



BUILDING RESEARCH NOTE

B.R.N. 12

NON-ERODABLE MUD PLASTER ON MUD WALL FOR RURAL HOUSES

Introduction

Most of the houses in villages are built either with kachha (Sundried) bricks or blocks, or with lump mud. Mud walls are protected against damage from rain by applying mud plaster, consisting of local soil or mud collected from village pond mixed with bhusha (wheat straw) on outer walls, rendering with gobri (Cow dung slurry). This traditional method of application of mud plaster of course is cheap, however can not with-stand even a few hours of continuous rains, with the result that usually the mud plaster gets eroded and considerable damage is done to the house. Thus a water proof mud rendering on mud walls can save the walls from frequent damage and increase its durability and life for 30 to 35 years with normal annual maintenance.

Investigation have been carried out in Central Building Research Institute Roorkee and else where during last 3 decades to develop a "Non-erodable mud plaster" based on bitumen cut back, and have been successfully adopted on several houses to prove it effectiveness. The present "building research note" describes in detail, the problems with ordinary mud plaster, method and material used, alongwith its application technique in the field, and cost economics for the guidance of field engineers and workmen.

2. Problems with Ordinary Mud Plaster

The problem of durability of mud plaster is two fold. Firstly the plaster should be non-erodable and secondly, it

should be water proof against local rain fall. The reason for the first requirement is obvious. As regards water proofness the necessity arises from the mechanism of separation of a plaster from kachha wall. During the continuous rain, moisture penetrates through out the plaster and softens the surface of the wall in contact with the plaster, thereby weakening the bond between the wall face and the plaster. Normally on drying out, the adhesion between the wall surface and the plaster should be fully restored, but due to the differential shrinkage between plaster and wall, local stresses develop, which are too high for the weakened bond between the plaster and the softened wall face to overcome. A partial separation thus occurs and by repeated wetting and drying, due to alternating rainfall and sun shine, the plaster ultimately comes off in flakes.

3. Solution with Improved Technique

If a bitumen cut back, prepared with, bitumen having 80/100 penetration & kerosene oil, is mixed to the ordinary mud mortar (having bhusha) is applied on the mud wall, it will provide a non-erodable and water proof plastered surface.

4. Preparation of Mud Mortar

Normally soil, from the bottom of village pond, is collected and mixed with the local soil and bhusha in suitable proportions for the purpose of plastering. The workability of the mud mortar prepared is ascertained by some simple field identification test based on the

experience, skill and the judgement of the person or the mason using the plaster.

However the following specification may also be adopted. The soil shall have a clay contents between 20-25% and sand between 40-45%, remaining being the silt, peat loam etc. The soil shall be free from any organic material, gravels, pebbles etc. The soil so selected shall be kept wet and kneaded every day for a period of 10 to 14 days. The soil having a plasticity index ranging from 6 to 10 is found to be suitable for plaster. If laboratory testing facility is available plastic limit, liquid limit, and plasticity index, may be ascertained. It may be noted and stressed here, that the performance of a good mud plaster will largely depend upon the selection of suitable soil mixed in correct proportion.

5. Addition of Bhusa

Fibres from decayed Bhusa or Wheat Straw acts as a reinforcement to the soil thus increases the cohesion and the strength of the mud mortar. Where wheat is not grown, rice straw may be used in its place. The size of bhusa i.e. the aspect ratio plays an important role in the strength of mortar. Normally a length of 20 mm and width 2 mm or aspect ratio of 10 is suitable for mortar. The period for which bhusa is decomposes also plays important role in the quality of mud plaster.

Bhusa at the rate of 6% by weight of dry soil, i.e. 64 Kg for every cubic meter of soil, is added to the dry soil and thoroughly mixed. The mix is formed into a round/circular heap and water is flooded in between the space to keep it constantly wet for 10 to 15 days. The mortar is kneaded every day by man's feet as well as overturned by shovel two to three times for a period of 10 to 14 days, depending upon local climate. Within this period the Bhusa fibres are disintegrate (i.e. 14 days in winter and rainy season and 10 in summer) and become soft which can be easily felt and identified by taking a lump of mortar in hand. In case old stored bhusa is available it should be preferred since it will shorten the time needed for disintegration of bhusa and will allow early use of mortar. This is the usual traditional practice of preparing conventional mud mortar, but for getting good result the above sequence may be followed. Suitability of mud mortar for plaster so prepared may also be tested by applying some plaster in a small patches of say 1m × 1m on the wall and is observed till it is completely dried. If the plaster does not have any appreciable cracks,

the plaster is suitable, otherwise more sand is added to make it in suitable proportion.

6. Preparation of Bitumen Cut Back

Bitumen of 80/100 grade penetration and kerosene oil is mixed in the proportion of 5:1 preparing cut back i.e. 53.25 kg. of bitumen and 10.5 litre of kerosene oil for every cubic metre of dry soil. Bitumen is heated till it melts and this molten bitumen is slowly added to the kerosene oil kept in a separate container, keeping the whole mixture stirred until the whole of bitumen is added.

7. Preparation of non-erodable and Water Proof Mud Plaster

The bitumen cut back so prepared is added to the mud mortar prepared earlier in the traditional manner as described above. The required quantity of cut back is taken from the container and it is spread over the heap of mud mortar uniformly and worked up with spade immediately after, several times to ensure its thorough mixing. Any undesirable matter, lump of mud, or bitumen formed should be removed. When the plaster is ready for use it will show a good workability and plasticity.

8. Application of Plaster

Mud plaster is normally applied on the walls constructed by lump mud, sundried blocks or bricks. The mud wall surface usually is not uniform or in plumb. Hence the following steps should be followed before applying the mud plaster :-

- (i) Scrap the undulation, irregularities and loose particles, if any with the trowel so as to make the surface uniform.
- (ii) Any appreciable crack may be filled with ordinary mud mortar and allow to dry.
- (iii) The plaster is commenced from the upper portion coming towards the bottom.
- (iv) Apply the plaster in uniform thickness of 12 mm with a trowel and finish it smooth. For a more better results, small patches in 12 mm thickness at a interval of one metre could be done first, checking the thickness with wooden strip and then the rest of the space is finished in uniform thickness. However if any appreciable crack. However if any appreciable cracks appears, it should be filled with the same non-erodable mud mortar and finished properly.

9. Application of Gobri (Cow Dung Slurry)

When the mud plaster is completely dry a gobri rendering is applied on the plastered surface by hand in two coats. Second coat is applied in vertical direction after drying the first coat. The gobri (cow dung slurry coat) is effective in filling the hair cracks and voids in the plaster and helps in stopping further cracks of plaster. To prepare the slurry, 1 part of cow dung, and 1 part of soil, is mixed and water is added to form a thick paste. To this paste, bitumen cut back, is added. The quantity of various material required is given in the Appendix II.

10. Test Conducted

Laboratory investigations consisted of study of the effect of (i) varying amount of cut back, (ii) Nature of soil, (iii) atmospheric condition during drying, (iv) erosion of plaster and penetration of water through it when tested by spraying water over a wall panel large enough to be a representative portion of a house wall. Rain is often accompanied by wind and it seldom happens that rain drops strike continuously at the same point. Thus penetration is more at the surface where water is flowing than where water is sprayed.

Laboratory tests were conducted in this institute with local soil having plasticity index of 10 having sand content 42.5% and the percentage of bitumen cut back from 0 to

4% Soil samples having 4% cut back have shown the lowest moisture absorption. The plaster was applied on a mud wall/panel of (1.83 m × 1.22 m × 0.34 m) and was sprayed with water from a sprayer after drying of the plaster. It was subjected to (i) constant wetting for 6 hours (ii) 45 cycles of alternate wetting and drying (one cycle consisted of wetting for one hour and drying for 23 hr.). Test results have shown no loss of adhesion or erosion of plaster at any stage while the panels plastered with plain mortar showed cracks in 8 to 10 cycles with substantial portion eroded.

11. Field Investigation and Performance

Mud wall at eight houses was plastered in the nearby village Daulatpur in 1957-58 to study : the effectiveness of the plaster under village conditions, practical difficulties involved in accepting the new technique and reaction of the villagers. Later on three more houses in village Khanjarpur near Roorkee were plastered. The performance of the plaster was observed for 30 years and found satisfactory. In 1975 non-erodable mud plaster having 4% bitumen cut back was applied on sundried brick walls of a house (Photo-I) in CBRI. So far it hasnot shown any distress even without much maintenance which has further established the effectiveness of this plaster. Photos I & II compare this non-erodable mud plaster, with traditional plaster.



Photo 1 Non Erodable Mud Plaster on Mud Wall



Photo 2 Traditional Mud Plaster on Mud Wall of a Kachha House

COST ANALYSIS OF TRADITIONAL MUD PLASTER FOR 10 m² WALL SURFACE
(Based on prevailing April 2004, Roorkee Market Rates)

A.	MUD MORTAR (1 Cu. m.)		Qty.	Unit	Rate	Amount (Rs.)
a.	Dry Soil		1.20	m ²	100.00	120.00

						Total 120.00

b.	Labour for breaking clods pundling & mixing.	Beldar	0.70	Mandays	75.00	78.75
		Bhisti	0.35	Mandays		
			-----			-----
			1.05			Total 78.75
			-----			-----
c.		Sundries	L.S.	L.S.		2.25

					G. Total Rs.	201.00

		Cost for one cu.m.	(a) With self help (a+c)			122.25
			(b) With hired labour & material (a+b+c)			201.00
B.	Providing 12 mm thick mud plaster, including two coats, of gobri rendering etc. complete,		For 10 m ² area			
a.	Material					
	(i)	Mud Mortar	0.120	m ³	122.25	14.67
	(ii)	Bhusa (Wheat Paddy/Straw)	7.68	Kg.	2.80	21.50
	(iii)	Cow Dung/Gobar	10.00	Kg.	0.50	5.00

						Total 41.17

b.	Labour	Mason	0.20	Mandays	125.00	25.00
		Beldar	0.10	} - do -	75.00	43.50
		Collie	0.20			
		Bhisti	0.08			

						Total 68.50

c.	Extra for Scaffolding T & P and sundries			L.S.	—	5.00

					Grand Total Rs.	114.67

	Cost per 10 m ² :		(i) With self help B (a+c)		41.17 + 5 =	46.17
			(ii) With hired labour & material B (a+b+c)		114.67 + 9.45 =	124.12
	RATE PER Sq.m. of plaster					
		(i) With self help		Rs.	4.62	
		(ii) With hired Labour		Rs.	12.41	

* Labour effect of mud mortar [A] b

COST ANALYSIS TRADITIONAL MUD PLASTER FOR 10 m² AREA
(Based on prevailing April 2004, Roorkee Market Rates)

A. Providing 18 mm non-erodable mud plaster including bitumenised gobri complete.

		QTY.	UNIT	RATE (Rs.)	AMOUNT (Rs.)
(a)	Material —				
	Mud Mortar	0.12	m ³	201.00	24.12
	Bitumen 80/100 gde.	7.50	Kg.	15.00	112.50
	Kerosene Oil	1.50	Litr.	10.00	15.00
	Bhusa (Wheat/Paddy straw)	7.68	Kg.	2.80	21.50
	Fire Wood	4.00	Kg.	3.00	12.00

				Total	185.12

(b)	Labour (Preparation of cut-back mixing with mortar and application etc.)				
	Mason	0.40		125.00	50.00
	Beldar	0.45			
	Coolie	0.45	} Mandays	75	4.00
	Bhisti	0.08			

				Total	123.50

(c)	Extra for Scaffolding T&P Sundries etc.			L.S.	6.50

				G. Total	315.12

Cost per 10 m² (a) With Self help A (a+c) = 185.12 + 6.50 = 191.62 - 9.45* = 182.17
 (b) With hired labour material A (a+b+c) = 315.12 + 9.45 = 324.57

* Labour effect on mud mortar [Appendix — I]

B. Preparation of bitumenised gobri (Mud cow dung slurry) and application

(a)	Material —				
	Dry soil	0.01	m ³	100.00	1.00
	Bitumen 80/100 gd.	1.00	Kg.	15.00	15.00
	Kerosene Oil	0.20	Litre	10.00	2.00
	Cow Dung (Gobar)	7.50	Kg.	0.50	3.75
	Fire Wood	1.00	Kg.	3.00	3.00

				Total	23.75

(b)	Labour —	Mason	0.05	}	Mandays	75.00	41.25	
		Beldar	0.25					
		Collie	0.20					
		Bhisti	0.05					

							Total	41.25
							-----	-----
(c)	Extra for T & P Sundries							1.50

							G. Total	66.50

Cost per 10 m³

With self help B (a + c) Rs. 23.75 + 1.50 = 25.25

With hired labour B (a + b + c) Rs. 23.75 + 41.25 + 1.50 = 66.50

Total Cost For 10 m² NEM Plaster

(i) With self help A (a + c) + B (a + c) = Rs. 182.17 + 25.25 = Rs. 207.42

(ii) With hired labour (A + B) = Rs. 324.57 + 66.50 = Rs. 391.07

Rate Per sq. metre of NEM Plaster

(i) With self help = Rs. 20.74

(ii) With hired labour = Rs. 39.11

12. Cost Economics

The extra labour requirement is nominal and the villager may contribute it as self-help. A rate analysis for 12 mm thick ordinary mud plaster as well as non-erodable mud plaster based on the cost of material and labour prevailing locally in April 2004 has been given in Appendices I and II.

13. Precautions

- (i) Soak the soil for at least 12 to 15 days and
- (ii) Add bitumen to kerosene oil and not the otherway, otherwise kerosene remains on top & mixing will be difficult. Do not heat Kerosene Oil.
- (iii) Pour the cut back into the prepared soil and knead it with feet and spades. Remember bitumen or Kerosene Oil does not harm the skin.
- (iv) Fill irregularities in mud walls with ordinary mud plaster & then apply NEM plaster in uniform thickness.

- (v) Thickness of plaster should not be less than 12 mm and not more than 15 mm.

14. Advantage

This plaster is water repellent & erosion resistant, more durable and provides safety against collapse of wall in rainy season. The life of the plaster is more than 30 years with annual maintenance by applying bitumenised gobbri only.

15. On the basis of several trials conducted in the laboratory as well as on the walls of several houses in villages around Roorkee it has been established that NEM plaster is durable & its life is more than 30 years. It gives a uniform finish and it can be finished with white/colour wash if desired. It improves the aesthetics of the village houses.

Reference

REHSI, S.S. Non-erodable Mud Plaster: Bulletin of The Institution of Engineers (India); Vol. 7, No. 12, Aug. 1958.

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