Gainful utilisation of stone waste for brick manufacturing Industry

Centre for Development Of Stones

RIICO
GROW WITH RAJASTHAN

"Virtual workshop"
on
"Gainful utilisation of stone waste and Slurry"

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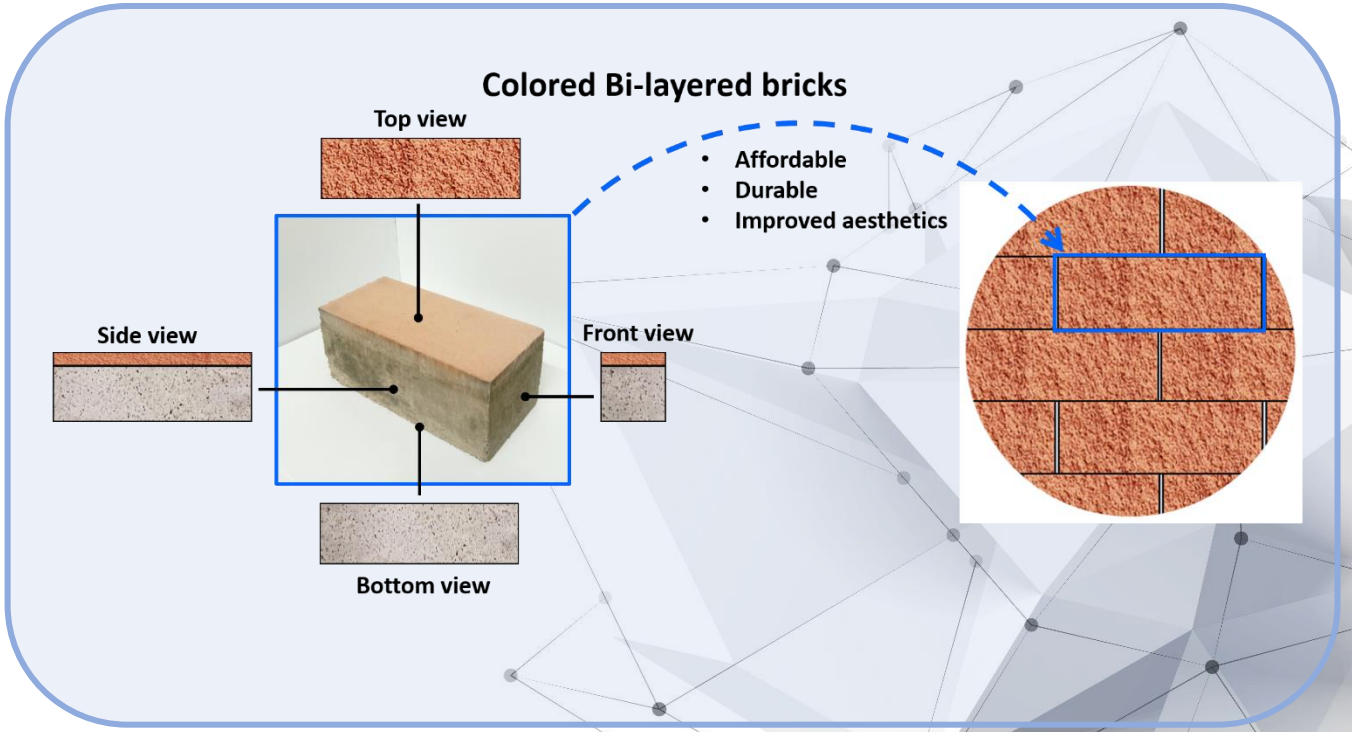


Ref: Gupta et al. (2021)

Contents

Introduction

Masonry bricks

Fired bricks

- Non eco-friendly
- Auspicious red color
- Heavier in weight
- Lower compressive strength
- More porous
- High water absorption

Clay bricks

Unfired bricks

- Eco-friendly
- Gray in color
- Lighter in weight
- Higher compressive strength
- Less porous
- Low water absorption

Fly ash bricks

Key challenges

Key challenges:

- **Aesthetics of unfired bricks**
- **Search of a low cost raw material which fit into the budget of brick mixes (typically in the range of INR 1 – 1.5 per kg.)**
- **Economic competitiveness of proposed solution in the existing product range**
- **Manufacturing feasibility of proposed solution in existing industrial set up**

How to improve the aesthetics of unfired bricks in low cost maintaining its sustainability?

Motivation for using stone waste

Stone wastes have inherent color

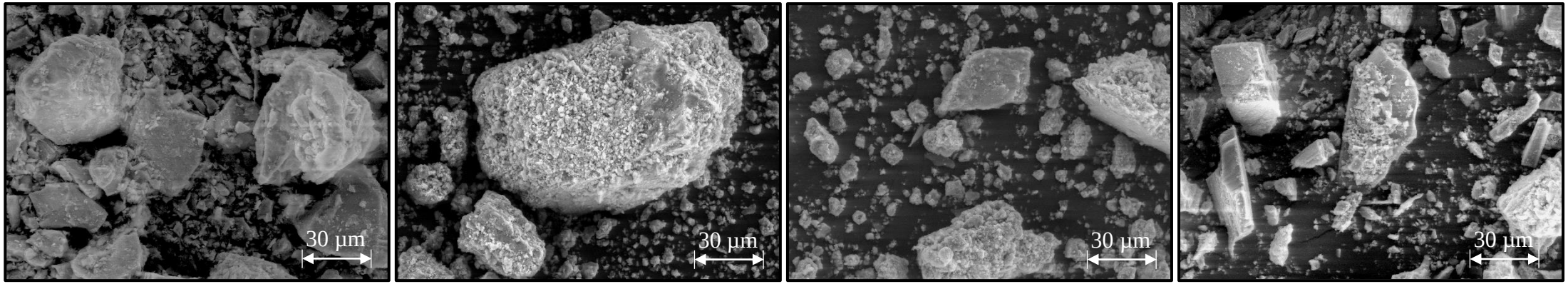
Stone wastes are originated from durable stones

Availability of dimensional stone wastes in huge quantity

Selected stone wastes from Rajasthan

	Dholpur (S – I)	Jaisalmer (S – II)	Kota (S – III)	Makrana (S – IV)
Photographs				
Loss on ignition	15.65%	39.38%	34.12%	37.82%

SEM Images



Mix design for various colored geopolymer mortars

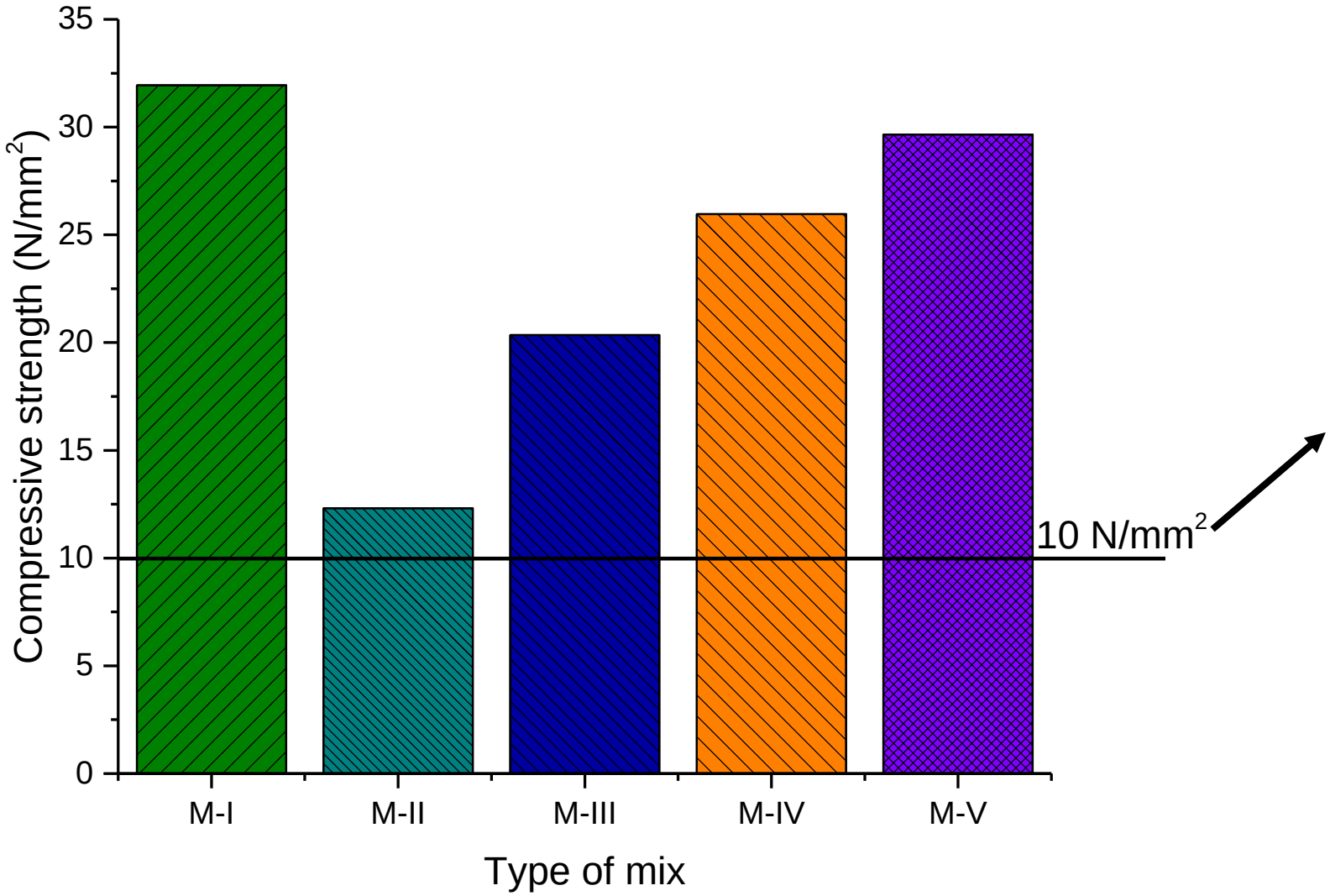
Mix	Solid precursor		
	GGBS (g)	Stone waste (g)	
M1	100	-	-
M2	50	S-I	50
M3	50	S-II	50
M4	50	S-III	50
M5	50	S-IV	50

Chemical binder	
NaOH solution (g)	Na_2SiO_3 solution (g)
40	40

Fine aggregate		
Standard sand		
Grade 1 (g)	Grade 2 (g)	Grade 3 (g)
100	100	100

Specimen size: 50×50×50 mm cubic specimens
Curing condition: For first 24 hours in drying oven at 50 ℃
Testing age: 3 days

Technical comparison of different colored composite mortars



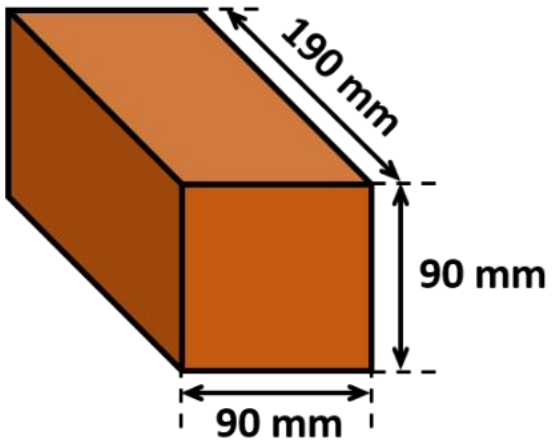
- **Shows a high potential to produce colored bricks of M10 class designation as per IS:12894**

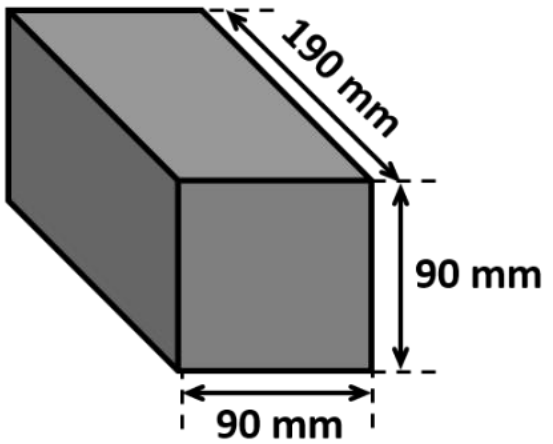
Conceptualization of colored bi-layered bricks

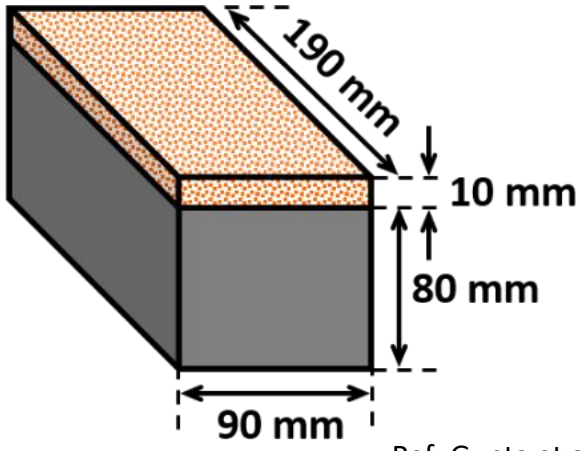
Fired clay bricks

Unfired fly ash bricks

Colored bi-layered bricks







Ref: Gupta et al. (2021)

Cost analysis of 10 mm thick top layer mortar

Raw material	Weight (kg)	Unit rate (In INR per kg)	Total Cost (In INR)
GGBS	0.111	2.50	0.278
Stone waste	0.111	1.40[#]	0.155
River sand	0.111	1.65	0.183
Sodium hydroxide pellets*	0.010	50.0	0.500
Sodium silicate solution*	0.025	20.0	0.500
Total raw material cost (in INR)			1.616

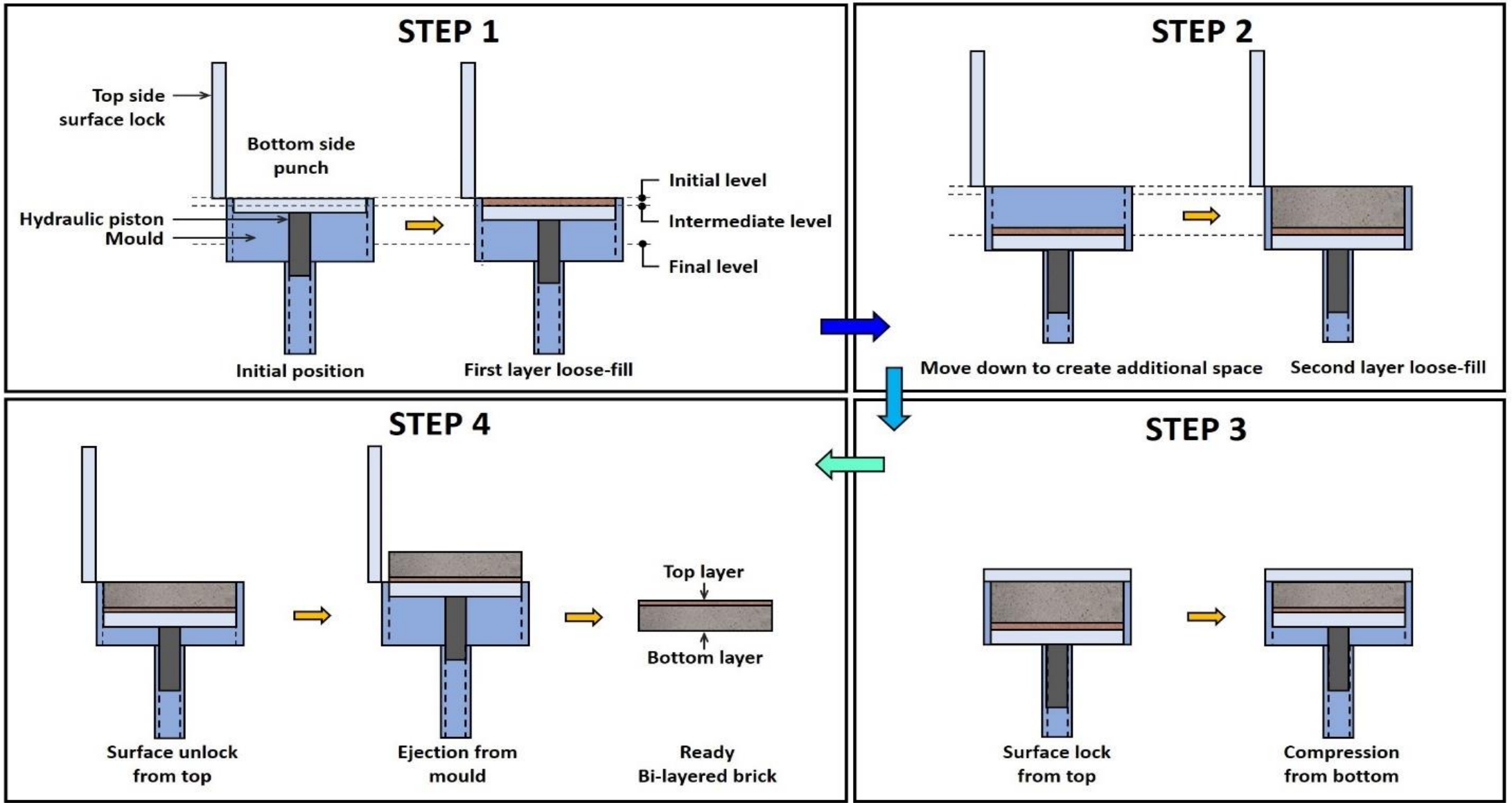
*For cost calculations, unit rates of commercial-grade sodium hydroxide pallets and sodium silicate solutions have been considered.

[#] While stone wastes are available free of cost, freight on delivery and other costs are considered in calculating the rates per unit

Economic feasibility of colored bi-layered bricks

Cost head	Fly ash bricks	Cost per brick (In INR)	Bi-layered bricks	Cost per brick (In INR)
Raw material cost	*Single layer (90 mm thick)*		*Bottom layer (80 mm thick)*	
	Hydrated lime	1.35	Hydrated lime	1.20
	Fly ash	0.42	Fly ash	0.37
	Stone dust	1.01	Stone dust	0.90
			Top layer (10 mm thick)	
			Colored composite	1.62
Total raw material cost (A)		2.78	→ Increase in cost → (~INR 1.31)	4.09
Other cost (B)		0.65		0.65
Overall manufacturing cost (A + B)		3.43	→ Increase in cost → (~INR 1.31)	4.74
Plaster and paint work cost		3.80		Nil
Net cost per brick (A + B + C)		7.23	→ **Saving per brick** → **(~INR 2.49)**	4.74

Step-by-step manufacturing method for colored bi-layered bricks



Ref: Gupta et al. (2021)

Actual bi-layered bricks produced at laboratory scale

Key take-away

- **Manufacturing of bi-layered bricks is feasible in conventional plants (used for manufacturing single layered bricks) with minor alterations**

- **Bi-layered bricks are found to be economically viable. Use of proposed bi-layered bricks result in a net saving of INR 2.49 per brick surface of 90 mm × 190 mm; amounting to a cost saving of ~35 %.**

Published article:
Gupta V, Pathak DK, Kumar R, Miglani A, Siddique S, Chaudhary S. Production of colored bi-layered bricks from stone processing wastes: structural and spectroscopic characterization. Construction & Building Materials, 278 (2021) 122339

Opportunities for Industries

- **Opportunity available at IIT Indore for technology transfer of the developed products**
- **Opportunity for research collaboration in the field of gainful utilization of waste in pre-manufactured products**

Glimpse of research facilities available at IIT Indore related to Pre-manufactured products