PAPER No. 296.

CHEAP SPECIFICATIONS ADOPTED FOR THE CONSTRUCTION OF MULTAN BOSAN ROAD.

BY

MR. GHIAS-UD-DIN HABIB, P.S.E.I., B. Sc. (Glas.),

A.M I E., Superintending Engineer, 2nd Circle, Punjab,

P.W.D., Buildings and Roads Branch, Multan.

INTRODUCTION.

This paper deals with the cheap specifications adopted for the construction of the village road, Multan to Bosan, in Multan District, a length of 10.85 miles.

2. The road serves a fertile rural area. The traffic on it is light (Appendix "A") and is expected not to become heavy for a long time.

3. The Specifications described in this PAPER for the construction of road crust were adopted as a large scale experiment with a view to decide cheap specifications for construction of village and District minor roads in the Province.

4. For several years past, the Department has been actively considering various specifications to evolve one for the construction of district minor and village roads which would be economical and at the same time efficient to take light traffic which such roads have usually to carry.

5. With this object in view it was originally considered during the year 1946 to provide a soil-stabilized crust on this road. But before the work was actually commenced Mr. H. A Harris, the then Chief Engineer, decided to alter the specifications as the climatic conditions of the area and the soil along the road was not considered suitable to adopt soil stabilized specifications and try out a large-scale experiment with special grooved brick soling, as described further, directly surfaced with bitumen over the bricks without the usual stone or brick metal wearing coat and with some other new specifications. In the past surfacing has been tried on ordinary brick soling but it proved unsuccessful. This was said to be due to the reason that there was no bond between the plain surface of the soling coat bricks and the bituminous surfacing.

ORIGINAL SPECIFICATIONS AS PROPOSED BY MR. HARRIS.

The Bosan Road was selected to be constructed as an experimental road with the new specifications, which Mr. Harris proposed as follows :—

(i) Bricks 9" × 4½" × 3" with grooves on the flat face for laying 3" thick soling coat or grooves on edge for laying 4½" soling coat or half bricks with grooves on the end. Four coats surfacing to be carried out directly over the soling.

(ii) Ordinary bricks to be moulded without frogs but with 1" to 1½" gauge metal spread at the base of mould before filling it with clay in the ordinary manner. Only sand stone to be used.

(iii) To make compressed bricks with stabilised soil following the above.

(iv) To make compressed bricks with stabilised soil using 30% aggregate of bricks or stones.

(v) To lay average 2" carpet of cement concrete 1 : 2 : 4 over pavement of flat bricks or bricks on edge both grooved.

ONLY No. (1) TRIED ON BOSAN ROAD.

6. Out of all the above specifications, only the first one has been tried on the Bosan Road. According to these specifications, grooved bricks were to be laid diagonally and covered with 4 coats of spray grouting.

MODIFICATIONS PROPOSED BY MESSRS BURMAH SHELL CO.

Before adopting final specifications Messrs. Burmah Shell were consulted in order to obtain their views, regarding suitable specifications for laying surfacing directly, over grooved-brick or soling coat. Messrs. Burmah Shell recommended the use of Shell Primer No. 2 as a tack coat applied at the rate of 20 lbs/100 sft. which was to be allowed to soak in for 24 to 48 hours without blinding the surface. For surfacing they suggested the use of Shelspra B. S. In ordinary built-up spray grout work with stone metal wearing coat, a heavier coat is applied first followed by lighter coats. It was suggested that in this case, if the heavier coat was applied first the bitumen would tend to collect in the grooves and so the application should be reversed. The specifications for the 2nd and 3rd spray coat were consequently suggested by Messrs. Burmah Shell to be as under :—

2nd Coat : – Shelspra B. S. using 25 lbs per 100 sft. blinded with 4½ cft. of 3/4" to 3/8" gauge shingle.

3rd Coat :— Shelspra B. S. at the rate of 35 lbs per 100 sft. blinded with 2½ cft. of 3/8" to 1/8" gauge shingle.

MODIFIED SPECIFICATIONS.

7. The Specifications for surface dressing work which were provided in the original estimate differed from the recommendations made by Messrs. Burmah Shell. After giving due consideration to the various suggestions it was decided to carry out the work of soling coat as described in para 11 and that of surface treatment as given in para 12 (*i*) to (*iii*).

MATERIALS :

8. (*a*) **Bricks** :—Bricks for soling consisted of $9'' \times 4\frac{1}{2}'' \times 3''$ and $4\frac{1}{2}'' \times 4\frac{1}{2}'' \times 3''$ size and were specially grooved on flat face or on edge. These bricks were sand moulded in specially made moulds shown in plate No. 1 and were manufactured in an ordinary Bull's trench kiln.

(*b*) **Bajri** :—Most of the Bajri which was used on this road was obtained from Mari Indus Quarry. The bajri was hard water worn quartzite stone but it was not well graded and was lacking in fine stuff for the final coat. This deficiency was made good with finer Bajri obtained from Harro.

(*c*) **Binder** : Shelmac MC 4, a special Burmah Shell Product, was used for the tack coat on Soling coat. It is a slow setting cutback having low viscosity and a high covering capacity. Its penetration is 150/250 and application temperature 250 degree F. This primer is an asphalt dissolved in a volatile solvent. Its function is to water-proof the base and to develop an adequate binding strength by virtue of its penetration. ' Shelspra B.S., another Burmah Shell Product, was used in the 3 subsequent spray coats.

Execution of Work :—

EARTH WORK AND FORMATION :

9. The average height of embankment above surrounding ground was kept $1\frac{1}{2}$ feet with the formation width of 24'. The width of road land acquired is 66 feet.

COMPACTION OF SUBGRADE

10. Earth work in embankment was done according to the standard specifications. It was carried out much in advance of other items of work and was soaked by rains, consolidated under traffic and well set before the laying of soling was started. The important factor in the execution of earth work for the particular specifications adopted on this road was proper compaction of the embankment with a Roller to ensure that subsequent settlement does not take place. In normal specifications where wearing coat is provided, such settlement in soling, if any,

can be made good in the wearing coat. But on this particular work where no wearing coat was provided the subgrade had to be absolutely firm so that there was no subsequent settlement once the soling coat was laid.

TRENCHING FOR SOLING :

After the bank was rolled and watered a trench was dug to accommodate 10 feet width of soling. The bed of the trench was rammed with hand rammers and finally dressed to designed levels.

CAMBER :

The camber provided was 1 in 48 instead of the usual 1 in 72 given on black-top roads. In certain reaches, where the soil was affected by salt-peter, a 3" thick insulation layer of sand below soling was provided. The edges of the soling were also covered with sand to provide afround insulation.

LAYING SOLING :—

11. After the sub-grade was prepared and dressed to camber a string course of grooved bricks 9" wide was laid along both sides of the trench parallel to the centre line of the road. At every 50 feet intervals a 9" grooved bricks string course was also laid across the road dividing it into compartments of 50 feet lengths. Grooved bricks were then laid diagonally at 45 degrees to the centre line of the road between string courses. The adjacent courses were laid to break joints, and the direction of courses was changed every 25 feet. The bricks were laid, tightly with close joints.

CONSOLIDATION OF SOLING COAT :—

After the soling was laid a thick coat of pit sand was laid over it filling thoroughly all the joints between the bricks. An 8 ton Tandom Roller was then used to consolidate this special type of soling. A Tandom Roller has the advantage over the ordinary three-wheeled Roller in that it does not break the grooves like the latter. A good cushion of sand bad to be maintained on the bricks during consolidation to avoid crushing of the lugs of the bricks.

BITUMEN SURFACING DIRECT ON SOLING COAT :—

12. (*i*) **Tack Coat :—** The surface of soling coat after consolidation was swept clean of sand. A spray of 12 lbs of tack coat of MC 4 - a Burmah Shell Primer - was applied at 250 degree F. and allowed to dry out without blinding. After 48 hours of the application of the primer the bricks gave a blackish appearance with no stickiness of the binder at all. The tack coat applied carried the asphalt into the pores of the bricks and left a thin film on the brick surface for tacking to the surfacing.

(*ii*) **2nd Spray Coat :—** Two days after the tack coat was laid, the surface was cleaned of dust by hair brushes and gunny bags and a 2nd spray with shelspra B.S., using 14 lbs per $^0/_0$ sft. given.

The surface was then blinded with $\frac{1}{2}''$ to $\frac{3}{4}''$ gauge bajri, using $3\frac{1}{4}''$ cft. per $^0/_0$ sft. This quantity of bajri did not cover more than 50 $^0/_0$ of the road surface. The blinding was then rolled a few times with a Tandam Roller avoiding crushing of Bajri.

(*iii*) **3rd Spray Coat :—** Immediately after the 2nd coat a 3rd spray coat using 17 lbs per $^0/_0$ sft of Shelspra B.S. was given and blinded with $\frac{1}{4}''$ to 3/8″ gauge Bajri using $2\frac{1}{4}$ cft. per $^0/_0$ sft.

After this coat, there were still about 15 $^0/_0$ of voids left on the road surface. The surface was then thoroughly checked for unevenness and defects were removed as explained further in para 17. On account of a large percentage of voids left after 2nd coat of surface dressing, a 3rd spray coat (excl[illegible]g the tack coat) was considered absolutely necessary.

(*iv*) **4th Spray Coat :—** After the 3rd Spray Coat, the surface was allowed to set for a day, and the road was kept closed to traffic. On the second day, the surface was again cleaned of dust by gunny bags and sprayed with 4th and final coat, using 14 Lbs of Binder and blinded with 1/8″ to 1/4″ fine Bajri, using $1\frac{1}{2}$ cft. per $^0/_0$ sft. The surface was then lightly rolled. There was a tendency of fine Bajri being crushed under Roller wheels. To avoid this, light sprinkling of water on the surface was given, which served as a lubricant and stopped this tendency to a great extent. After the 4th Spray coat, the road was closed to traffic for a week.

FAILURE IN PART OF FIRST MILE

13. Two miles of the road were first completed according to the above mentioned specifications, and opened to traffic after a week. An inspection of the surface a few days after, revealed patches and signs of disintegration in a portion of the first mile, though the rest of the portion was quite in tact. Further work of surfacing was, therefore, stopped in order to investigate the probable cause of failure. The following was the result of this investigation.

CAUSE AND REMEDY :—

On careful inspection it was noticed that most of the binder used had been sucked in by soling bricks leaving the surface rather brittle and dry. This led to the conclusion that for laying sufacing over bricks much more quantity of binder is needed than for normal specifications with stone wearing coat, and also that it was necessary to soak bricks with water in order to reduce their tendency of sucking oils from the binder.

QUANTITY OF BINDER INCREASED :

It was consequently decided to sprinkle water thoroughly over the bricks before the tack coat was laid and also to revise the specifications increasing the quantity of primer from 12 to 22 lbs per % sft. and also the quantity of Binder in the 2nd, 3rd and 4th coats from 14 to 17 lbs, 17 to 25 1bs and 14 to 20 lbs per % sft. respectively.

TRIAL OF PREMIXED CARPET OVER SOLING COAT :

14. During the course of construction Messrs. Burmah Shell suggested to try premixed carpet work for reasons that it would result in economy of cost due to :—

(*a*) Large size of shingle used costing less.

(*b*) Reduction in manual labour employed.

(*c*) Reduction in trips of Rollers.

(*d*) Reduction in quantity of bitumen used.

(*e*) Reduction in waste due to chipping off of shingle

(*f*) Reduction in leakage of bitumen while spraying and loss of bitumen coated bajri chipped off under traffic.

(*g*) Gain in strength arising from the uniform film of bitumen coating each individual stone, hence lessening the intensity of pressure in each stone.

On actual trial, however, as described below, the premix specifications were found neither suitable nor economical.

15. Laying of a premixed carpet was tried in a 100 feet length. Bajri of 1/4″ to 3/4″ gauge was precoated with Shelspra B. S. at the rate of 4 lbs per cft. of Bajri. The precoated Bajri was then spread on the grooved soling. It was found that some of the stuff went into the grooves and whatever was left could only form a thin carpet with large percentage of voids. The surface remained uneven and perforated. From this it was realised that it was not possible to lay a $\frac{3}{4}$″ carpet of premixed Bajri over the grooved bricks. Much more precoated bajri was required to bring it to a uniform thickness. It was, therefore, realized that it was difficult to adopt premixed specification without incurring heavy extra cost, while the 4 coats spray specification gave a much more uniform surface, and was easy in execution and cheaper in cost. The idea of laying precoated carpet any further was, therefore, dropped.

COMPLETION OF REMAINING WORK.

16. The rest of the work in the remaining about 9 miles of the road was completed as per revised specifications as in para 13 above and the surface on the whole was finished quite satisfactorily.

SURFACING :—

The final specifications which were adopted for are summed up as under :—

After cleaning the dust the surface was sprinkled with water to allow it to soak to the bottom of soling. A tack coat of Shelmac MC 4 was then applied at a rate of 22 lbs per % sft. This was allowed to dry out for 48 hours.

2nd Coat :— Shelspra B.S. was applied at the rate of 17 lbs per % sft. and blinded with coarse grade bajri of $\frac{3}{4}$" to $\frac{1}{2}$" gauge at $3\frac{1}{4}$ cft. per % sft.

3rd Coat :— Shelspra B.S. was sprayed at the rate of 25 lbs per % sft. and blinded with 3/8" to $\frac{1}{4}$" gauge Bajri at $2\frac{1}{4}$ cft per % sft. All depressions and inequalities noticed in surfacing were made good as described further.

4th Coat :— In the final coat binder was applied at the rate of 20 lbs % sft. and blinded with fine grade Bajri 1'4" to 1/8 gauge at $1\frac{1}{2}$ cft. per % sft.

DEFECTS NOTICED DURING CONSTRUCTION AND HOW REMEDIED.

17. The defects in the surface during construction were set right as described below :—

(*a*) Although the earthwork had been thoroughly watered and consolidated yet due to settlement of the bank under the roller, some ruts and depressions appeared in the soling coat In some cases where the settlement was more pronounced the soling was dismantled and relaid after consolidating the subgrade once again. In other cases where the depressions were not very deep, the inequalities were set right by patch work with precoated Bajri. Some of the very minor depressions were also set right by simply coating with binder and blinding it with coarse bajri. Laying of one or two such repair coats removed the unevenness completely.

(*b*) It was noticed that after a number of bricks had been manufactured with a particular brick mould, the cavities in its bottom plate got filled up with mud and also in the case of wooden moulds the lugs of the plate got worn out. As a result of this some of the moulded bricks could not have grooves of the full proper size. It was therefore necessary to inspect these plates quite often and clean them or replace them as the necessity arose. For the manufacture of grooved bricks iron moulds were found to be much better than wooden ones.

(*c*) Particular attention had to be given to the size of moulds so that after burning, the bricks produced were of right dimensions, which point is of vital importance for this particular kind of construction. It is

therefore, of the highest importance that at the very start of the work, shrinkage of bricks on drying as well as on burning is carefully determined and the moulds are made of proper size, making due allowance for total shrinkage.

18. The work was originally sanctioned in 1947 at an estimated cost of Rs. 2,18,000/-, which works out to Rs. 20,100/- per mile. During the course of construction the estimate had to be revised on account of the high cost of bricks, Bajri and Binders and it was completed at a total cost of Rs. 37,000/- per mile.

19. On an average the work has been carried out on rates which were 150 % above the Schedule of Rates prevalent in the II Circle of Superintendence (Multan Circle).

COST AND RATES:

20. The cost per mile of ordinary road crust consisting of 4½" soling, 4" of wearing coat and three coats of surfacing as compared with the cost of surfacing over grooved bricks has been worked out in detail in Appendix B. An abstract of cost indicating the saving by adopting this type of specifications for minor roads as compared with the conventional roads specification is given below :—

(*a*) Cost per mile of road 10 feet wide using brick soling coat wearing coat and surfacing :—

	PER MILE
1. Cost of soling coat complete.	Rs. 11,300/-
2. Coat of Wearing coat complete.	Rs. 13,700/-
3. Cost of Surfacing complete.	Rs. 7,900/:
Total :—	Rs. 32,900/- per mile.

(*b*) Cost per mile of 10′ wide road with Bosan Road Specifications as finally adopted on this work is :—APPENDIX "C".

1. Cost of Soling coat complete.	Rs. 11,100/- per mile.
2. Cost of surfacing complete.	Rs. 9,800/- per mile.
Total :—	Rs. 20,900/- per mile.

The net saving in cost per mile by leaving out the wearing coat is Rs. 12,000/- per mile.

CONCLUSION :—

21. The main feature of the design of a road crust is that it should be sufficiently strong to support the traffic using the road without serious deformities, and should be constructed in such a way as to minimise the

effect of vertical movements due to change in the moisture content of foundation soil. The road crust under normal specifications consists of wearing coat and soling coat. The surface of the wearing coat receives the wheel load directly, and transmits it to the underlying layer. It also possesses sufficient strength to resist failure by shear under traffic, and resist abrasion under the action of the wheels. The soling coat which is laid directly on the subgrade transmits the wheel load stresses to the under lying subgrade soil strata without subjecting it to unsafe shearing stresses. It gives as well structural stability and thickness to the crust to withstand the complex stresses produced by the traffic. The crust as a whole must be waterproof and flexible to stand the wheel loads and their impact due to irregularities of the surface and frequency of the traffic called the wheel load repetition.

Crust provided on Bosan Road does not, however, possess adequate elasticity and resilience to accommodate deformation and bear shock. It, therefore, appears doubtful whether after elimination of wearing coat, which is a flexible part of the crust, the road will be able to avoid failure characterised by depressions and puncturing of the surface for want of cohesion of the road materials. The specifications adopted are, therefore, open to serious criticism on these grounds. But keeping in view that the special specifications evolved are only for light intensity of traffic, there is every reason to hope that they will stand to the test. At the time of writing the paper, a part of the road had been under traffic for nearly one year and has not so far shown any signs of failure.

In order to improve the surface, another coat of bitumen has been given within six months of the completion. As explained in the beginning these specifications have been evolved to reduce the cost of road construction on minor roads. The experiment on the whole may be said to have proved quite successful and has cut down expenditure by nearly one-third.

ACKNOWLEDGMENT :—

22. I take this opportunity to express my gratitude to Khan Muhammad Inamullah Khan, I.S.E, Chief Engineer & Secretary to Government, Punjab P.W.D, Buildings and Roads Branch, who took great pains and interest in guiding the construction of this work throughout-and helped in overcoming difficulties and made several valuable suggestions in evolving suitable specifications for this new kind of construction.

APPENDIX A

ROAD TRAFFIC CENSUS ON MULTAN BOSAN ROAD IN MULTAN DISTRICT.

NATURE OF SURFACE ...METALLED
WIDTH OF SURFACE..... .....10 Ft.
WIDTH OF FORMATION..... 24 Ft.
TOTAL WEIGHT OF ALL TRAFFIC IN 24 HOURS.....75.16 TONS.

Date & Time.	No. of motor vehicles.				No. of non-motor vehicles.		Total.	No. of Tongas Vehicles 1.5 tons.	Remarks
	Lorries & Busses over 25 seats 4 tons.	Busses upto 25 seats 3 tons.	Cars 1.5 tons.	Total Cars and Lorries.	Two wheels carts				
					with iron tyres 1.5 tons	without iron tyres 1.5 tons.			
1	2	3	4	5	6	7	8	9	10
23-10-51 9-A.M. to 24-10-51 9-A.M.	2	2	20	24	28	30	58	70	
24-10-51 0-A.M. to 25-10-51 0-A.M.	2	2	18	22	26	27	53	80	
25-10-51 9-A.M. to 26.19-51 9.A.M.	2	2	16	20	20	19	39	69	
Total ...	6	6	54	66	74	76	150	219	
Average ...	2	2	18	22	24-2/3	25.1/3	50	73	
Weight (in tons) ...	8	6	27	(41)	37	38	(75)	(109.5)	

WEIGHT 10 FEET WITHIN 24 HOURS.....75.16 TONS.

APPENDIX B

Cost of road crust per mile 10 ft. wide with conventional specification of $4\frac{1}{2}$" thick brick soling, 4" stone metalling and 3 spray coats.

Average lead three miles pucca and six miles kuccha.

Soling Coat.

		Rs.	a.	p.	Rs.	a.	p.
(*a*) $1 \times 5280 \times 11 \times 3/8 = 21780$ cft. at 1400 bricks per $\frac{9}{10}$ cft. = 304910 Nos. at 32/- per $\frac{0}{0}$0 Nos.	...	9759	0	0			
(*b*) Preparing subgrade 53 chains at Re. 1/- per chain	...	53	0	0			
(*c*) Consolidation of soling = 21780 cft. at Rs. 2/8/- $\frac{0}{0}$ cft.	...	545	0	0			
Add premium on items *b* & *c* above *i.e.* 598 at 150%	...	897	0	0			
Total	...	11354	0	0	11354	0	0

Wearing Coat.

$1 \times 5280 \times 10 \times 1/3 = 17800$ cft. at Rs. 68/4/- $\frac{9}{10}$ cft.	...	12012	0	0			
Consolidation of stone metal = 17600 cft. at Rs. 3/12/- $\frac{9}{10}$ cft.	...	660	0	0			
Add premium at 150%	...	990	0	0			
Total	..	13662	0	0	13662	0	0

Surface Treatment

BINDER

$\frac{1 \times 5280 \times 10 \times 57}{2240 \times 100} = 13.44$ tons at Rs 265/- per ton ... 3562 0 0

BAJRI

$\frac{1 \times 5280 \times 10 \times 7}{100} = 3700$ cft. at Rs. 100/- $\frac{9}{10}$ cft. ... 3700 0 0

LABOUR

$1 \times 5280 \times 10 = 52800$ sft. at Rs. -/7/6 per $\frac{9}{10}$ sft.	...	248	0	0			
Add 150% premium on 248/-	...	372	0	0			
Total	...	7882	0	0	7882	0	0
Grand Total	...				32,898	0	0
Say	...				32,900	0	0

APPENDIX C

Analysis of cost of road crust per mile of Multan—Bosan Road—width - 10 ft.

Average lead three miles pucca and six miles kaccha.

		Rs.	a.	p.	Rs.	a.	p.
Soling Cost.							
With grooved bricks							
1. $1 \times 5280 \times 10 \times 3/8 - 19800$ cft. at 1400 bricks per % cft. = 277200 Nos. at Rs. 35/- %0 Nos.	...	9702	0	0			
2. Preparing subgrade = 53 chains at Re. 1/- per chain	...	53	0	0			
3. Laying and consolidation of bricks soling 19800 cft. at Rs 2/8/- % cft.	...	495	0	0			
Total	...	548	0	0			
Add premium at Rs. 150/- on 2 & 3	...	822	0	0			
Total	...	1370	0	0			
G. Total	...	11072	0	0	11072	0	0
Surface Treatment.							
MATERIAL							
Tack cost shalmac MC 4. $1 \times 5280 \times 10 = 52800$ sft. at 22 lbs. % sft. = 5.6 ton. at Rs. 265/- per tons	...	1484	0	0			
B. S. Shalspra $\frac{}{(17+25+20)} = 62$ lbs. per % sft. $= 14.6$ Tons at 265/-	...	3869	0	0			
BAJRI							
$\frac{5280 \times 10 \times 7}{100} = 3700$ cft at Rs. 100/- % c.ft.	...	3700	0	0			
LABOUR							
For spray of shalmac at 22 lb. $5280 \times 10 = 52800$ at 0/1/- per % s.ft.	...	33	0	0			
For spray of 3 coats of bituman 51800 × -/7/6 % sft.	...	248	0	0			
Add premium at 150/- % on labour *i.e.* 281/-	...	422	0	0			
Total	...	9756	0	0	9756	0	0
Grand Total per mile 10 ft. wide	...				20828	0	0
Say	...				20900	0	0

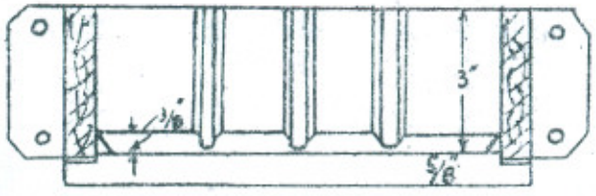
APPENDIX D

Analysis of rate for 1,000 Nos. 9″ × 4½″ × 3″ specially moulded grooved bricks supplied in stacks at site on Bosan road

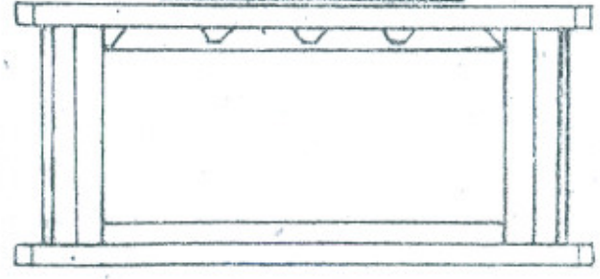
		Rs. A.	Rs. A.
1.	Cost of coal 25 Tons at 45/- per ton including carriage to kiln site ...	12 8	
2.	Iron (chimney's mould etc) ...	0 12	
3.	Cost of erecting kiln and payment for lease of land ...	1 0	
4.	Moulding of bricks ...	4 8	
5.	Kiln loading (Carriage of bricks to kiln) ...	1 8	
6.	Arranging bricks in proper manner and providing covering of kiln ...	1 0	
7.	Unloading of kiln ...	1 4	
8.	Burning of bricks (labour) ...	2 4	
9.	Providing water, moulds and cottages, etc. for labour and work ...	2 4	
10.	Stacking of burnt bricks outside kiln ...	0 8	
11.	Providing sand ...	0 8	
12.	Establishment charges and petty items including contractor's profit ...	0 8	
	Total cost of bricks at site of kiln ...	29 0	per % Nos.
13.	Carriage to road side at 6 ‰ Nos. ...	6 0	
	Total at roadside ...	35 0	per ‰ Nos.

PAPER No 296

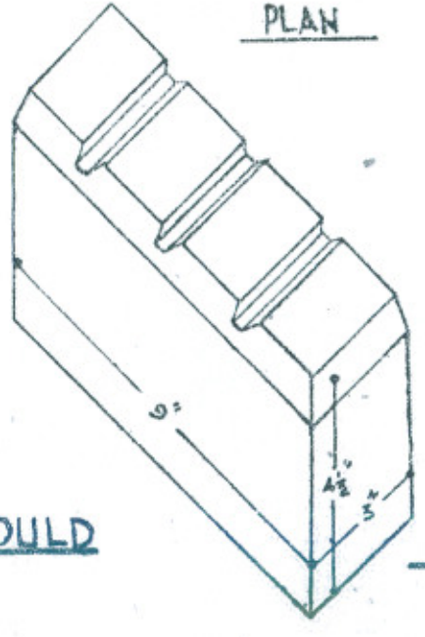
PLATE I



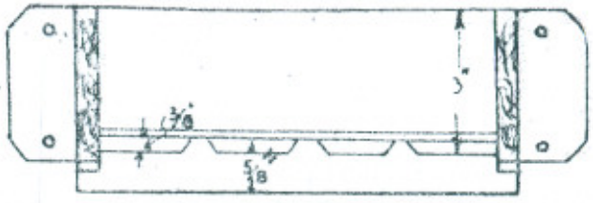
SECTIONAL ELEVATION
SCALE 3" = 1 FT:



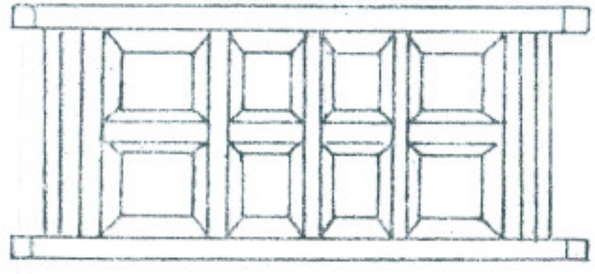
PLAN



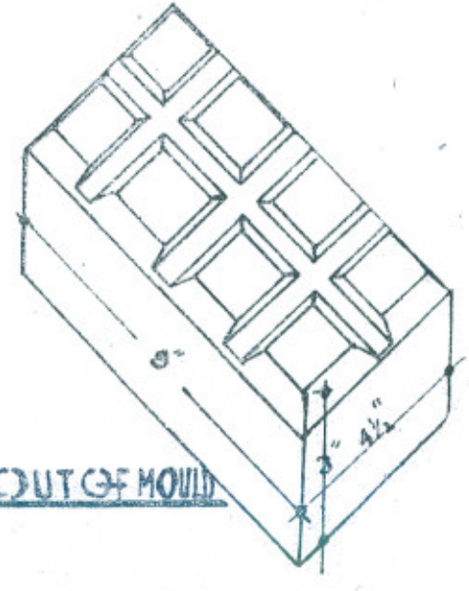
BRICK TURNED OUT OF MOULD
SCALE 3" = 1 FT:



SECTIONAL ELEVATION
SCALE 3" = 1 FT:



PLAN



BRICK TURNED OUT OF MOULD

