COST CALCULATION OF CONSTRUCTION TECHNIQUES USED IN BMTRC

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INTRODUCTION: All the costs calculated in this report are based on informations collected during the construction phase of BMTRC from June 90 until March 91. The date of reference for the cost of the materials is the 15.12.90.

Of course the construction costs may vary from one site to another and they have to be calculated for each different project taking into account the cost of local materials, the transportation problems, the availability of water, the need of equipment and so on...

For more detailed informations concerning the technical options and the work output please refer to "Fazel's technical report" and to "Output/BMTC progress report" July 1991.
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COST OF PLASTERING 1m² OF WALL WITH MUD PLASTER (KAH GEL)

COST OF WOODEN REINFORCEMENT ANGLE
COST OF MATERIALS:

Materials delivered in BMTC. Reference date = 15.12.90

Soil = 1 truck 3.90m X 2m X 0.70m = 5.46m³/250Rs = 45.8Rs/m³
Sand = 1 truck 3.90m X 2m X 0.70m = 5.46m³/600Rs = 109.9Rs/m³
Gravel = 1 truck 3.90m X 2m X 0.60m = 4.68m³/350Rs = 74.8Rs/m³
Water = free on the site
Grey cement = 92Rs/bag of 50Kg => 92 Rs/bag
White cement = 145Rs/bag of 50Kg => 145Rs/bag
COEFFICIENTS AND LOSSES:

Mud (screening + mixing) = 1.2
Sand (mixing) = 1.05
Gravel (mixing) = 1.05
Mortar (lost during masonry work) = 1.1
Stabilized bricks (broken during masonry work) = 1.1
29.5 X 14 X 9.5
Stabilized bricks (broken during masonry work) = 1.05
22 X 10.5 X 5.5
Unstabilized bricks (broken during masonry work) = 1.15
Mud (lost during production of mud bricks) = 1.1
Sun dried bricks (broken during masonry work) = 1.15
COST OF BRICKS 29.5 X 14 X 9.5
UNSTABILIZED

Recipe = 8 wheel barrows of soil + 2WB of gravel + 2WB of sand = 840L.

MA Soil = 560L x 1.2 = 672L x 45.8Rs/m³ = 30.8Rs
Gravel = 140L x 1.05 = 147L x 74.8Rs/m³ = 11Rs
Sand = 140L x 1.05 = 147L x 109.9Rs/m³ = 16.2Rs
Cement =
Water = available on the site = free
Total = 58Rs

With 840L of mix we produce 132 bricks => 58Rs / 132b = 0.44Rs/brick

LA 11 labourers produce 1400 bricks/day (including the transportation of the bricks to the storage area).
11 x 40Rs. = 440 Rs. b/day = 0.31 Rs./brick

EC (Equipment + charges)
Brick press = 0.4 Rs./b
Transport of press = 0.04 Rs./b
Production area = 0.04 Rs./b
Tools = 0.014 Rs./b
Diesel = 0.01 Rs./b
Maintenance = 0.02 Rs./b

MA + LA + EC = 0.524 Rs./brick

1.27 Rs./brick
COST OF BRICKS 29.5 X 14 X 9.5
STABILIZED AT 4.5% OF CEMENT

Recipe = 7 wheel barrows of soil + 4WB of gravel + 1.5WB of sand + 50Kg of cement.

MA

Soil = 490L X 1.2 = 588L X 45.8Rs./m$^3$ = 26.9Rs.
Gravel = 280L X 1.05 = 294L X 74.8Rs./m$^3$ = 22Rs.
Sand = 105L X 1.05 = 110L X 109.9Rs./m$^3$ = 12.1Rs.
Cement =
Water = free.

Total = 153Rs.

With 875L of mix we produce 137.5 bricks => 153Rs:137.5 = 1.1Rs./brick

LA

11 labourers produce 1400 bricks/day (including the transportation of the bricks to the storage area).
11 X 40Rs. = 440Rs. : 1400 = 0.31Rs./brick

EC (Equipment + Charges)

Brick press = 0.4Rs/b
Transport of press = 0.04Rs/b
Production area = 0.04Rs/b
Tools = 0.014Rs/b
Plastic = 0.043Rs/b
Diesel = 0.01Rs/b
Maintenance = 0.02Rs/b

0.57Rs/brick

MA + LA + EC = 1.98Rs/brick
COST OF BRICKS 29.5 X 14 X 9.5
STABILIZED AT 6% OF CEMENT

Recipe: 6WB of soil + 3WB of gravel + 1WB of sand + 50kg of cement.

MA

Soil = 420L x 1.2 = 504L x 45.8Rs/m³ = 23.08Rs.
Gravel = 210L x 1.05 = 220L x 74.8Rs/m³ = 16.45Rs.
Sand = 70L x 1.05 = 73.5L x 109.9Rs/m³ = 8.07Rs.
Cement = = 92Rs.
Water = = free.

Total = 139.6Rs.

With 700L of mix we produce 110 bricks => 139.6Rs : 110

= 1.27Rs/brick

LA (See bricks stabilized at 4.5% of cement).

0.31Rs/brick

EC (See bricks stabilized at 4.5% of cement).

0.57Rs/brick

MA + LA + EC = 2.15Rs/brick
COST OF MORTAR STABILIZED AT 11% OF CEMENT PER WEIGHT OF SOIL

Recipe = 2 wheel barrow of course sand + 1 wheel barrow of fine sand + 2 wheel barrow of soil + 50kg of cement.

**MA** (Materials)

1m³ of mortar is made of 1200 liters of aggregates.
Gravel = 480L X 1.05 (coefficient of loss) = 504L X 74.8Rs/m³ = 37.7Rs
Sand = 240L X 1.05 (coefficient of loss) = 252L X 109.9Rs/m³ = 27.7Rs
Soil = 480L X 1.2 (coefficient of loss) = 576L X 45.8Rs/m³ = 26.4Rs
Cement = 171.5Kg X 1.84Rs = 315.6Rs
Water = = free
Total = 407.4Rs/m³

**LA** (Labour)

1 labourer prepares 1.5m³ of mortar per day (including the screening and the delivery).
40Rs (daily wages) : 1.5 = 26.7Rs/m³

**MA** + **LA** = 434.1Rs/m³
COST OF WALL (THICKNESS 0.14m)
MADE OF BRICKS 29.5 X 14 X 9.5
STABILIZED AT 4.5% OF CEMENT

MA
\[31b/m^2 \times 1.1 \text{ (breakage)} = 34b \times 1.98Rs = 67.32Rs\]
\[26L/m^2 \times 1.1 \text{ (loss)} = 29L \times 434.1Rs/m^3 = 12.59Rs\]
\[79.9Rs/m^2\]

LA
1 mason + 1 labourer build 7.8m²/day.
\[100Rs + 40Rs : 7.8 = 17.95Rs/m^2\]

\[MA + LA = 97.86Rs/m^2\]
COST OF WALL (THICKNESS 0.14m) MADE OF BRICKS 29.5 X 14 X 9.5 STABILIZED AT 6% OF CEMENT

MA

31b/m² X 1.1 (breakage) = 34b X 2.15Rs = 73.1Rs

26L/m² X 1.1 (loss) = 29L X 434.1Rs/m³ = 12.59Rs

85.69Rs/m²

LA

1 mason + 1 labourer build 7.8m² / day.

100Rs + 40Rs : 7.8 = 17.95Rs/m²

MA + LA = 103.64Rs/m²
COST OF WALL (THICKNESS 0.3m) MADE
OF BRICK 29.5 X 14 X 9.5 STABILIZED AT
4.5% OF CEMENT

\[
\begin{align*}
\text{MA} & \quad 62b/m^2 \times 1.1 \text{ (breakage)} = 68b \times 1.98Rs = 134.64Rs \\
& \quad 67L/m^2 \times 1.1 \text{ (loss)} = 74L \times 434.1Rs/m^3 = 32.1Rs \\
& \quad \text{166.9Rs/m}^2
\end{align*}
\]

\[
\begin{align*}
\text{LA} & \quad 1 \text{ mason + 1 labourer build 3.9m}^2/\text{day.} \\
& \quad 100Rs + 40Rs : 3.9 = 35.9Rs/m^2
\end{align*}
\]

\[
\begin{align*}
\text{MA} + \text{LA} & = 202.66Rs/m^2
\end{align*}
\]
COST OF WALL (THICKNESS 0.3m) MADE OF BRICK 29.5 X 14 X 9.5 STABILIZED AT 6% OF CEMENT

\[
\text{MA} \quad 62b/m^2 \times 1.1 \text{ (breakage)} = 68b \times 2.15Rs = 146.2Rs
\]
\[
67L/m^2 \times 1.1 \text{ (loss)} = 74L \times \text{434.1Rs/m}^3 = 32.12Rs
\]
\[
\text{MA} + \text{LA} = 178.32Rs/m^2
\]

See wall of 0.30m made with bricks
29.5 X 14 X 9.5 stabilized at 4.5% of cement.
\[
35.9m^2
\]
\[
\text{MA} + \text{LA} = 214.22Rs/m^2
\]
COST OF WALL (THICKNESS = 0.45m) 
MADE OF UNSTABILIZED BRICKS 29.5 X 14 X 9.5

**MA**
93 bricks/m² X 1.15 (breakage) = 107b.
108L of mortar X 1.1(loss) = 119L.
107b X 1.27Rs/b = 135.89Rs
119L X 434.1Rs/m³ = 51.66Rs

\[ \text{Total Cost} = 187.55\text{Rs/m}² \]

**LA**
1 mason + 1 labourer build 2.6m² in one day.
100Rs + 40Rs : 2.6m² = 53.87Rs/m²

\[ \text{Total Cost} = 241.4\text{Rs/m}² \]
COST OF WALL (THICKNESS = 0.45m) MADE OF 60% OF BRICKS 29.5 X 14 X 9.5 STABILIZED AT 4.5% OF CEMENT AND 40% OF UNSTABILIZED BRICKS:

\[
\text{MA} \quad 65b \times 1.1 \text{ (breakage)} = 62b \times 1.98\text{Rs} = 122.76\text{Rs}.
\]
\[
37b \times 1.15 \text{ (breakage)} = 43b \times 1.27\text{Rs} = 54.61\text{Rs}.
\]
\[
108L \times 1.1 \text{ (loss)} = 119L \times 434.1\text{Rs/m}^3 = 51.66\text{Rs}.
\]

\[
\text{Total: } 229.03\text{Rs/m}^2
\]

\[
\text{LA} \quad \text{(See wall made of unstabilized bricks)}.
\]
\[
53.85\text{Rs/m}^2
\]

\[
\text{MA} + \text{LA} = 282.88\text{Rs/m}^2
\]
COST OF WALL (THICKNESS = 0.45m) MADE OF BRICKS 29.5 X 14 X 9.5 STABILIZED AT 4.5% OF CEMENT

\[
\begin{align*}
\text{MA} & \quad 93\text{b/m}^2 \times 1.1 \text{ (breakage)} = 102\text{b} \times 1.98\text{Rs} = 201.96\text{Rs/m}^2 \\
& \quad 108\text{L} \times 1.1 \text{ (loss)} = 119\text{L} \times 434.1\text{Rs/m}^3 = 51.66\text{Rs/m}^2 \\
& \quad \text{253.62Rs/m}^2 \\
\text{LA} & \quad (\text{See wall made of unstabilized bricks}). \\
& \quad 53.85\text{Rs/m}^2 \\
\text{MA} + \text{LA} & \quad 307.47\text{Rs/m}^2
\end{align*}
\]
COST OF WALL (THICKNESS = 0.45m) MADE OF BRICKS 29.5 X 14 X 9.5 STABILIZED AT 6% OF CEMENT

\[ MA \quad 93b/m^2 \times 1.1 \text{ (breakage)} = 102b \times 2.15Rs = 219.3Rs. \]
\[ 108L \times 1.1 \text{ (loss)} = 119L \times 434.1Rs/m^3 = 51.66Rs/m^2 \]
\[ \text{Total Cost} = 270.96Rs/m^2 \]

LA (See wall made of unstabilized bricks).
\[ 53.85Rs/m^2 \]

\[ MA + LA = 324.81Rs/m^2 \]
COST OF MORTAR FOR OUTSIDE POINTING

Recipe: 2 wheel barrows of fine sand + 1 bag of cement.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>1.2m$^3$ X 1.1 (coefficient loss)</td>
<td>1.32m$^3$</td>
<td>109.9 Rs</td>
<td>145.07 Rs</td>
</tr>
<tr>
<td>Cement</td>
<td>500 kg</td>
<td>500 kg</td>
<td>1.84 Rs/kg</td>
<td>920 Rs</td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td>free</td>
<td></td>
<td>free</td>
</tr>
</tbody>
</table>

Total = 1065.1 Rs/m$^3$

1 labourer produces 2.5m$^3$ of mortar/day.

40 Rs : 2.5m$^3$ = 16 Rs/m$^3$

MA + LA = 1081 Rs/m$^3$
COST OF POINTING 1m² OF WALL MADE OF STABILIZED BRICKS 29.5 X 14 X 9.5 (OUTSIDE POINTING)

Horizontal joints = 9m

Vertical joints = 4.5 joints X 0.09m X 9 lays = 3.645m

\[ 12.645m \times 0.015 \times 0.015 \times 1.2 (\text{loss coefficient}) = 0.0034m^3 \]

\[ 0.0034m^3 \times 1018.1Rs/m^3 = 3.7Rs/m^3 \]

1 mason does the pointing of 5m²/day.

100Rs : 5m² = 20Rs/m²

MA + LA = 23.7Rs/m²
COST OF BRICK 29.5 X 14 X 6 STABILIZED AT 7% OF CEMENT FOR ARCHES AND ARCH LINTELS

Recipe: 5WB of soil + 2WB of gravel + 1WB of sand + 50kg of cement.

<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity</th>
<th>Loss</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil</td>
<td>350L</td>
<td>1.2</td>
<td>19.24Rs.</td>
</tr>
<tr>
<td>Gravel</td>
<td>140L</td>
<td>1.05</td>
<td>10.99Rs.</td>
</tr>
<tr>
<td>Sand</td>
<td>70L</td>
<td>1.05</td>
<td>8.08Rs.</td>
</tr>
<tr>
<td>Cement</td>
<td>1 bag</td>
<td></td>
<td>92Rs.</td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
<td>free</td>
</tr>
</tbody>
</table>

With 560L of mix we produce 140 bricks 29.5 X 14 X 6

130.31Rs : 140b = 0.93Rs/brick

(See cost of bricks 29.5 X 14 X 9.5).

0.31Rs/brick

(Equipment + charges)

(See cost of bricks 29.5 X 14 X 9.5).

0.057Rs/brick

MA + LA + EC = 1.81Rs/brick
COST OF MORTAR STABILIZED AT 13% OF CEMENT FOR ARCHES AND VAULTS (200KG OF CEMENT / m³)

MA  Sand 720L X 1.05 (loss) = 756L X 45.8Rs = 83.08Rs.
     Soil 480L X 1.2 (loss) = 576L X 45.8Rs = 26.38Rs.
     Cement 200kg X 1.84Rs = 368Rs.
     Water  free = free.

LA  1 sabourer prepares 1.5m³ of mortar/day (including the screening and the delivery).
     40Rs : 1.5 = \[\frac{26.7\text{Rs}}{\text{m}^3}\]

MA  +  LA  = \[\frac{504.16\text{Rs}}{\text{m}^3}\]
COST OF WHITE CONCRETE FOR ARCHES AND LINTELS KEYS

Gravel 800L X 1.05 (loss) = 840L X 74.8Rs = 62.83Rs.
Sand 400L 1.05 (loss) = 420L X 109.9 = 46.16Rs.
Cement 250kg/m³ X 2.9Rs = 725Rs.

(Same as for mortar)

MA + LA = 860.69Rs/m³
COST OF ARCH LINTEL 0.94m X 0.45m (THICKNESS) MADE OF BRICK 29.5 X 14 X 6 STABILIZED AT 7% OF CEMENT

\[ \text{MA} \quad 14b + 14 \text{ Half } b = 21b \times 1.1 \text{ (breakage)} = 23b \times 1.81 \text{Rs} = 41.63 \text{Rs} \]

Mortar = 0cm at the intrados/2cm at the extrados -> 1cm

1.5cm thickness between the bricks.

\[ 0.14 \times 0.295 = 0.0413 \times 0.01 = 0.000413 \text{m}^3 \times 14b = 0.00578 \text{m}^3 \]
\[ 0.14 \times 0.06 = 0.0084 \times 0.015 \times 0.000126 \text{m}^3 \times 7b = 0.000882 \text{m}^3 \]

Total = 0.006662\text{m}^3

\[ 0.006662 \text{m}^3 \times 1.1 \text{ (loss)} = 0.00733 \times 504.16 \text{Rs/m}^3 = 3.69 \text{Rs} \]

White concrete = 0.14 X 0.13 X 0.45 = 0.00819 \text{m}^3 \times 860.69 \text{Rs} = 7.05 \text{Rs}

\[ \text{MA} = 52.37 \text{Rs} \]

\[ \text{LA} \quad 1 \text{ mason + 1 labourer make 2 lintels/day.} \]

\[ 140 \text{Rs} : 2 = 70 \text{Rs/lintel} \]

\[ \text{MA} + \text{LA} = 122.04 \text{Rs/lintel} \]

NOTE: This calculation doesn’t take into account the depreciation cost of the wooden form and the use of the girder machine for cutting the bricks.
COST OF ARCH (SPAN = 2.18m) AND THICKNESS = 0.45m) MADE OF BRICKS 29.5 X 14 X 6 STABILIZED AT 7% OF CEMENT

**MA** 156 bricks X 1.1 (breakage) = 178b X 1.81Rs = 311.32Rs

Mortar: At the intrados = 0cm. > Average = 1.5cm.
At the extrados = 3cm.
Between the bricks = 1.5cm.

0.45 X 0.30 X 0.015 = 0.002025 X 50 lays = 0.10125m³
0.295 X 0.06 X 0.015 = 0.000531 X 50 says = 0.02655m³

0.1278m³ X 1.1 (loss) = 0.13149m³ X 504.16Rs/m³ = 67.65Rs

White concrete key:

0.45 X 0.30 X 0.15 = 0.02025m³ = 17.43Rs

**MA** = 396.4Rs

**LA** 2 masons + 2 labourers build 1 arch in one day.

(2 X 100Rs) + (2 X 40Rs) = 280Rs/Arch

**MA** + **LA** = 676.4Rs/Arch

**NOTE:** This calculation doesn’t take into account the depreciation cost of the wooden form.
COST OF BRICK 22 X 10.5 X 5.5 STABILIZED AT 6% OF CEMENT FOR VAULTED ROOF

Recipe: 6 Wheel barrows of soil + 3WB of gravel + 1WB of sand + 50kg of cement.

**MA**

Soil 420L X 1.2 (loss) = 504L X 45.8Rs/m³ = 23.08Rs.

Gravel 210L X 1.05 (loss) = 220L X 74.8Rs/m³ = 16.45Rs.

Sand 70L X 1.05 (loss) = 73.5L X 109.9Rs/m³ = 8.07Rs.

Cement 1 bag = 92Rs.

Water = free.

139.6Rs

Based on the informations provided by the brick production officer we produced an average of 336 bricks/bag of cement.

139.6Rs : 336 = 0.415Rs/brick

**LA**

11 labourers produce 2800 bricks/day (including the transportation of the bricks to the storage area.)

11 X 40Rs = 440Rs : 2800b = 0.157Rs/brick

**EC**

(Equipment + Charges)

(See bricks of 29.5 X 14 X 9.5 stabilized at 4.5% of cement)

0.57Rs : 2 (because we produce 2 times more small bricks) = 0.285Rs/b

MA + LA + EC = 0.86Rs/brick
COST OF VAULTED ROOF MADE OF BRICKS 22 X 10.5 X 5.5 STABILIZED AT 6% OF CEMENT ON CONCRETE GIRDER

Calculation for one room 3m X 3m / 3 3 vaults of 1m span.
2 concrete girders (4" X 10" section) X 11 X 35.5Rs/ft = 781Rs
Bricks: 130 bricks/vault X 1.05(breakage) = 137b X 3 vaults = 411 bricks

411b X 0.86Rs = 353.46Rs

Mortar:
0.105 X 0.055 X 0.01 = 0.0000577X130bX3 = 0.022503m³
0.22 X 0.055 X 0.01 = 0.000121X 130bX3 =0.04719m³
0.069693 X 1.1 (loss) = 0.0766623m³ X 504.16Rs/m³ = 38.65Rs

MA = 1173.11Rs : 9m² = 130.35Rs/m²

LA 1 mason + 2 labourers build 1 room/day.
180Rs : 9m² = 20Rs/m²

MA + LA = 150.35Rs/m²
COST OF MORTAR FOR INSIDE POINTING

Recipe: 3 Wheel barrows of fine sand + 1 bag of cement.

\[
\text{MA \ Sand } 1.2 \text{m}^3 \times 1.1 (\text{coefficient loss}) = 1.32 \text{m}^3 \times 109.9 \text{Rs} = 145.07 \text{Rs}
\]
\[
\text{Cement} = 333 \text{kg} \times 184 \text{Rs/kg} = 612.72 \text{Rs}
\]
\[
\text{Water} \quad \text{free}
\]
\[
\text{Total} = 757.8 \text{Rs}
\]

\[
\text{LA} \quad \text{1 labourer produces } 2.5 \text{m}^3 \text{ of mortar/day.}
\]
\[
40 \text{Rs} : 2.5 \text{m} = 16 \text{Rs/m}^3
\]

\[
\text{MA} + \text{LA} = 773.85 \text{Rs/m}^3
\]
COST OF POINTING 1m² OF VAULTED ROOF (INSIDE POINTING)

\[
\begin{align*}
\text{MA} & \quad 0.01 \times 0.01 \times 0.22 = 0.000022m^3 \quad \rightarrow 0.0000325m^3 \\
& \quad 0.01 \times 0.01 \times 0.105 = 0.0000105m^3 \\
& \quad 0.0000325m^3 \times 45b \times 1.2 \text{ (loss)} = 0.0018m^3 \text{ of mortar/m}^2 \\
& \quad 0.0018 \times 773.8\text{Rs/m}^3 = 1.4\text{Rs/m}^2 \\
\end{align*}
\]

1 mason does the pointing of 4m² of vault (including the preparation of support + cleaning.)

100Rs : 4m² = 25Rs/m²

\[
\begin{align*}
\text{MA} & \quad + \quad \text{LA} \\
& \quad = 26.4\text{Rs/m}^2
\end{align*}
\]
COST OF SUN DRIED BRICKS 22 X 10.5 X 5.5

\[
\begin{align*}
22 \times 10.5 \times 5.5 &= 0.00127 \text{m}^3 \\
\text{Soil: } 0.00127 \text{m}^3 \times 1.2 \text{ (coefficient of unmolded soil)} \times 1.1 \text{ (loss)} &= 0.00167 \text{m}^3 \\
0.00167 \text{m}^3 \times 45.8 \text{Rs/m}^3 &= 0.076 \text{Rs/brick} \\
\text{Water: free} \\
\text{Sand for molding: } 0.1 \text{m}^3/1000 \text{ bricks} \times 0.1 \text{m}^3 \times 109.9 \text{Rs} &= 10.99 \text{Rs} \\
10.99 \text{Rs} : 1000 \text{b} &= 0.011 \text{Rs/brick} \\
\text{Cost} &= 65 \text{Rs/1000 bricks (contract)} \\
65 \text{Rs} : 1000 \text{b} &= 0.065 \text{Rs/brick} \\
\text{Tools} &= 1 \text{ wheel barrow} = 850 \text{Rs} \\
2 \text{ shovels} &= 100 \text{Rs} \\
1 \text{ pick} &= 70 \text{Rs} \\
2 \text{ buckets} &= 60 \text{Rs} \\
1 \text{ mold} &= 150 \text{Rs} \\
\text{----------} \\
1230 \text{Rs} \\
\text{Depreciation cost calculation on 1 year} = 264 \text{ days} \times 1000 \text{b/day} = 264000 \text{ bricks} \\
1230 \text{Rs} : 264000 \text{b} &= 0.005 \text{Rs/brick} \\
\text{MA} + \text{LA} + \text{EC} &= 0.157 \text{Rs/brick}
\end{align*}
\]
COST OF MUD MORTAR

MA

1m³ of mortar.

1m³ soil X 1.2 (coefficient of work ability) X 1.1 (coefficient of loss) = 1.32m³

1.32m³ X 45.8Rs = 60.46Rs/m³

LA

1 labourer prepares 2.5m³ of mud mortar/day.

40Rs : 2.5m³ = 16Rs/m³

MA + LA = 76.46Rs/m³
COST OF A WALL 0.465m THICKNESS MADE OF SUN DRIED BRICKS

**MA** Bricks: 208b/m² × 1.15 (coefficient of breakage) = 239b.

\[
239b \times 0.157\text{Rs} = 37.52\text{Rs}
\]

Mortar: 0.171m³/m² × 1.1 (coefficient of loss) = 0.188m³

\[
0.188\text{m}^3 \times 76.46\text{Rs} = 14.37\text{Rs}
\]

\[
\text{MA} = 51.89\text{Rs/m}^2
\]

**LA** 1 mason + 2 labourers build 5.3m² of wall/day.

\[
180\text{Rs} : 5.3\text{m}^2 = 33.96\text{Rs/m}^2
\]

\[
\text{MA} + \text{LA} = 85.85\text{Rs/m}^2
\]
COST OF A WALL OF 0.585m THICKNESS MADE OF SUN DRIED BRICKS

**MA** Bricks : 260b/m² X 1.15 = 299b

\[ 299b \times 0.157\text{Rs} = 46.94\text{Rs} \]

Mortar : 0.223m³/m² X 1.1 (coefficient of loss) = 0.245m³

\[ 0.245\text{m}^3 \times 76.46\text{Rs} = 18.75\text{Rs} \]

\[ \text{MA} = 65.69\text{Rs/m}^2 \]

**LA** 1 mason + 2 labourers build 4.2m² of wall/day.

\[ 180\text{Rs} : 4.2\text{m}^2 = 42.85\text{Rs/m}^2 \]

\[ \text{MA} + \text{LA} = 108.55\text{Rs/m}^2 \]
COST OF A WALL OF 0.71m THICKNESS MADE OF SUN DRIED BRICKS

\[
\text{MA} \quad \text{Bricks} : 312b/m^2 \times 1.15 = 359b \times 0.157Rs = 56.36Rs
\]

\[
\text{Mortar} : 0.267m^3 \times 1.1 = 0.294m^3 \times 76.46m^3 = 22.48Rs
\]

\[
\text{MA} = 78.84Rs/m^2
\]

\[
\text{LA} \quad 1 \text{ mason} + 2 \text{ labourers build } 3.53m^2 \text{ of wall/day.}
\]

\[
180Rs : 3.53m^2 = 50.99Rs/m^2
\]

\[
\text{MA} + \text{LA} = 129.83Rs/m^2
\]
COST OF WALL 0.70m THICKNESS MADE OF PAKHSA (MASS CLAY)

**MA**

Soil 0.8m$^3$ X 1.1 (loss) X 45.8Rs/m$^3$ = 40.30Rs.
Gravel 0.4m$^3$ X 1.1 (loss) X 74.8Rs/m$^3$ = 32.91Rs.
Water = free.

Total = 73.21Rs/m$^3$

**NOTE:** As we consider that the thickness of the rough wall (before cutting) is 0.80m, no other loss coefficient should be added for the building process.

1m$^2$ of mass clay wall = 2m length X 0.8m thickness
X 0.5m height = 0.8m$^3$

73.21Rs $\times$ 0.8m$^3$ = \boxed{58.57Rs/m$^2$}

**LA**

2 options for pakhsa are possible:

1) mixing with cow.
2) mixing without cow.

1) 1 mason + 3 labourers + 1 cow (with the cowkeeper) make 5m$^2$/day.

100Rs + 120Rs + 140Rs = 360Rs : 5 = \boxed{72Rs/m^2}

2) 1 mason + 3 labourers make 5m$^2$/day.

100Rs + 120Rs = 220Rs : 5 = \boxed{44Rs/m^2}

**MA** + **LA** : option 1) \boxed{130.6Rs/m^2}

option 2) \boxed{102.6Rs/m^2}
COST OF SUN DRIED BRICKS 25 X 25 X 5.5

\[ 25 \times 25 \times 5.5 = 0.00344 \text{m}^3 \]

Soil = \[ 0.00344 \text{m}^3 \times 1.2 \text{ (coefficient of unmolded soil)} \times 1.1 \text{ (loss)} = 0.00454 \text{m}^3 \]
\[ 0.00454 \text{m}^3 \times 45.8 \text{Rs/m}^3 = 0.208 \text{Rs/brick} \]

Water = free

Sand for molding = \[ 0.2 \text{m}^3 /1000 \text{ bricks} \] \[ 0.2 \text{m}^3 \times 109.9 \text{Rs} = 21.98 \text{Rs} \]
\[ 21.98 \text{Rs} : 1000 \text{ b} = 0.022 \text{Rs/brick} \]

\[ \text{MA} = 0.23 \text{Rs/brick} \]

Cost = 170Rs/1000 bricks (contract)
\[ 170 \text{Rs} : 1000 \text{ b} = 0.17 \text{Rs/brick} \]

Tools = 1 wheel barrow = 850Rs.
2 shovels = 100Rs.
1 pick = 70Rs.
2 buckets = 60Rs.
2 molds = 300Rs.
\[ \text{---------} \]
\[ 1380 \text{Rs} \]

Depreciation cost calculation on 1 year = 264 days \times 750b/day
\[ = 198000 \text{bricks} \]
\[ 1380 \text{Rs} : 198000 \text{ b} = 0.007 \text{Rs/brick} \]

\[ \text{MA} + \text{LA} + \text{EC} = 0.407 \text{Rs/brick} \]
COST OF GUNBAD ROOF

**MA**  Bricks: 100b (25 X 25 X 5.5)/m²

\[
100b \times 1.15 \text{ (breakage)} = 115b \times 0.41 = 47.15\text{Rs/m}^2
\]

Mortar: 0.0012125m³ X 100b = 0.12125 X 1.1 = 0.133m³ X 7646Rs

\[
10.17\text{Rs/m}^2
\]

Plaster: (first cost)

\[
0.025m³/m² \times 1.1 = 0.0275m³ \times 76.47\text{Rs} = 2.1\text{Rs/m}²
\]

\[
\text{MA} = 59.42\text{Rs/m}²
\]

**LA**  1 mason + 6 labourers build 1 gunbad (18m²)/day.

340Rs : 18m² = 18.88Rs/m²

\[
\text{MA} + \text{LA} = 78.3\text{Rs/m}²
\]
COST OF MUD PLASTER

Recipe: Soil 800L + Sand 400L + Straw 70kg.

\[
\begin{align*}
\text{Soil} &= 800\text{L} \times 1.05 = 840\text{L} \times 45.8\text{Rs/m}^3 = 38.47\text{Rs.} \\
\text{Sand} &= 400\text{L} \times 1.05 = 420\text{L} \times 109.9\text{Rs/m}^3 = 46.16\text{Rs.} \\
\text{Straw} &= 70\text{kg} \times 1.25\text{Rs/kg} = 87.5\text{Rs.} \\
\text{Water} &= 200\text{L} = \text{free.}
\end{align*}
\]

Total = 172.13Rs

1 labourer prepares 2.5m$^3$ of mud plaster/day.

\[
40\text{Rs} : 2.5\text{m}^3 = 16\text{Rs/m}^3
\]

\[
\text{MA} + \text{LA} = 188.13\text{Rs/m}^3
\]
COST OF ASPHALT STABILIZED MUD PLASTER

*Recipe: Soil 800L + Sand 400L + Straw 92kg + Asphalt 40kg.

MA

Soil = 800L X 1.05 = 840L X 45.8Rs/m³ = 38.47Rs.
Sand = 400L X 1.05 = 420L X 109.9Rs/m³ = 46.16Rs.
Straw = 92kg X 1.25Rs/kg = 115Rs.
Water = 200L = free.
Asphalt : 40kg X 9.9Rs/kg = 396Rs.
Karosene : 10L X 5.4Rs/L = 54Rs.
Paraphine wax : 1kg X 33Rs = 33Rs.
Wood for fire : 10kg X 2.5Rs = 25Rs.

707.63Rs/m³

LA

1 labourer prepares 1.25m³ of mix/day.

40Rs : 1.25 = 32Rs/m³

MA + LA = 739.63Rs/m³

* Based on the recipe used by Fazel for the plastering of the first gunbad in BMTRC.
COST OF PLASTERING 1m² OF WALL WITH MUD PLASTER (KAH GEL)

MA

1m² X 0.003 = 0.003 X 1.05 (loss) = 0.0042m³

0.0042m³ X 188.13Rs = 0.79Rs/m²

LA

1 mason + 2 labourers plaster 40m² of wall.

180Rs : 40 = 4.5Rs/m²

MA + LA = 5.29Rs/m²
COST OF WOODEN REINFORCEMENT ANGLE

MA  Wood: 2 X 0.9 X 0.1 thickness = 0.02m -- > 2.4m
1 X 0.6 X 0.1

1 poplar tree 3m of 13cm = 35Rs -- > 55Rs
Cost of cutting by machine = 20Rs

1 tree = 6 boards 0.1 X 3m thickness = 0.02m = 18m
55Rs : 18m = 3.05Rs/m

2.4m X 1.1 (loss) X 3.05Rs/m = 8.05Rs

Chicken wire: 0.3 X 0.3 = 4Rs

Nails: 10 units X 0.25Rs = 2.5Rs

Used mortar oil: 1L free.

Total: MA = 14.55Rs

LA 1 carpenter produces 24 reinforcement angles/day.

100Rs : 24 = 4.16Rs/unit

MA + LA = 18.71Rs/unit