silt may preferably be not less than 50 percent by mass.

NOTE — The limits for particle size grading specified above are not applicable to black cotton soil and lateritic soils.

5.1.2.1 The total lime (CaO) and magnesia (MgO) (*see* IS 1727 : 1967) in the case of alluvial soil will be not more than one percent and in other cases shall not preferably be more than 15 percent. The lime shall be in finely divided form. The total water soluble material shall not be more than one percent by mass [*see* IS 2720 (Part 21) : 1977].

NOTE — The data for the chemical and minerological composition of the soil as raw material for the manufacture of building bricks are not yet conclusively established.

5.1.2.2 The chemical analysis of the soil shall be made in accordance with IS 1727 : 1967 and IS 2720 (Part 21) : 1977.

5.1.3 The plastic properties of the clay shall be determined by finding the plasticity index by the method given in IS 2720 (Part 5) : 1985. The range of plasticity index shall be 15 to 25.

5.1.3.1 For quick field observations and intermittent checks, sample tests as given in Annex B may be found useful.

5.2 Additives

Certain additives such as fly ash, sandy loam, rice husk ash, basalt stone dust, etc are often required not only to modify the shaping, drying and firing behaviour of clay mass but helps in the conservation of agricultural land and utilisation of waste materials available in large quantities. These additives should, however, have a desirable level of physical and chemical charateristics so as to modify the behaviour of clay mass within the optimum range without any adverse effect on the performance and durability of bricks. Some of the basic physico-chemical requirements of conventional additives are as under:

5.2.1 *Fly Ash*

5.2.1.1 Fly ash is a waste material available in large quantities from thermal power plants and can be mixed to the brick earths as alluvial, red, black, marine clays, etc used for brick making. The Indian fly ash contains amorphous glassy material, mullite, haematite, magnetite, etc and shows a chemical composition similar to brick earths. These silicates also help towards strength development in clay bodies on firing, when mixed in optimum proportion depending on the physico-chemical and plastic properties of soils to be used for brick making. The proportion of fly ash mixed as an additive to the brick earth should be optimum to reduce drying shrinkage, check drying losses and to develop strength on firing without bloating or black coring in fired product. The crystallites present in the fly ash should comply with the resultant high temperature phases in the finished product.

5.2.1.2 The desirable characteristics of fly ash which could be used as an additive to the soil mass are given in Table 1.

Table 1 Desirable Characteristics of Fly Ash for Use as an Admixture with Brick Earths

Sl No.	Characteristics	Desired Level
(1)	(2)	(3)
i)	Texture	Fine, 2 000 to 3 000 cm^2/g
ii)	Coarse material (+1 mm), *Max*	0·5 percent
iii)	Unburnt carbon percent by mass, *Max*	15 percent
iv)	Water soluble percent by mass, *Max*	0·1 percent

5.2.2 *Sandy Loam*

Addition of sandy loam is often found effective in controlling the drying behaviour of highly plastic soil mass containing expanding group of clay minerals. Sandy loam should preferably have mechanical composition as under:

Clay	< 2 micron	8-10 percent
Silt	2-20 micron	30-50 percent
Sand	> 20 micron	40-60 percent

The material should, however, meet the other requirements as specified under **5.0.**

5.2.3 *Rice Husk Ash*

The ash should preferably having unburnt carbon content in the range of 3-5 percent (determined as LOI) and free from extraneous material can be used with plastic black and red soils showing excessive shrinkages.

5.2.4 *Basalt Stone Dust*

Basalt stone occurs underneath the black cotton soil and its dust is a waste material available in large quantities from stone crushers. The finer fraction from basalt stone crushing units can suitably be mixed with soil mass to modify the shaping, drying and firing behaviour of bricks. The dust recommended for use as an additive with brick earth should be fine (passing 1 mm screen) free from coarse materials or mica flakes and should be of non-calcitic or dolomitic origin.

6 PREPARATION OF CLAY (ALLUVIAL) CLAY ADMIXTURES

6.0 The soil used for making building bricks should be processed so as to be free from gravel, coarse sand (practical size more than 2 mm) lime and *kanker* particles, vegetable matter, etc.

6.1 Requisite predetermined proportions of additives such as fly ash, sandy loam, rice husk ash, stone dust, etc as indicated above should be spread over the plain ground surface on volume basis. The soil mass is then manually excavated, puddled, watered and left over for weathering and subsequent processing.

6.2 Weathering

The soil should be left in heaps and exposed to weather as long as possible and for at least one month in cases where such weathering is considered necessary for the soil. This is done to develop a homogeneity in the mass of soils, particularly if they are from different sources, and also to eliminate the impurities which get oxidized. Soluble salts in the clay would also be washed off by rain to some extent by this, which otherwise, may cause scumming at the time of burning the bricks in the kiln. The soil should be turned over at least twice and it should be ensured that the entire soil is wet throughout the period of weathering.

NOTE — In order to keep the soil wet, water may be sprayed as often as necessary.

6.3 Tampering

6.3.1 Addition of water to the soil at the dumps is necessary for the easy mixing and workability, but the addition of water should be controlled in such a way that it may not create problem in moulding and drying. Excessive moisture content may affect the size and shape of the finished brick. The tempering of the clay should preferably be carried out by storing the soil in a cool place in layers of about 30 cm thick for not less than 36 hours. This will produce homogeneity in the mass of clay for subsequent processing.

6.3.2 After weathering, the required quantity of water should be mixed with the soils so as to obtain the right consistency for moulding. Additions of sand and other materials, if necessary, may also be made at this stage to modify the

composition of the soil. The quantity of water may range from 1/4 to 1/3 by mass of the soil, sandy soils requiring less water and clayey soils more water. Nature and degree of wetness of the soil at the stage of water addition shall also be duly considered in this respect and the observations made in preliminary test (*see* **5.1.3.1**) may be useful for the judgement. The moistened soil may be kneaded with spades or other manual or mechanical equipment into a plastic mass.

6.3.3 After addition of water and kneading, the soil may be pugged in a pug-mill of suitable size corresponding to the quantity of production of bricks. The pug-mill may be mechanically operated or may be a simple animal driven type. Salient features of the simple design of a pug-mill are given in Annex C. The plastic mass as given in **6.3.1** will be conveyed and fed into the pug-mill, and the tempered soil issuing from the pug-mill will be collected for moulding operations.

6.4 Mixing

Two or more soils may have to be mixed so as to conform to the requirements of clay as laid down in **5.1.1**. The mixing may be done in a vat, before tempering or in the pug-mill described in Annex C.

7 PREPARATION OF CLAY (BLACK) COTTON AND ALLIED

7.0 In the areas where black cotton soils occur, a more elaborate method* of processing as given in **7.1** shall be followed.

7.1 The clay, which may be black or a mixture of black and yellow, is first washed free of the lime *kanker* in the ' *GHOL* ' tanks. The slurry is then run off to the settling tanks. After 3-4 days, when the clay has settled down, the supernatant water is bucketed off. Opening material like powdered grog of fine coal ash (passing 2·00 mm-IS Sieve), which opens up the texture of clay mass, is then added in predetermined proportions. This is usually 30 to 40 percent of the mass of clay. A solution of 0·5 percent sodium chloride may also be added at this stage to prevent lime bursting. The clay is then thoroughly mixed with the opening material added and allowed to dry further for a period of 3-4 days till the mix attains the correct moulding consistency.

7.1.1 *Preparation of Grog*

Grog is prepared by lightly calcining lumps of black cotton soil (about 10 to 15 cm dia) in a clamp at about 700 to 750°C. Coal ash, fire wood, brambles, etc, may be used as fuel. The fuel and clay lumps are arranged in alternate layers in the clamp. After calcination, the clay is pulverized in a machine, such as a disintegrator, a hammer mill or a pan-mill, to a fineness of less than 2·0 mm.

* A detailed layout of the processing plant may be obtained from Central Building Research Institute, Roorkee.

8 MOULDING

8.1 Design and Construction of the Brick Mould

8.1.1 The mould should be constructed preferably of metal. Seasoned wood with or without sheet metal lining may also be used (*see* Fig. 1). The thickness of the sides of the mould shall be not less than 3 mm if of metal, and not less than 10 mm if of wood.

8.1.2 The inner faces of the mould shall be smooth. All angles between adjacent interior faces of the mould as assembled should be 90° $\pm$ 0·5°.

8.1.3 The base of the mould should have a projection corresponding to the frog of the brick as shown in Fig. 1.

8.1.4 The size of the mould may incorporate due allowance for the total linear shrinkage of the moulded brick on drying and burning as shown in Fig. 1, so as to obtain the specified size for the finished product. Gang moulds suitable for moulding a number of bricks at a time may also be employed.

NOTE — Values of the allowance for shrinkage $\triangle L$, $\triangle B$, $\triangle H$, $\triangle D$, $\triangle X$, $\triangle Y$, etc as percentage of the corresponding dimensions of the finished brick and frog, will depend not only upon the nature of raw material but also on quantity of water added in the moulding and building operations. Normally total linear shrinkage allowance (inclusive of firing shrinkage) will vary between 8 and 15 percent. For large scale production it is recommended that before finalizing the mould size, experimental lots of bricks will be actually burnt in the kiln and a statistical analysis made for the size of bricks produced and the mould size will be adjusted accordingly.

8.2 Moulding Procedure

8.2.1 Hand-made bricks may be either ground-moulded or table-moulded. A level, firm surface of ground, will be used in the former case. Typical specification for accessories for table moulding are given in Annex D.

8.2.2 Before moulding, the inside of the mould will be cleaned and then sprinkled with sand or ash. If slop moulding is adopted the mould should be dipped in water and cleaned. The mould will then be set firmly on the level surface.

8.2.3 A quantity of clay slightly more than the volume of the mould, should be taken, rolled in sand, if found necessary, then shaped suitably into a single lump and dashed firmly into the mould with a force (that is to be judged by the moulder by experience) so that the clay completely occupies the mould without air pockets and with the minimum surplus for removal.

8.2.4 The surplus clay should be scraped off with a sharp straight edge or a stretched wire and the top surface levelled.

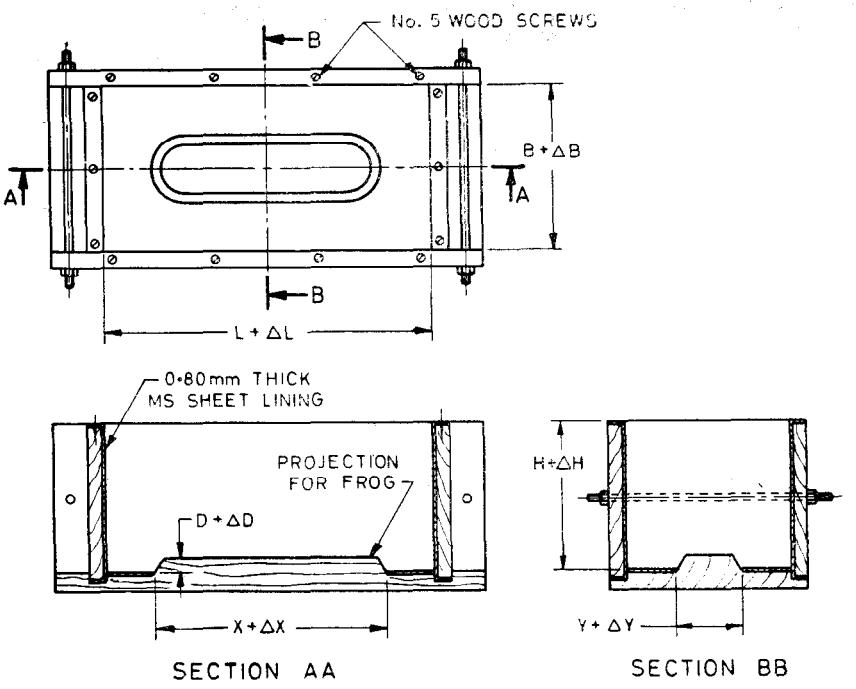


FIG. 1 DETAILS OF MOULD

8.3 The whole assembly of mould should then be lifted, given a slight jerk, and inverted to release the moulded brick on a pallet board in the case of table moulding or on dry level surface of the ground in the case of ground moulding. The ground may be advantageously sprinkled with sand before releasing the brick over it, so that the brick does not stick to the ground.

8.4 Operation of Brick Moulding Table

8.4.1 Alternatively, an improved hand moulding table for shaping building bricks may be used. Details of the same are given in Annex E.

8.4.2 For moulding bricks, clay is mixed with water and kneaded in the same manner as detailed under **6.0** and **7.0**. The consistency of the clay should be plastic and preferably be kept marginally stiff.

8.4.3 At the moulding table a quantity of clay is rolled into clots slightly larger in volume than the mould. The clot is then rolled over fine sand and thrown with little force into the mould so that the clay completely occupies the mould without air pockets and with minimum surplus for removal.

NOTE — Before throwing the clot into the mould, the inside of the mould should be cleaned and then sprinkled with sand or ash. However, in case of highly sticky or plastic soil mix, the inner side of the mould may be wiped off with wet or oily rag for easy demoulding. This may be done whenever necessary, and preferably, after shaping 4 or 5 bricks from the mould.

8.4.4 The surplus clay is removed off with a sharp straight edge or a stretched wire and top surface levelled.

8.4.5 The shaped brick is then ejected by pressing down the pedal when the loose bottom steel plate alongwith the shaped brick is lifted out of the mould. A wood plank of similar size as that of a brick is placed over the shaped brick and is manually lifted along with the loose base plate.

8.4.6 The pedal is then released and the base plate drops to its original position.

8.4.7 The moulded brick is then turned on the side, over the wooden pallet. Both the plates loosely adhering to the brick surface are gently removed. The base plate is returned to the mould box for subsequent shaping of other bricks from the brick moulding table.

8.4.8 Another wooden pallet is then placed on the top face of the brick which is then carried away to the drying ground where it is placed on edge to dry.

9 DRYING

9.1 The moulded brick should be allowed to dry to an approximate moisture content of 5 to 7 percent. The recommended method of drying is shown in Fig. 2.

9.1.1 It may be noted that all the channels in the longitudinal and transverse directions are cross ventilated.

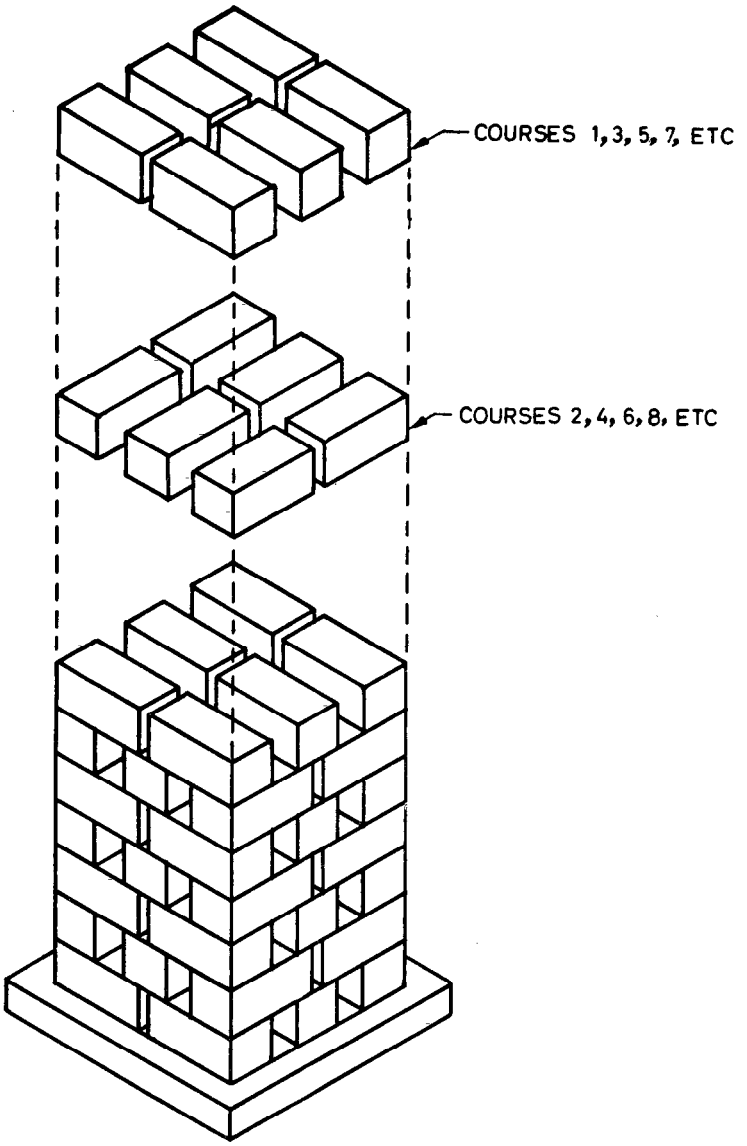


FIG. 2 METHOD OF DRYING OF BRICKS

9.2 As far as possible the moulded bricks should be protected effectively against rain and dampness till they are stacked inside the kiln.

10 HANDLING AND TRANSPORT OF MOULDED BRICKS

10.1 During conveyance to the kiln, the moulded bricks should be loaded or unloaded one by one.

11 SETTING BRICKS IN THE KILN

11.1 Pattern of setting of bricks in bull's trench kilns is shown in Fig. 3A. The details of brick setting based on $2\frac{1}{2}$ brick length* is shown in Fig. 3B. The pattern of setting shown in this figure is for coal firing. The pattern shall be slightly different for wood firing.

*Detailed drawings for other brick lengths are available at Central Building Research Institute, Roorkee.

11.2 The moulded bricks should be set in a uniform pattern in the kiln with trace holes, fuel shafts, flues, etc, in accordance with the design of kiln. While arranging the bricks a minimum space of 10 mm shall be given between adjacent bricks in the header and stretcher courses.

11.2.1 In the fuel shaft, bricks, should be suitably arranged to project in such a manner so as to form a series of ledges on which the fuel could rest and burn, with only a small portion falling direct to the floor of the kiln.

11.3 The top two courses of *KACHCHA* bricks in the kiln, should be set as close as possible with little or no spacing between them so as to form a complete roof covering for the kiln-setting. Holes of size not less than 100 × 100 mm shall be left in the roof for feed of fuel into the fuel shafts.

11.4 The top of the setting excluding portions occupied by feed holes should be covered with a fine ash about 200 mm thick. The feed holes should be tightly closed with cast iron pot and caps.

11.5 After every second chamber a gap of about 120 mm should be left for inserting the sheet iron cross dampers along the entire width of the chamber.

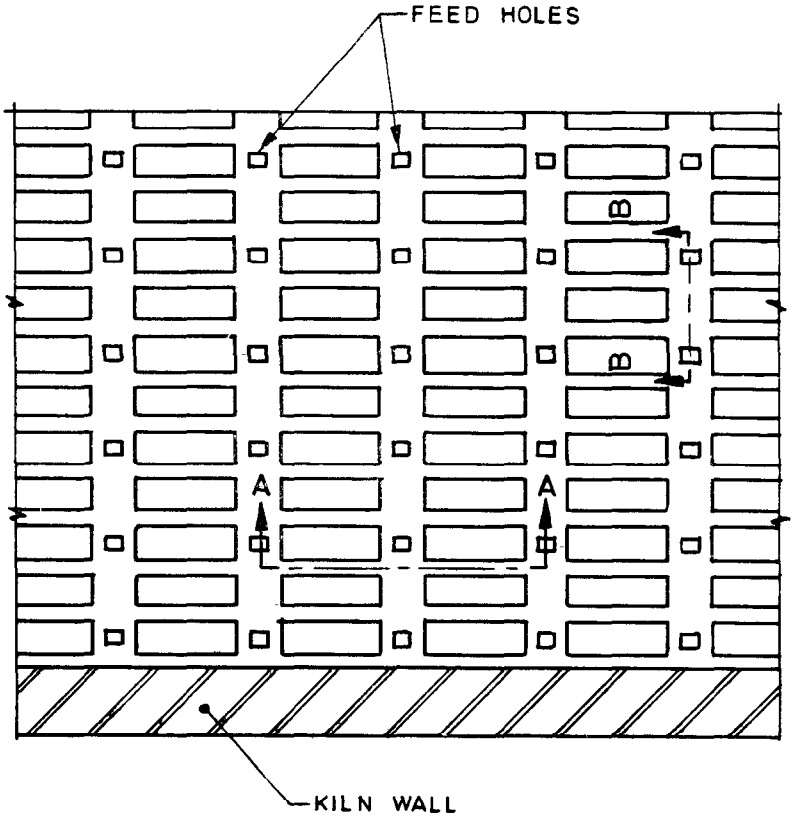
11.6 The wicket opening to chambers should be sealed by temporary cavity walls. The cavity (about 50 mm width) may be filled with fine kiln ash and the outside of the walls may be plastered over with a thick layer of mud.

12 INITIATION OF FIRE

12.1 Firing may be started after nearly three-fourth of the trench has been loaded. The chimneys may be positioned about 5·5 to 6 0 m away from the first row of feed holes. When starting the fire, a temporary cross wall, one-brick thick, is constructed at a distance of 250 mm from the first row of brick columns. A number of air holes (100 × 100 mm) (*see* Fig. 4) are left at the foot of this wall. The top opening between this wall and the main setting is closed up bv projecting bricks from either side and the usual cover of ash is laid on. A number of feed-holes are provided on this space (*see* Fig. 5), the actual number depending on the width of the trench.

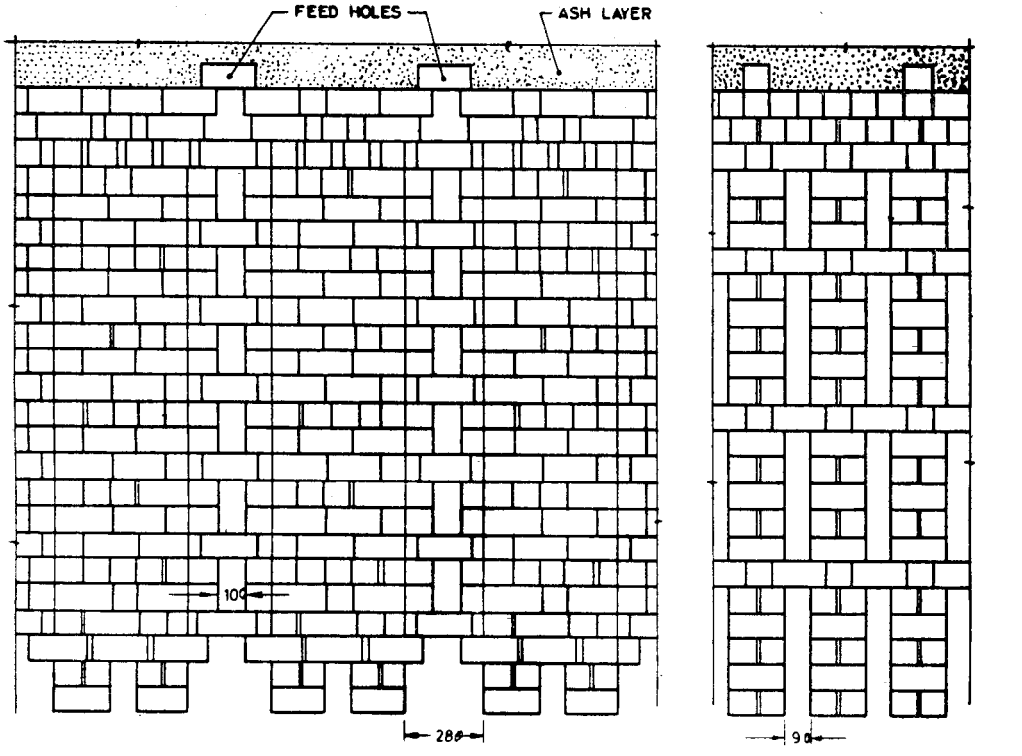
12.2 Initially log wood (100 to 150 mm dia and 1·5 to 2 m long) soaked in kerosene oil is fed through the top feed holes over the temporary wall and are ignited by introducing lighted rags through the air holes at the bottom. Feeding of fire wood is continued at 20-30 min intervals, the holes being kept closed by metallic caps between the feeds. The red hot charcoal that collects on the floor must be pushed forward through the trace holes in the setting by long iron pockers (about 3 m long). The chimneys should be observed for formation of dense black smoke which should not persist for more than 3 to 4 min after each feed. Observation should also be made of the condition of the fire and the movement of flames and hot gases through the brick setting to get an idea of the draught If draught appears to be slack, the chimneys may be heated up by lighting small fires at the chimney bases (externally).

12.3 After about 10 to 12 hours of firing the kiln floor and the bricks in the first row of columns should be heated to red heat (that is 750 to 800°C) and feeding of black coal in the first row of feed holes in the main setting started. Within 5 to 6 hours after this a good bottom heat in the furance beyond the first row of feed holes should be obtained. Feeding in all the feed holes in the



3A General Arrangements

FIG. 3 PATTERN OF SETTING OF BRICKS IN KILN — *Contd*



3B Details of Brick Setting Based on 2½ Brick Length

All dimensions in millimetres.

FIG. 3 PATTERN OF SETTING OF BRICKS IN KILN

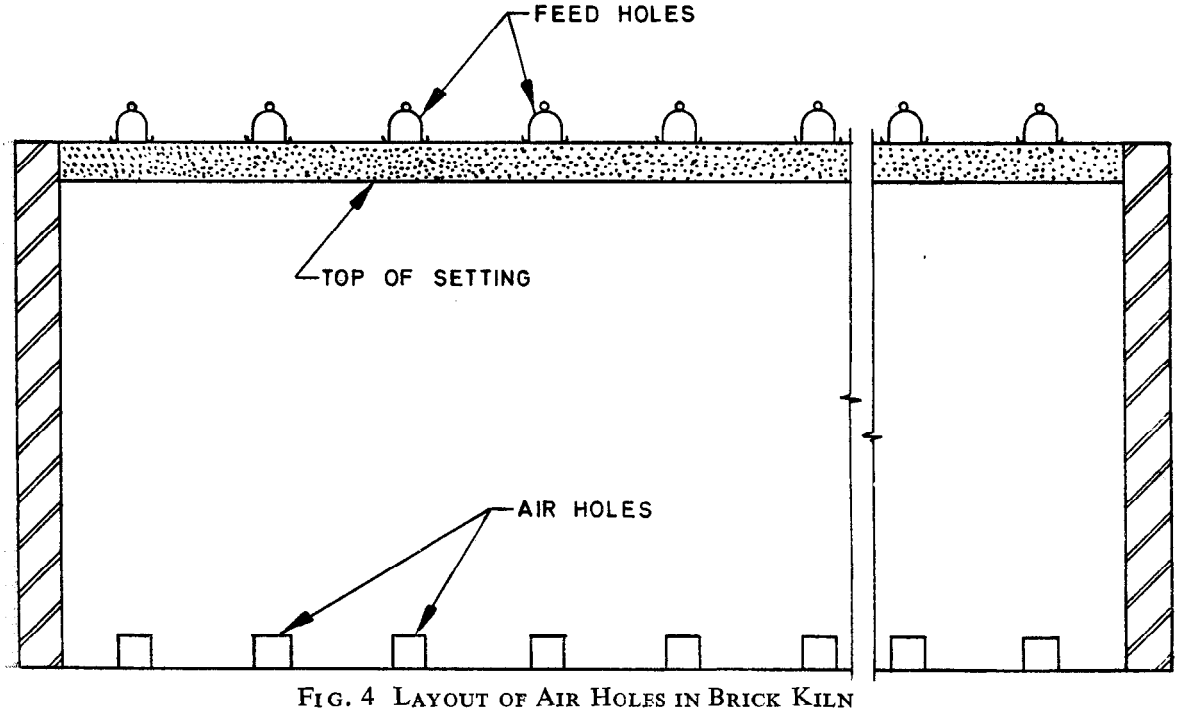


FIG. 4 LAYOUT OF AIR HOLES IN BRICK KILN

temporary wall as well as the first row of columns should be continued till sufficient bottom heat is built up.

12.4 When a sufficiently strong draught has been built up, the chimney may be advanced by 5 to 6 m and the position of the cross damper readjusted. Thus within 24 to 30 h the kiln should be brought up to full firing order. Firing in the feed holes of the temporary wall should be continued till the fire has advanced by at least 10 to 12 m and the bricks in the first row have been fully burnt. The temporary wall can be pulled down only after the fire has gone round the curved part of the trench and the bricks in the first row have cooled down sufficiently to permit unloading to start.

13 CONTROL OF BURNING

13.1 Schedule of Firing

In a large capacity kiln, there are normally 30 chambers (*see* IS 4805 : 1978). When the kiln has been brought up to the regular firing order, the schedule of firing that should generally be maintained is indicated below:

Loading	1	chamber
Unloading	1	”
Firing	1	”
Preheat	3	”
Cooling	20	”
Empty	4	”
	30	

The schedule of firing may, however, vary according to the requirements of a kiln firing a particular clay using a particular type of coal. It will also vary if coal ash or fly ash containing a certain amount of unburnt carbon, is admixed with the clay.

13.1.1 Bituminous slack coal Grade I should preferably be used for firing brick.

13.1.2 When advancing the fire, a fresh row should be opened only when the temperature at the base of the setting or on the kiln floor has reached at least 750°C. This is indicated by the appearance of a dull red glow. Initially small quantities of coal, say, 250 to 500 g should be fed at a time in each feed hole; the amount of feed should be raised gradually to 1 to 2 kg/feed-hole as the temperature rises. After each feed the feed-hole caps should be tightly replaced to prevent in-leakage of cold air. While feeding fuel, loose ash from the top covering should not be allowed to drop into the feed hole.

13.2 The temperature at which bricks are to be fired may range from 900 to 1 000°C depending upon the type of clay. The temperature may be observed by means of suitable temperature measuring devices, and the fuel feed and draught adjusted for control.

NOTE — Either a pyrometer or pyrometric cones whichever is suitable may be used for the measurement of temperature.

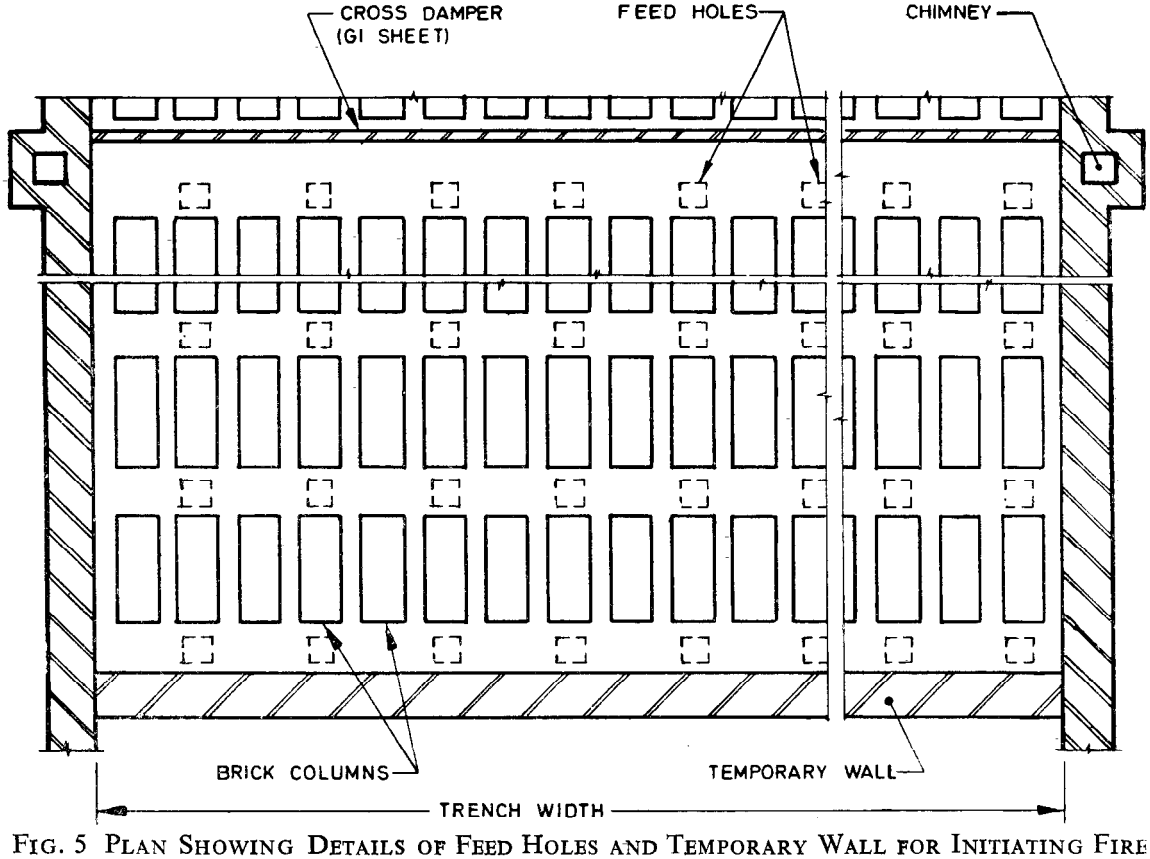


FIG. 5 PLAN SHOWING DETAILS OF FEED HOLES AND TEMPORARY WALL FOR INITIATING FIRE

13.2.1 The rate of fire travel should generally be not less than 5 m/24 h. Operation of dampers, setting of bricks and emptying of bricks will keep pace with the advancing fire cycle.

13.3 There are five distinct stages in the firing cycle, such as (a) smoking, (b) pre-heating, (c) firing, (d) soaking, and (e) cooling, to which the bricks in the kiln should be subjected to. The proper and efficient control of these stages greatly depend upon the technique and experience of the burner.

13.4 Under normal conditions, the pair of chimneys are maintained at a distance of 10 to 15 m from the first row under fire, and are shifted once every 12 hours. However, if any combustible matter has been mixed with the clay then the chimneys should be maintained at a distance of 20 m or so.

13.4.1 The draught of the kiln should be observed by suitable draught gauges at the base of chimney and should be adjusted by operating the temperature as specified by the designer of the kiln.

13.5 Cooling

Cooling of the brick in the kiln should be gradual. Normally about 15 to 20 chambers are maintained in the cooling zone.

14 UNLOADING OF BRICKS FROM THE KILN, SORTING AND STACKING

14.1 The bricks should be unloaded from the kiln and conveyed to the sorting area with minimum breakage.

14.1.1 In the case of bricks made from clays containing lime *kanker*, the bricks in stack should be thoroughly soaked in water (docked) to prevent lime bursting.

14.2 The bricks should be sorted out into the various classes.

14.3 Bricks, which remain underburnt may be stacked along the walls of freshly loaded chambers.

14.4 For proper inspection of the quality and count of bricks, they may be arranged in stacks on dry surface, the stacks being two-brick thick up to ten-course high and up to hundred-brick long and the distance between two adjacent stacks being not less than 0 8 m.

ANNEX A

(*Clause* 2.1)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
1727 : 1967	Methods of test for pozzolanic materials (*first revision*)
2248 : 1981	Glossary of terms relating to clay products for building (*first revision*)
2720	Methods of test for soils:
(Part 5) : 1985	Determination of liquid and plastic limits (*second revision*)
(Part 21) : 1977	Determination of total soluble solids (*first revision*)
4805 : 1978	Guide for construction of brick kiln (*first revision*)

ANNEX B

(*Clause* 5.1.3.1)

FIELD TESTS FOR SOIL FOR BRICKS MANUFACTURE

B-1 TESTING SOIL FOR DRYING SHRINKAGE

B-1.1 The soil should be ground to a fine power and mixed with sufficient water, added in small quantities. The mix should then be kneated into a plastic mass of the required consistency.

B-1.2 Take a handful of the soil prepared as in **B-1.1** and form into a ball of about 80 mm diameter.

B-1.3 Keep the ball in the sun for drying. When dried, examine the ball for loss of shape and surface cracks, if any.

B-1.4 Conclusions

B-1.4.1 If the ball has deformed on drying and crumbles easily when pressed lightly, it may be inferred that sand content is excessive.

B-1.4.2 If the ball is hard but shows cracks on the surface, then the sand content is insufficient.

B-1.5 If the soil is not found suitable as inferred in **B-1.4**, the test should be repeated after modifying the composition of the soil, such as by mixing different proportions of two soils or by addition of sand, etc, for checking the suitability.

B-2 TESTING SOIL MOULDING CHARACTERISTCS

B-2.1 A quantity of soil as adjusted for composition should be taken and water should be added in just enough quantities and the mix kneaded well so as to attain a plastic consistency at which it is possible to roll threads of about 3 mm out of the soil.

B-2.2 Bricks of standard size should be actually moulded from the soil as prepared in **B-2.1** and examined for sharpness of edges and corners in green condition.

B-2.3 If edges and corners are not sharp, the test should be repeated varying the quantity of water added, so that finally a satisfactory result is obtained.

B-2.4 The moulded bricks should be left to dry four days in the sun and examined for shrinkage cracks.

ANNEX C

(*Clauses* 6.3.3 *and* 6 4)

SALIENT FEATURES OF A SIMPLE TYPE OF ANIMAL DRIVEN PUG-MILL

C-1 SALIENT FEATURES

C-1.1 The pug-mill (*see* Fig. 6) consists of a conical tub made of strong timber or iron, typical dimensions being 1 to 1·8 m high, and 1 to 1·2 m diameter at top. The tub is fitted in the centre with a revolving upright, iron shaft carrying horizontal knives, the shape and inclination of which may be as required for the type of soil being worked. The knives at the top and bottom are such that they exert in addition to cutting a downward force on the clay during rotation. Cross knives may also be fitted to the middle horizontal knives for cutting through and breaking all clay lumps. There is a square or rectangular opening at the bottom as shown in Fig. 6, through which the pugged clay will be forced out.

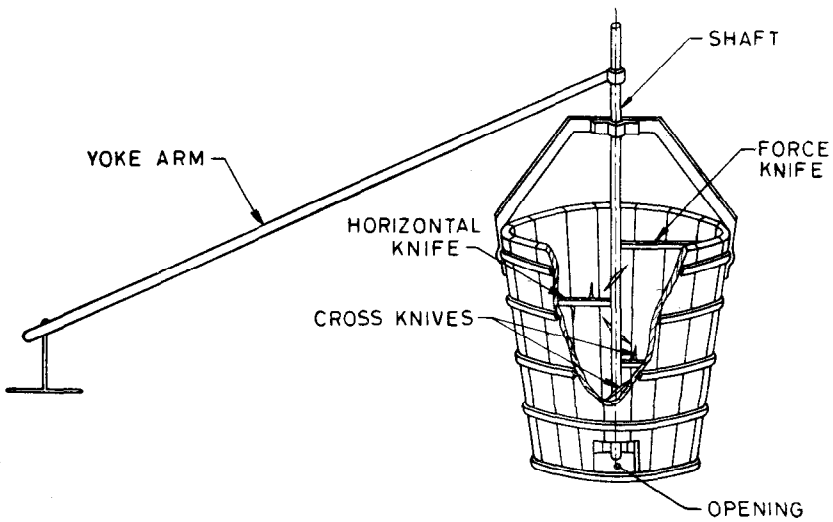


FIG. 6 DETAILS OF PUG-MILL

ANNEX D

(*Clause* 8.2.1)

TYPICAL SPECIFICATIONS FOR ACCESSORIES FOR MOULDING TABLE

D-1 MOULDING TABLE

D-1.1 The moulding table is 1·2 to 1·8 m long and 0·6 to 1·0 m wide, and made of wood or iron (*see* Fig. 7).

D-1.2 It is smoothly finished at top and supported horizontally at a height of 1 to 1·2 m. The table also has holes to accommodate accurately, the bottom pins of the stock board (*see* **D-2**).

D-2 STOCK BOARD

D-2.1 A wooden board has iron lining around the upper edge and with such dimensions as to fit accurately but loosely the interior of the mould The stock board is provided with four pins one at each corner of the bottom side, which when fitted into corresponding holes on the moulding table hold the board tightly in position during moulding. The stock board also has a projection at the top so as to form the frog of the brick being moulded (*see* Fig. 8).

D-3 PALLET BOARDS

D-3.1 These are rectangular pieces of wood of size 30 cm × 15 cm and 10 mm thick with smooth surface on one side. The pallet boards are used conveying for the moulded bricks in the drying yard (*see* Fig. 7).

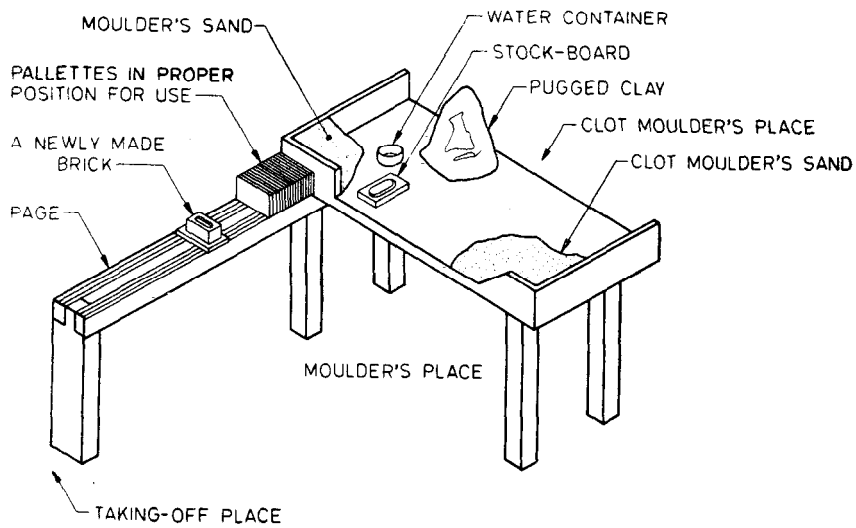


FIG. 7 DETAILS OF MOULDING TABLE

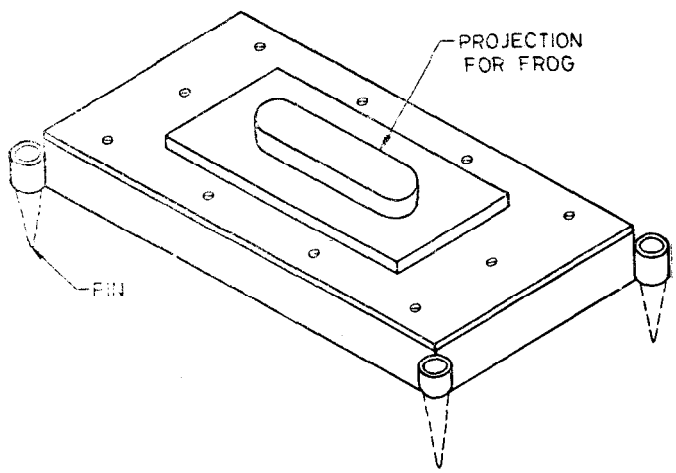


FIG. 8 DETAILS OF STOCK BOARD

ANNEX E

(*Clause* 8.4.1)

IMPROVED BRICK MOULDING TABLE

E-1 DESIGN AND CONSTRUCTION OF BRICK MOULDING TABLE

E-1.1 Various parts of the moulding table are shown in Fig. 9. The brick moulding table essentially consists of a wooden table to which a metallic mould is fixed. The mould is provided with a movable mild steel bottom plate attached to a vertical ejector system. The vertical shaft is actuated by a foot lever mechanism. Two guide rollers are provided for the smooth vertical movement of the shaft. On releasing the pedal, the base plate drops down to rest on four corner blocks, the position of which is also adjustable.

E-2 The inner faces of the mould shall be smooth. All angles between adjacent interior faces of the mould as assembled should be 90° ± 0·5°.

E-2.1 The frog shall be fixed to the base plate immediately above which a false bottom plate with its centre cut out to accommodate the frog is loosely fitted.

E-2.2 The size of the mould may incorporate due allowance for the total linear shrinkage of the moulded bricks on drying and burning so as to obtain the specified size of the finished brick.

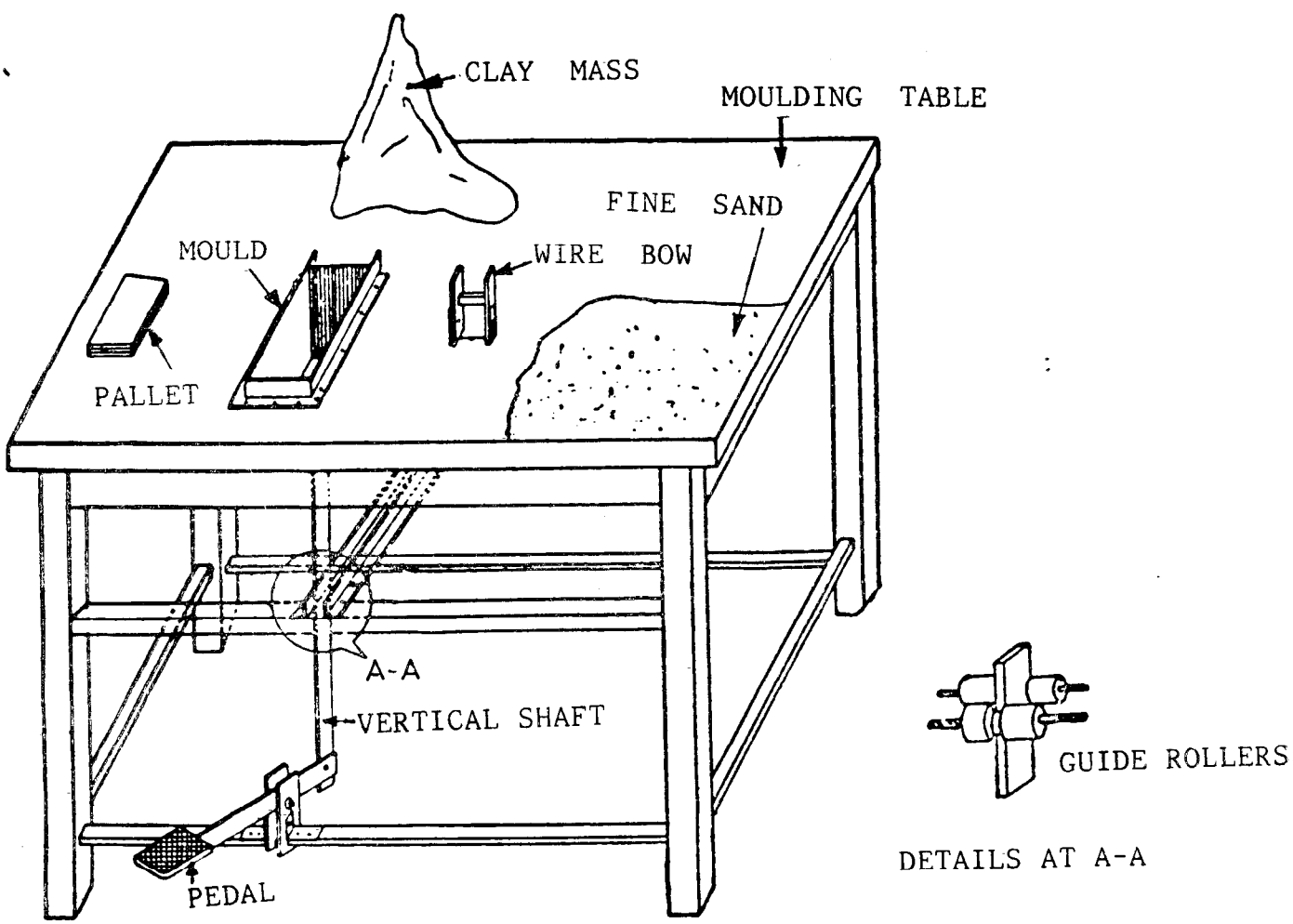
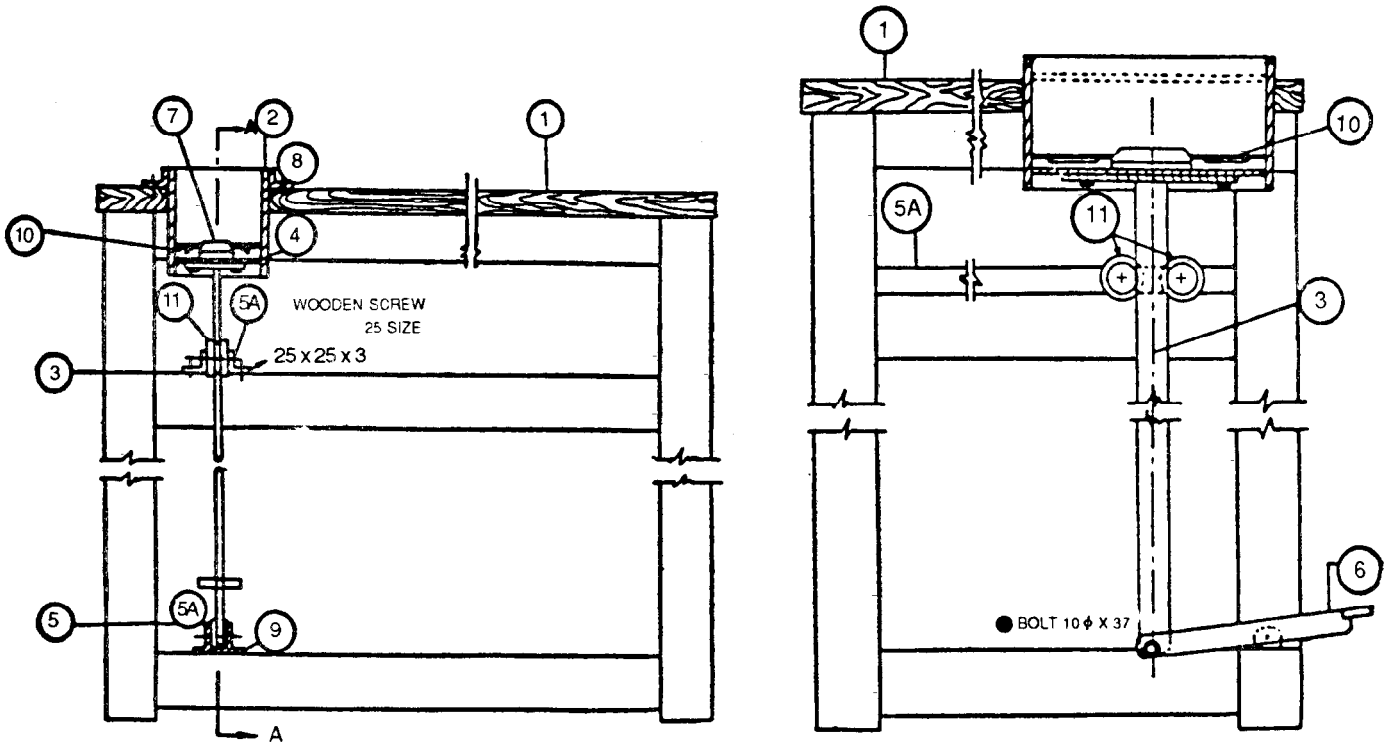


FIG. 9 IMPROVED BRICK MOULDING TABLE (ASSEMBLY DRAWING) — *Contd*



SECTIONAL ELEVATION

SECTION AT A-A

Sl No.	Legend	Material	Sl No.	Legend	Material
1	Table	Wood	6	Foot Lever	M.S.
2	Brick Mould	M.S.	7	Frog	Wood
3	Ejector	M.S.	8	Flange	M.S. Angle Iron
4	Ejector Top Plate	M.S.	9	Ejector Support	M.S.
5	Lever Guide	M.S.	10	Loose Plate	M.S.
5A	Angle Iron	M.S.	11	Roller	M.S. 2 Nos.

All dimensions in millimetrs.

FIG 9 IMPROVED BRICK MOULDING TABLE

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