

Punaravartan Clay Recycling Experiments

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Introduction / Background

1. The Punaravartan campaign:

Natural clay known as shaadu maati in Marathi is a naturally occurring clayey soil mined from Gujarat and widely used to make Ganesh idols for the festival of Ganesh Chaturthi. This and other soils have been traditionally used for idol making before the introduction

of Plaster of Paris. Since POP idols do not disintegrate in water, there is a push to revert to the use of natural clays and soils in the past decade.

Shaadu maati idols when immersed into natural water bodies form a sediment at the bottom of these and affect the ecosystems negatively. This clay can easily be reused over and over again and so for the past six years the **Punaravartan**¹ campaign, launched by the eCoexist Foundation, has been setting up systems to collect the clay sludge after immersion. When collected with care the sludge is of a fairly good quality and is offered back to artisans free of cost. This campaign achieves two goals of :

- a. conserving this non renewable resource by putting it back into the supply chain and
- b. protecting the waterbodies and ecosystems by preventing the immersion in them.

2. Why recycle clay ?

a. It is a non-renewable resource:

Shaadu maati is naturally occurring clay that is mined from the earth. Continuous extraction reduces the available resource. Recycling allows the same clay to be used repeatedly instead of constantly mining new clay.

b. It prevents pollution of water bodies ultimately preventing the environment from degradation:

During Ganesh idol immersion, large quantities of clay can settle at the bottom of lakes, rivers and other water bodies. This creates clay accumulation in water in larger quantities, as the Ganesh festivals are on a larger scale and can disturb aquatic ecosystems. Collecting and recycling the clay prevents it from entering natural water bodies.

c. Clay can be reused multiple times:

Unlike many materials, clay can be reconstituted with water and reused for making new idols or other clay products. Also, because of its properties, it can be used in many other industries like architecture, etc. Therefore, discarded clay does not necessarily need to become waste, but can be recycled and reused again.

d. It reduces the need for fresh mining and transportation:

If recovered clay is returned to artisans, the demand for newly mined clay decreases. This can reduce the environmental impacts associated with mining, processing and transporting fresh clay.

e. It supports a circular material system:

- Instead of the traditional linear cycle: Mining → Idol making → Immersion → Waste
- Recycling creates a circular cycle:
Mining → Idol making → Collection → Reprocessing → New idol making → Reuse in other industries

¹ www.punaravartan.org

3. Application in Natural Building

- a. **Adobe/ Earth blocks:** Recycled clay can be combined with natural additives (including natural fibres), adhesives and moulded into blocks.
- b. **Natural wall plasters:** Mixed with materials such as sand/Rangoli, fibres, sawdust or natural binders, the Shadu clay can give good plaster properties. It reduces use of cement-based plaster and uses recycled Shadu clay as a good replaceable material.
- c. **Surface finishes/ Top coats/ Natural decorative finishes:** Fine recycled clay can be used as a smooth finishing layer with natural pigments such as geru, charcoal, etc.
- d. **Architectural panels (Acoustic panels, thermal insulation panels, wall decor panels):** After adding certain additives, fibres, adhesives, it can be possible to make architectural panels, which are soundproof, thermally insulated, and decorative. Clay + natural pigments can create textured or coloured surfaces.
- e. **Non structural elements (Partition walls, Interior walls/ decorative panels):** The Shadu clay can be recycled to produce different kinds of interior elements such as partition walls which are non-load bearing walls, decorative walls, etc.
- f. **Mortars:** As mortars and base materials of any tiling uses high amount of cement, Shadu clay can act as a good replacement material.
- g. **In fill blocks:** The Shadu clay can be used in the form of in-fill blocks by addition of different kinds of additives and fibres into it, which can increase the thermal and acoustic properties of the wall.
- h. **COB/ Earthen construction:** Clay acts as the binding component with sand and fibres. Recycled Shaadu maati could potentially replace the clay-rich soil component. The Shaadu clay provides cohesion/binding, while sand or another granular material helps control shrinkage. Natural fibres such as straw, coco coir or rice husk can provide reinforcement and help limit cracking.

In the experiments conducted, explorations of several of these possible applications were done with the Shadu clay.

The Properties of Shaadu Maati - Natural clay

Moisture absorption & swelling

- Strength: Absorbs water and becomes workable.
- Weakness: Excess water causes swelling and drying shrinkage → cracking.

Absorption

- Strength: Can retain water, certain pigments and additives.
- Weakness: Can increase water demand and affect mix behaviour.

Cohesiveness & adhesion

- Strength: Holds particles together and provides good bonding.
- Weakness: Certain materials needs to be studied as Shadu does not adhere fully with other material and may need fibres and other additives.

Mouldability

- Strength: Suitable for cob, plaster, blocks and other earthen forms.
- Weakness: Poorly balanced mixes can deform or crack during drying.

Other properties include:

- Colloidal properties: Fine Shadu clay particles remain dispersed in water, forming a smooth and cohesive paste that improves bonding and workability
- Viscosity: Shaadu clay increases the resistance of the wet mix to flow, helping plaster remain on the surface but becoming sticky if too viscous.
- Rheological properties as a soft solid: Shaadu clay behaves like a soft solid at rest but deforms and flows when force is applied, making it suitable for moulding and plastering.

Overall:

Strength: Cohesive + plastic + mouldable → **good natural building material.**

Weakness: Excess clay + water → **shrinkage + cracking + poor workability.**

Aim / Objectives

Aim: To explore the architectural applications of Recycled Shadu clay in green buildings.

Objectives:

- To investigate the potential of recycled Shaadu maati as a natural building material.
- To study its properties and to study how it reacts to the additives.
- To develop suitable clay-based mixes by incorporating natural fillers and fibres to control shrinkage and cracking.
- To explore application of recycled Shadu clay in natural building systems.
- To identify the strengths and limitations of recycled Shaadu clay for construction applications.
- To reduce dependence on pure clay and conventional high-energy building materials through material reuse.

Methodology

1. Literature Review

- Study existing research on Shaadu clay, earthen construction, clay properties, natural plasters, cob, and clay recycling.

- Study the properties of clay and all the other additives, adhesives, pigments needed to be added in the Shadu clay.

2. Study the procedure of collection of Shadu clay and the process of recycling of Shadu clay:

Collect Shaadu clay sludge recovered after Ganesh idol immersion through the Punaravartan process.

3. Mix Development

Based on the research carried out on Shadu clay, additives, adhesives, bases, pigments, develop different formulations by combining recycled Shadu clay with **them**.

Following additives, adhesives, pigments, bases are to be studied for its end product applications in blocks, panels and plasters.

Additives to Shadu Clay:

- Cow dung
- Rice husk
- Coco coir
- Rangoli
- Saw dust
- Paper mache
- coco peat

Adhesives

- Tapioca starch
- Fenugreek water
- Natural Gum

Bases to be studied:

- Canvas
- Woven bamboo panels
- Jute sheet
- Cement sheet

Pigments

- Red earth
- Charcoal powder
- Multani mitti
- Yellow oxide

4. Sample Development

Prepare samples for potential applications such as adobe blocks, panels, plasters, etc.

5. Observation and performance evaluation:

Documenting the observations made during and after the process, and evaluating it based on mix, Wet and dry Weights, shrinkage, Cracking, Bonding, Dusting, Fungus growth, efflorescence, surface finish, etc.

6. Comparative Analysis

Compare the different formulations to identify the **most suitable recycled Shaadu clay mix for natural building applications**.

7. Conclusion

Assess whether recycled Shaadu maati can function as a **circular, low-impact natural building material**, and identify its most appropriate application.

Additives (Blocks)

Shadu clay block and the need for additives

- SHADU CLAY is a precious, non-renewable resource. And to bring the clay into circularity, we created different types of blocks starting from pure clay to many other additives.
- Obtaining the only Shadu clay block required 1/3rd volume of water. The clay's natural stickiness forms a strong mix without additives.
- A 3.5" x 3.5" x 3.5" cubic block was cast for three days of monsoon curing.
- The result was zero shrinkage and absolutely zero structural cracks, with rough powdery finish, but extremely dense and heavy. This confirms Pure Shadu clay is moderately stable, but to unlock its true potential for green building, it needs to be explored with additives.



1. Rangoli powder

- It introduces a sandy mineral aggregate into the sticky Shadu clay.



- The fine Rangoli particles add a filler in the micro gaps between clay particles to reduce shrinkage and give a smooth finish.
- Volumetric Proportions used were: 3 Clay to 1 Rangoli - R1
- Mixing required more time and force than pure clay because Rangoli grains offer higher physical resistance during kneading.
- A 3.75" x 3.75" x 3.75" cubic block was cast for three days of monsoon curing.
- The result was zero shrinkage and absolutely zero structural cracks. This confirms excellent granular packing, creating a compact matrix free of fungus or efflorescence.



2. Sawdust and coco coir

- It introduces lightweight organic additives within a Shadu clay–Rangoli matrix.
- Rangoli was introduced as a non-sticky mineral material to improve particle packing, while sawdust and coco coir were used as fibrous internal support, capable of reducing weight and introducing porosity.
- Volumetric Proportions used were
 - 2 Clay to 1 Rangoli 1 Sawdust - R2
 - 2 Clay to 1 Rangoli 1 Coco coir (25-50mm long) - R3
- R2 was easy to knead but R3 was much harder to prepare because the longer coir fibers resisted bonding with the clay and rangoli.
- 2nos. of 3.75" x 3.25" x 3.75" cubic block was cast for two days of monsoon curing.
- The result was zero shrinkage and absolutely zero structural cracks, moderate dusting, no fungus growth or efflorescence. But R3 produced a rougher surface than R2.
- R3 (1.15kg to 0.75kg) showed greater reduction in weight than R2 (1.35kg to 1.05kg)



3. Coco coir

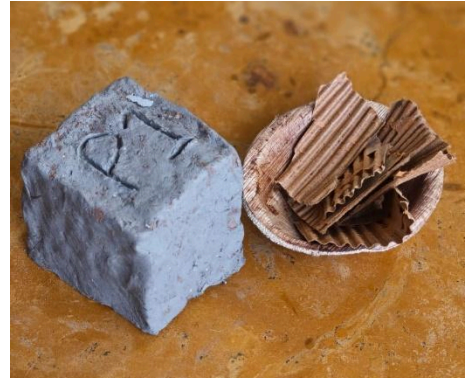
- It introduces a structural support system and reduces weight per unit volume.
- The 25-50mm long coco coir fibers act like small support bars, holding the clay together and reducing drying stress.
- Volumetric Proportions used were: 4 Clay to 3 coco coir.



- The fibers made mixing difficult, reduced workability, and required more water.
- A 3.25" x 3.5" x 3.75" cubic block was cast for two days of monsoon curing.
- The result was zero shrinkage and absolutely zero structural cracks. This confirms an inert, odorless, ultra-lightweight, crack-free block with a good interwoven fibrous network.

4. Waste corrugated sheet mache

- It introduces a structural support system and reduces weight per unit volume.
- Corrugated sheets contain long cellulose fibers that, when made into pulp, strengthen the clay, reduce its weight, and act as an eco-friendly aggregate.
- Volumetric Proportions used were: 8 Clay to 5.5 Paper pulp
- Mixing required more time and force than pure clay because its irregular fibres are difficult to mix with the clay.
- A 3.25" x 3.5" x 3.75" cubic block was cast for two days of monsoon curing.
- The result was zero shrinkage and absolutely zero structural cracks. The resulting block had a slightly rough surface and remained odorless, chemically stable, and free from fungus and efflorescence.



5. Rice husk

- It introduces a natural lightweight filler into the sticky Shadu clay.
- Rice husk was selected for its rigid, lightweight and porous structure, which can create internal air gaps and improve overall stability.
- Volumetric Proportions used were: 1 Clay to 1 rice husk
- The sharp and irregular structure of the rice husk made the mixture harder to knead than other additives.
- A 3.5" x 3.5" x 3.5" cubic block was cast for two days of monsoon curing.
- The result was zero shrinkage and absolutely zero structural cracks. The resulting lightweight block had a porous structure and remained odorless, chemically stable, and free from fungus and efflorescence.



6. Sawdust

- It introduces an organic lightweight filler into the sticky Shadu clay.
- Sawdust was selected for its lightweight and porous structure, which can create internal air gaps, reduce weight, introduce internal porosity and potentially improve thermal insulation.
- Volumetric Proportions used were
 - 1 Clay to 1 Sawdust (SD1)
 - 3 Clay to 1 Sawdust (SD2)
- Sawdust made the clay easier to knead by reducing its stickiness and producing a workable, stable dough.
- A 3.5" × 3.5" × 3.5" cubic block was cast for two days of monsoon curing.
- The result was zero shrinkage and absolutely zero structural cracks. The resulting lightweight blocks had a porous structure and remained odorless, chemically stable, moisture sensitive with rough surface finish.



7. Coco peat

- It introduces a lightweight, fibrous organic additive into the sticky Shadu clay.
- Coco peat was selected for its high Moisture-proof quality, porous and fibrous structure, with the potential to reduce block weight and improve moisture performance.
- Volumetric Proportion used was: 1 Clay to 1 Coco peat
 - But with 2 different methods-
 1. Both are mixed in their dry state and then water is added -CP1 and
 2. Shadu Mati dough is mixed with the wet coco peat obtained from the process of squeezing the water out after keeping it in water for 1 hour- CP2.
 - CP1 was significantly harder to knead because the dry coco peat rapidly absorbed water.
 - CP2 was simple to make a dough and required less additional water due to the pre-soaking process.



- A 3.5" × 3.5" × 3.75" cubic block was cast for two days of monsoon curing.
- The result was zero shrinkage and absolutely zero structural cracks, stable bonding, rough surfaces, no fungus growth and efflorescence. CP1 reduced in weight from 1.0 kg wet to 0.95 kg dry, whereas CP2 showed a substantial reduction from 1.0 kg to 0.45 kg, It indicates that CP2 works well.

8. Cow dung

- It introduces a natural, soft, fibrous organic additive into the sticky Shadu clay.
- Cow dung was selected to act as an organic filler and supporting agent in the block, which might also contribute in making the block lightweight.
- Volumetric Proportions used were
 1. 1 Clay to 1 Cow dung- CD1
 2. 3 Clay to 1 Cow dung- CD2
- In CD1, adding wet cow dung in equal proportions makes the shadu clay mix very easy to knead. As cow dung naturally contains a lot of water content, the need for the extra water is reduced.
- Compared to CD1, more water is required for the CD2 block dough making.
- A 3.5" × 3.5" × 3.5" cubic block was cast for three days of monsoon curing.
- The result was zero shrinkage and absolutely zero structural cracks, slight efflorescence, moderately rough surfaces. CD1 showed good bonding and low dusting, whereas CD2 showed good bonding but moderate dusting.



● Bases (Panels)

1. Canvas Sheet

- Canvas sheet was introduced as a reinforcement layer within the Shadu–Rangoli mix, with the intention of improving the panel's structural integrity and holding the clay-based layers together. The porous, woven surface of the canvas provides a physical texture for the wet Shadu mati to grip onto.



- The volumetric proportions used were 1 Shadu mati : 1 Rangoli, with a 1' × 1' × 0.75 mm canvas sheet as reinforcement.
- The mix was tested as a 20 mm thick sandwich panel, with a canvas sheet at the core and 10 mm Shadu–Rangoli layers on both sides. The panel developed no cracks, had a smooth surface, but remained relatively heavy. Bonding with the canvas sheet was moderately stable.
- However, when the thickness was reduced to 15 mm, with 7 mm layers on either side, the panel developed significant cracking due to brittleness, and parts of the Shadu–Rangoli layers separated from the canvas sheet. Hence, the thinner panel was considered unstable, indicating that additional fibre reinforcement may be required for reduced-thickness applications



2. Bamboo Mat

- Bamboo mat was introduced as a structural reinforcement layer, with the intention that its thicker and rigid woven structure would provide additional structural support to the clay-based panel.
- The volumetric proportions used were 1 Shadu mati : 1 Rangoli, with a 1' × 1' × 1.5 mm bamboo mat as reinforcement.
- The mix was tested as a 15 mm thick sandwich panel, with the unvarnished bamboo mat at the core and approximately 8 mm Shadu–Rangoli layers on both sides. The mix was relatively difficult to prepare because the Rangoli reduced the binding property of the clay, although sufficient water helped achieve a workable dough. The panel had a smooth surface but remained heavy.
- After drying, the panel developed many cracks, and the Shadu–Rangoli layers separated from the bamboo mat, resulting in poor adherence and bonding. Hence, the bamboo mat did not provide the expected reinforcement in this formulation. It was inferred that the presence of Rangoli may have reduced adhesion to the mat, suggesting that a Shadu mati-only panel with bamboo mat could be explored further.



3. Jute sheet

- Jute sheet was introduced as a natural reinforcement layer because of its tensile strength, porous mesh structure and flexibility, with the intention of improving the panel's structural ductility while allowing the Shadu mati mixture to mechanically grip the sheet.
- The initial volumetric proportions used were 1 Shadu mati : 1 Rangoli, with a $1' \times 1' \times 0.5$ mm jute sheet as reinforcement.
- The mix was first tested as a 20 mm thick sandwich panel, with a jute sheet at the core and 10 mm Shadu–Rangoli layers on both sides. Although the equal proportion of Rangoli made dough preparation slightly difficult, sufficient water produced a workable mix. The panel had a smooth surface, was relatively heavy, developed no cracks, and showed moderately stable bonding with the jute sheet.
- However, when the thickness was reduced to 12 mm, with 6 mm layers on either side, the panel developed significant cracking and ultimately failed due to brittleness. The Shadu–Rangoli layers also separated from the jute sheet, indicating inadequate bonding at the reduced thickness. Hence, the jute sheet alone was insufficient for maintaining stability in thinner panels, leading to the exploration of additional fibre reinforcement.
- With sawdust, the formulation was modified to 3 Shadu mati : 1 Rangoli : 1 Sawdust. This reduced the weight and improved bonding with the jute sheet to a moderate level. Although slight cracking still occurred, the panel did not fail completely, indicating that sawdust provided some reinforcement.
- With coco coir, the formulation was further modified to 3 Shadu mati : 1 Rangoli : 1 Coco coir. The 10 mm panel was the lightest among the earlier options, developed no shrinkage or cracking, and bonded well with the jute sheet. Therefore, coco coir acted as a more effective reinforcement fibre and successfully prevented cracking in this panel.
- One may safely conclude that without any compression the clay on either side of the fabric does not penetrate and adhere to each other which is why when it cracks it falls off to one side only. Also the addition of fibres such as saw dust or coco coir may have improved the penetration of the clay through the fabric and held it in place.



4. Cement sheet

- Jute twine (Sutali) was introduced as a reinforcement material to provide structural support and create a decorative panel pattern.

The jute twine was dipped into Shadu slurry and arranged into the desired form before casting the panel.

The resulting panel used the twine as a reinforcing and decorative element, combining structural support with a visible woven pattern.

- The resulting panel showed strong adhesion to the cement sheet, with no visible cracks, while the jute twine provided strong reinforcement and significantly improved the panel's integrity.
- This was a successful experiment and can be explored further to design panels for interior use.



- Adhesives (Plasters)

1. Tapioca Starch

- Tapioca starch introduces organic binder into the Shadu-Rangoli mix which might reduce cracks.
- Tapioca starch is the viscous gel like substance which can act as Polymer film/binding network.
- Volumetric Proportions used were: 3 Clay to 1 Rangoli to 1 Tapioca starch
- The mix has been tested on 2 types of bricks- fly ash brick and clay brick in single layer with 2 thicknesses- 0.5-1mm and 2-3mm.
- The starch-added mix was easy to prepare but developed cracks, a rough finish and peeling, with salt efflorescence remaining on the brick surface, making the plaster unstable, indicating that starch alone was insufficient to provide adequate bonding and cohesion.
- Hence, fibers added to prevent cracks.
 - Sawdust acts as a lightweight organic filler, a structural binder.
 - Hence, another mix tried of volumetric proportions
 - 3 Clay to 1 Rangoli to 1 Tapioca starch 1 sawdust
 - On both the bricks with 2 thickness 0.5mm and 2mm



- The 0.5–1 mm plaster on fly ash brick showed better results, with only minor hairline cracks, no peeling or efflorescence, and a slightly rough finish, making the mix more suitable for thinner plaster applications.

2. Fenugreek Water

- Fenugreek water makes the mix workable and introduces an organic binder into the Shadu-Rangoli mix.
- Volumetric Proportions used were: 3 Clay to 1 Rangoli to 1 Fenugreek water.
- The mix has been tested on 2 types of bricks- fly ash brick and clay brick in single layer with only 1 thickness of 0.5-1mm. Because, in all earlier plasters, the larger thickness plaster did not sustain on both the bricks surfaces.
- The mix was workable and easy to make. However, when applied to a fly ash brick surface, this plaster mix is comparatively difficult to apply and does not adhere as easily as the other mixes.
- The result showed that the plaster developed cracks and a rough finish on both brick surfaces, with significant peeling observed on the fly ash brick surface, resulting in an unstable plaster layer.



3. Natural gum

- Natural Gum introduces a natural binder that improves the interaction between the other 2 materials- Shadu and Rangoli.
- Volumetric Proportions used were: 3 Clay to 1 Rangoli to 0.3 Natural Gum.
- The mix has been tested on 2 types of bricks- fly ash brick and clay brick in a single layer with only 1 thickness of 0.5-1mm.
- The mix was very easy to work with and was easy to apply on both brick surfaces, unlike earlier plaster mix.
- The result showed that the addition of natural gum enhanced the binding quality of the Shadu- Rangoli mix and generated a comparatively smooth plaster layer with a very lesser number of cracks. Hence, it can be considered strongly for plaster mix exploration further.



From the above 3 experiments, it was clear that the best combination was Natural gum with Shadu clay and Rangoli in the proportion of 3:1:0.3, on Fly ash brick.

● Observations

- Pure Shadu clay showed good natural cohesiveness and zero cracking, but its high density, weight and powdery surface limited its application potential.
- Rangoli improved particle packing, surface smoothness and dimensional stability, consistently preventing shrinkage and structural cracking.
- Organic fillers and fibres such as sawdust, coco coir, rice husk, paper pulp, coco peat and cow dung successfully reduced weight and controlled cracking, but their effect on workability and surface finish varied.
- Coco coir provided particularly effective reinforcement, producing lightweight, crack-free blocks and improving the stability of jute-based panels.
- Panel performance depended strongly on thickness, reinforcement type and bonding. Canvas and jute performed better at greater thicknesses, while bamboo showed poor adhesion with the Shadu–Rangoli mix.
- Among the plaster mixes, natural gum showed the best overall workability, bonding, surface finish and crack control.

- **Conclusions**

- Recycled Shadu clay has potential as a circular natural building material, but its high density and tendency toward shrinkage require mix optimization.
- Rangoli improves particle packing, surface smoothness and dimensional stability, making it a useful mineral filler for Shadu-based mixes.
- Natural fillers and fibres reduce weight and control cracking, making Shadu clay more suitable for lightweight building applications.
- Coco coir showed strong potential as a reinforcement, particularly for producing lightweight and crack-resistant blocks and panels.
- Panel performance is highly dependent on thickness and reinforcement type; thinner panels require additional fibre reinforcement to maintain stability.
- Natural gum was the most promising adhesive for plaster applications, providing good workability, improved bonding, smoother finish and better crack control.
- Overall, recycled Shadu clay shows promising applications in blocks, reinforced panels and thin plaster layers, subject to further optimization of mix proportions, reinforcement and thickness.

- **Further directions to be explored**

- **Research avenues**

- **Pigments with clay-** Study of natural pigments such as red earth, charcoal powder, Multani mitti and yellow oxide with recycled Shadu clay to evaluate colour, bonding, cracking, surface finish and colour stability can be explored further.

- **Applications**

- **3D Printing** – The development of a suitable Shadu clay-based printable mix using different additives can be explored further for 3D printing applications.
- **Ready-Mix Wall Plaster** – The development of a standardized ready-mix formulation using recycled Shadu clay and suitable additives can be explored further, particularly for thin plaster applications where promising results were observed

- **Testing**

- **Test for moisture resistance or absorption, water sensitivity**
- **Compressive strength testing**
- **Testing for heavy metals in recycled clay**
- **Plasticity tests**

- Shrinkage test
 - Organic material content
 - Mould formation
- Cost effectiveness
 - Study of cost effectiveness of each ingredient and formulation and Comparative costings
 - Rural versus Urban applications
 - The appropriate application of the recycled shadu clay also depends on the availability of the materials of the formulations in a rural or urban context.

Annexures

Properties tables

SHADU CLAY PROPERTIES	Description	Reason	Link of Research paper from where data is taken
Mechanical and structural properties			https://www.jetir.org/papers/JETIR2412744.pdf https://www.atamanchemicals.com/bentonite_u29661/ https://thesharadgroup.com/bentonite-clay-6-benefits-and-uses/ Naturally occurring bentonite clay: Structural augmentation, characterization and application as catalyst

Shrinkage Compensation	Moderate	Pure clay lacks a physical skeleton. Without aggregates, the volume loss during drying triggers massive surface cracks	Shrinkage and Cracking Behavior of Earthen Plaster (ResearchGate)
Compressive strength	Low	Raw, unfired Shadu clay possesses a baseline compressive strength of only 1.8 to 3.5 MPa. Because it is an unbaked, air-dried earthen material, its internal cohesion relies entirely on weak van der Waals forces and dried hydrogen bonds between clay platelets. Without cementitious hydration or ceramic vitrification (firing), the structural matrix collapses easily under concentrated perpendicular loads.	
Tensile strength	Low	The material displays an exceptionally poor tensile/flexural strength threshold (<0.6 MPa). Pure clay mineral structures are highly brittle under tension. Shadu clay lacks an internal fibrous network or interlocking gravel-sized particles. When subjected to pulling or cantilever forces, micro-fissures propagate instantaneously through the material, causing clean, catastrophic shearing.	
Granular packing	Bad to average	Natural riverbed Shadu clay is a highly poorly graded or gap-graded material. The material consists almost exclusively of ultra-fine particles (<2 microns) and silt fractions. It lacks a continuous spectrum of particle sizes (such as coarse or medium sand aggregates). Without smaller particles filling voids between larger particles to form a stable physical skeleton, the internal matrix lacks aggregate-to-aggregate frictional interlocking	
Plasticity	Moderate	It holds its shape reliably when molded without being overly sticky or hyper-elastic.	
Thermal and moisture			

properties			
Thermal mass and breathability	High	It absorbs heat slowly and allows vapor passage easily. Its high thermal mass enables it to buffer surrounding ambient temperatures by storing thermal energy. Furthermore, its open micro-porous structure gives it high water vapor permeability	
High Hydrophilic Sensitivity (water loving)	High	Disintegrates rapidly upon immersion. When liquid water comes into contact with the dry matrix, capillary action pulls water deep into the micro-pores. This instantly neutralizes internal capillary pressure, resulting in rapid slaking	
Porosity changes	Low porosity	Once compacted and fully dried, the material forms a dense, tightly packed microtexture.	
Chemical and surface properties			
Alkalinity and inertness	Neutral	pH = 7.1, It is an weathered secondary sediment that is chemically stable and non-reactive with standard organic pigments or structural binding agents.	
Surface "Dusting" Tendency:	High	The outermost dried layer sheds a fine clay powder when handled. Because there is no chemical or fused binder holding them down, these unbonded surface particles loosen, causing a "chalking" effect that can interfere with paint adhesion.	
Outer surface texture	Moderately rough	Scanning electron profiles of Shadu clay reveal an irregular micro-topography composed of flat, overlapping flakes.	
Application			
Because of its extreme water sensitivity (rapid slaking) and low tensile strength, pure, unrefined Shadu Mati cannot be used as an outdoor, load-bearing building block or structural facade panel.			

Environmental impact			
Any gas emissions ?	No		
User group			
Villagers and Urbanites			

RICE HUSK PROPERTIES	Description	Reason	Link of Research paper from where data is taken
Mechanical and structural properties			https://www.researchgate.net/publication/318550046_Microstructure_and_Tensile_Properties_of_Various_Varieties_of_Rice_Husk https://www.researchgate.net/publication/355107496_Production_of_Light_Weight_Blocks_Using_Rice_Husk
Shrinkage Compensation	Moderate	They balance each other's structural stresses perfectly. As the Shadu Mati contracts aggressively (10% to 15%) during water evaporation, it pulls inward and hits the rigid, non-shrinking silica shells of the rice husk. The husks act as a protective internal skeleton, forcing the clay to shrink uniformly in tiny micro-pockets rather than splitting the block apart.	

Compressive strength	Low	Because of porous nature	
Tensile strength	Low	Particles do not get along well to resist bending	
Granual packing	very good	the particles between the clay filled with rice husks create highly porous block	
Thermal and moisture properties			
Thermal mass and breathability	High insulation and breathability	Because of highly porous nature, open pore network allows the dense clay to breathe, absorbing and releasing room humidity seamlessly	
High Hydrophilic Sensitivity (water loving)	Very water loving	rice husks catch water	
Porosity changes	Highly porous block	Air cavities inside rice husks	
Chemical and surface properties			
Alkalinity and inertness	Chemically inert	coexist passively without any chemical bonding	
Surface "Dusting" Tendency:	Low	On the exterior face, the clay cannot fully encapsulate the smooth, protruding rice husk flakes.	
Outer surface texture	Rough		
Ratios	Reason		

1:1	Create a lot of air pockets which absorbs sound and traps heat		
Application			
Acoustic panels	absorbs sound		
in fill blocks	Stores heat in pores		
Environmental impact			
Any gas emissions ?	No gas emissions		
Cost			
Shadu mati			
Rice husk			
User group			
Villagers	readily available locally		

COW DUNG PROPERTIES	Description	Reason	Link of Research paper from where data is taken
Mechanical and structural properties			https://www.irjet.net/archives/V5/i10/IRJET-V5I10364.pdf https://pmc.ncbi.nlm.nih.gov/articles/PMC12948849/
Shrinkage Compensation	Moderate and less visible cracks.	Soluble organic binders and micro-cellulose strands within cow dung form an internal mesh. As the Shadu clay loses its internal water volume, these fibers absorb tensile stresses evenly rather than allowing deep macro-cracks to split the core	https://www.scribd.com/document/418136647/KnO-100068-Utilization-of-Cow-dung-in-Brickmaking

		open. cowdung also act as a reinforcing agent which reduces concentrated cracks.	
Compressive strength	Low (Moderate if bricks stabilized with about 15–30%)	Excessive content of cowdung reduces strength and density. 15–30% cow dung showed increased dry compressive strength and acceptable wet strength, confirming suitability for non-load-bearing applications. The best ratio for addition is 20% to 30% that gives the desired properties for a brick.	EFFECT OF COWDUNG AND COIR IN STRENGTHENING OF CLAY BRICKS https://rjwave.org/ijedr/papers/IJEDR2504753.pdf
Tensile strength	Moderate	Fibres in cowdung takes the tensile stress when clay shrinks after the water from clay is evaporated.	
Granual packing	Good	the particles between the clay filled with cowdung fibres.	
Plasticity	Good	Addition of cowdung enhances the plasticity of clay because of its nature.	
Thermal and moisture properties			
Thermal mass and breathability	High insulation and breathability	Thermo-physical investigations show that adding cow dung can significantly lower thermal conductivity and	https://rjwave.org/ijedr/papers/IJEDR2504753.pdf

		diffusivity of clay bricks, improving their insulation performance.	
High Hydrophilic Sensitivity (water loving)	Moderate	Reduce water absorption up to an optimum dosage, though over-addition can compromise mechanical performance.	
Porosity changes	Slightly Porous	Cowdung creates some gaps in the block which makes it slightly porous. And When fibers are burnt out, it leave cavities within the brick which reduce the unit weight and improve thermal characteristic	
Chemical and surface properties			
Alkalinity and inertness	Slightly alkaline	Fresh cow dung naturally has a weakly alkaline profile, typically hovering around pH 7.4 to 8.4. Shadu mati (kaolinite clay) tends to be neutral	
Surface "Dusting" Tendency:	Moderate		
Outer surface texture	Rough	Fibrous nature of cowdung make surface rough.	
Ratios	Reason	Research paper referred	
Shadu clay: Cowdung=			

1:1			
Shadu clay: Cowdung= 3:1	If bricks stabilized with about 15–30% cowdung, then they are of moderate strength.	https://www.scribd.com/document/418136647/KnO-100068-Utilization-of-Cow-dung-in-Brickmaking	
Application			
Acoustic panels	Superior sound-dampening qualities, ideal for interior office barriers or home theater backdrops		
Non load bearing in fill blocks	Good insulating properties		
Breathable Thermal Plaster (Gobri Lep)	Because of its breathability, applied directly over raw masonry walls. This plaster creates a smooth, crack-resistant outer layer that blocks external liquid rain while regulating indoor ambient humidity		
Environmental impact			
Any gas emissions ?	No gas emissions		
Cost			
Shadu mati			
Cowdung			
User group			
Villagers	readily available locally		

PAPER MACHE (CORRUGATED SHEET) PROPERTIES	Description	Reason	Link of Research paper from where data is taken
Mechanical and structural properties			
Shrinkage Compensation	Highly Compensated (Shrinkage is heavily mitigated)	The long, interlocking cellulose micro-fibres from the corrugated sheets create a stable internal structural skeleton. As moisture evaporates, the capillary pressure that pulls clay particles closer together is resisted by the tensile skeleton of the fibers. Studies on earth-construction materials confirm that introducing organic fibrous pulp can cut matrix drying shrinkage by up to 80%, minimizing crack risks in thick sections	https://www.researchgate.net/publication/319260452_Effects_of_fibre_reinforcement_in_the_shrinkage_behaviour_of_compacted_clay
Compressive strength	Decreases	Paper pulp introduction inherently disrupts the dense, continuous, stone-like matrix of dried clay. Because cellulose fibers are compressible and elastic, substituting rigid clay mass with soft pulp drops raw compressive load thresholds.	https://www.researchgate.net/publication/286168515_Re-Pulped_Waste_Paper-Based_Composite_Building_Materials_with_Low_Thermal_Conductivity
Tensile strength	Improved	Fibre content leads to improved tensile strength, as	
Granular packing	Disrupted and interrupted.	The addition of corrugated pulp interrupts this uniform packing structure. Cellulose fiber bundles have irregular, long morphologies that physically separate the dense clay platelets. This creates micro-scale spatial pockets, shifting the material from a purely continuous dense mineral matrix to a highly complex, heterogeneous network filled with micro-voids	

Thermal and moisture properties			
Thermal mass and breathability	Decreased Thermal Mass;_hence good insulator with Drastically Increased Breathability	The introduction of paper pulp lowers the composite's density and thermal conductivity, lowering its thermal mass while acting as a natural insulator. Simultaneously, the interconnected fibrous network allows gas molecules to migrate freely, facilitating vapor diffusion and breathability.	
High Hydrophilic Sensitivity (water loving)	Highly	the cellulose fibers actively absorb moisture via capillary action, while the clay particles swell.	
Porosity changes	Significantly Increased Porosity.	Porosity increases because the fibers themselves are hollow and porous (lumen structures), and they prevent the clay from packing tightly together. Scanning electron microscopy (SEM) and physical absorption testing of cellulose/clay composites confirm that as fiber concentration rises, mass density drops while total pore volume expands significantly. [1, 2, 3, 4, 5]	
Chemical and surface properties			
Alkalinity and inertness	Mildly Alkaline to Neutral ; Chemically Stable.	Pure river clay is chemically inert. Corrugated paper pulp contains residual processing elements from kraft pulping, including trace calcium carbonates (CaCO_3) used as fillers and sodium-based processing salts, imparting a mild alkalinity (pH 7.5 to 8.5) to the wet mixture. Once dry, the entire composite is chemically stable and does not react with organic paints or coatings.	
Surface "Dusting" Tendency:	Decreased	The internal cellulose fibers act as a microscopic netting that binds loose surface clay particles,	https://www.sciencedirect.com/science/article/abs/pii/S01

		anchors the surface particles and eliminates chalky dusting.	44861715007754
Ratios	Reason	Research paper referred	
Shadu clay: Paper pulp= 8:5.5	According to the paper, natural starch acts as an abundant, low-cost "green strength additive" and filler that provides mechanical reinforcement when blended into a composite material matrix. And, The 8:5.5 ratio provides the ideal balance between structural strength and sculptural workability.	https://www.sciencedirect.com/science/article/abs/pii/S0144861715007754	
Application	Reason		
Eco-Friendly Wall Plasters & Finishes	Cellulose fibres prevent cracking and creates highly breathable finishes.		
Acoustic & Thermal Insulation Panels	Decreased Thermal Mass;_hence good insulator with Drastically Increased Breathability		
Architectural mouldings	Lightweight alternative		
Non-load bearing partition bricks	Lightweight alternative		
Environmental impact			
Any gas emissions ?	No gas emissions		
Cost			
Shadu mati			
Corrugated sheet			

User group			
Urbanites	readily available locally in urban areas.		

SAWDUST PROPERTIES	Description	Reason	Link of Research paper from where data is taken
Mechanical and structural properties			https://www.researchgate.net/publication/319532974_Evaluation_of_Lime_Treated_Mixed_Sawdustas_Fractional_Replacement_for_Sand_in_the_Production_of_Sandcrete_Hollow_Blocks https://www.mdpi.com/2411-9660/5/3/57 https://www.researchgate.net/publication/386045948_Sawdust_As_A_Sustainable_Substitute_Experimental_Insights_On_Lightweight_Concrete_For_Non-Load-Bearing_Members
Shrinkage Compensation	Linear Shrinkage decreases.	Raw Shadu mati consists of fine, highly expansive clay minerals (like montmorillonite or illite) that absorb water and contract aggressively upon drying. Introducing sawdust fibers creates an internal mechanical skeleton, disrupting continuous clay contraction and arresting micro-cracks before they spread	https://www.researchgate.net/publication/354600417_Influence_of_Sawdust_Particle_Sizes_on_the_Physico-Mechanical_Properties_of_Unfired_Clay_Blocks
Compressive strength	Decreases		https://www.researchgate.net/publication/354600417_Influence_of_Sawdust_Particle_Sizes_on_the_Physico-Mechanical_Properties_of_Unfired_Clay_Blocks

Tensile strength	Decreases when the % exceeds 2.5%	Incorporating a small amount of sawdust (around 2.5%) initially improves shadu clay's bonding strength, but higher concentrations lead to a sharp decline in tensile strength, according to studies. Higher sawdust percentages disrupt the clay matrix and create internal voids, resulting in poor adhesion and accelerated stress-related failure	https://www.sciencedirect.com/science/article/pii/S2772912525000843
Granular packing	Decreases	The sawdust disrupts the dense granular packing of the fine clay, reducing bulk density and creating a more porous, lighter materia	
Thermal and moisture properties			
Thermal mass and breathability	Thermal mass decreases (Increasing its insulation propoerties) with increase in breathability	The addition of porous organic matter creates microscopic air voids, lowering thermal conductivity by 22% to 43%	https://www.mdpi.com/2673-7108/2/4/16
High Hydrophilic Sensitivity (water loving)	Increases	Adding sawdust to shadu clay significantly increases the hydrophilic sensitivity of bricks by accelerating water absorption. The sawdust introduces organic components and creates micro-porosity, which boosts capillary water absorption and can lead to poor dimensional stability. Research indicates this increased	
Porosity changes	Porous		

		moisture sensitivity often requires protective coatings or limits usage to indoor applications	
Chemical and surface properties			
Alkalinity and inertness	Neutral and low chemically inert (if not fired)	Pure shadu clay naturally sits at a highly stable pH of approximately 7.0 (neutral). When raw wood sawdust is added, the natural organic resins and tannic acids inside the wood can introduce mild acidity. However, clay minerals have a built-in buffering capacity that absorbs these hydrogen ions. This prevents major chemical shifts, keeping the raw mix safely near-neutral	
		Sawdust retains an affinity for moisture. If the unfired brick is subjected to a humid environment, the raw sawdust can sprout fungal growth, rot, or mold, which eventually degrades the structural integrity of the clay matrix	
Surface "Dusting" Tendency:	Moderate	Raw sawdust expands when wet and shrinks as it dries. This constant micro-movement breaks the physical grip between the clay particles and the smooth wood fibers.	
Ratios	Reason	Research paper referred	
Shadu clay: Sawdust= 1:1		https://www.sciencedirect.com/science/article/pii/S2772912525000843	

Shadu clay: Sawdust= 3:1	Research highlights 10% sawdust by weight as an optimal addition, reducing thermal conductivity by 30%.		
Application	Reason		
Acoustic & Thermal Insulation Panels	Superior sound-dampening qualities, ideal for interior office barriers or home theater backdrops		
Non load bearing in fill blocks	Good insulating properties		
Breathable Thermal Plaster (Gobri Lep)	Because of its breathability, applied directly over raw masonry walls. This plaster creates a smooth, crack-resistant outer layer that blocks external liquid rain while regulating indoor ambient humidity		
Environmental impact		Research paper referred	
Any gas emissions ?	Dry & Raw: Safe; almost no gas emissions.	https://www.nature.com/articles/s41598-025-00365-z	
	Wet & Raw: Emits greenhouse/odorous gases (Carbon dioxide, methane) due to rotting sawdust.		

	Baking/Firing: Emits high amounts of combustion gases (Carbon dioxide, CO, steam) as the sawdust burns out to leave porous holes		
Cost			
Shadu mati			
Sawdust			
User group			
Urbanites and villagers	sawmills, Industrial Block Board & MDF Pallet Factories produces a lot of sawdust		

RANGOLI PROPERTIES	Description	Reason	Link of Research paper from where data is taken
Mechanical and structural properties			https://www.researchgate.net/publication/354445838_Soil_Improvement_Using_Waste_Marble_Dust_for_Sustainable_Development
Shrinkage Compensation	No structural cracks if mixed with rangoli	Shadu mati has a high plasticity and water-retention capacity, meaning it shrinks drastically and cracks when drying. Rangoli powder consists of non-plastic, rigid crystalline particles. When mixed, the rangoli particles occupy space and break the continuity of the shrinking clay, significantly reducing structural cracks.	
Compressive strength	moderate	Because of packed rangoli particles	

Tensile strength	Without fibres (jute etc.) it is brittle	(resistance to pulling/bending) remains very low. Without added fibers (like jute), the dried plaster will be brittle and prone to snapping under stress.	
Granual packing	Good- highly dense compact plaster	The fine clay particles perfectly fill the microscopic voids between the larger rangoli grains	
Thermal and moisture properties			
Thermal mass and breathability	excellent breathability (vapor permeability)	It allows indoor humidity to pass through the wall naturally, creating a cooling effect in tropical climates.	
High Hydrophilic Sensitivity (water loving)	highly vulnerable to moisture	If exposed to rain or high humidity, the clay will re-hydrate, soften, and wash away	
Porosity changes	If unsealed it can absorb oil and other stains	: Rangoli powder increases the macro-porosity of the plaster. While this helps it dry uniformly from the inside out	
Chemical and surface properties			
Alkalinity and inertness	plaster won't chemically degrade or emit toxic fumes over time	Shadu is slightly alkline to neutral and rangoli is inert. So, chemical reaction and no fumes.	
Surface "Dusting" Tendency:	If the proportion of rangoli powder is too high (above 40%), dusting happens	there won't be enough Shadu mati paste to coat every grain. This results in a "dusting" effect, where the surface feels chalky and rubs off on clothes or hands.	

Color Neutralization	Red earth, yellow oxide, multani mitti		
Ratios	Reason	Research paper referred	
Shadu clay: Rangoli= 3:1	The 3:1 ratio provides the precise volumetric balance needed to optimize particle packing, mitigate drying shrinkage, and maximize the mechanical strength of the clay block. The 3:1 matrix optimization follows established soil-stabilization and ceramic packing models, where a ~25% volumetric substitution of highly plastic clay with calcium carbonate aggregates minimizes drying shrinkage while maintaining binder film continuity.	https://www.sciencedirect.com/science/article/abs/pii/S0950061823005044	
Application	Reason	Research paper referred	
Plaster	Smooth surface finish, reduced cracks	https://www.sciencedirect.com/science/article/abs/pii/S0950061823005044	
Panels			
Environmental impact		Research paper referred	
Any gas emissions ?	No		

Cost			
Shadu mati			
Rangoli			
User group			
Urbanites and villagers			

COCO PEAT PROPERTIES	Description	Reason	Link of Research paper from where data is taken
Mechanical and structural properties			https://www.mdpi.com/2673-7108/2/4/16
Shrinkage Compensation	Excellent	highly flexible fibers bridge micro-cracks during drying.	
Compressive strength	Lower	As the coco peat is not a strong material, the porous nature keep it lower in compressive strength.	
Tensile strength	Moderate	Moderate because, the particles are shorter, create moderate tensile strength when shadu clay releases water after evaporation.	
Granual packing	Coco peat interrupts packing	They are not easily bonding material, and when mixed with clay, it reduces the binding capacity.	
Thermal and moisture properties			
Thermal mass and breathability	Highly breathable	The block can absorb and release moisture.	
High Hydrophilic Sensitivity (water loving)	Highly water loving	water vapor can move through the material more easily.	
Porosity changes	More porous than sawdust	Coco peat contracts	

Chemical and surface properties			
Alkalinity and inertness	Neutral to slightly alkaline and slightly chemically inert	The composite is less alkaline than cement-based materials because neither shadu mati nor coco peat contains the highly alkaline calcium compounds found in cement, and it is not completely inert because the organic coco peat can slowly biodegrade and interact with moisture and microorganisms over time.	
Surface "Dusting" Tendency:	Moderate	fine clay particles on the surface can become detached under abrasion or weathering, especially if the unfired shadu mati block is insufficiently stabilized or protected	
Ratios	Reason	Research paper referred	
Shadu clay: Coco peat= 1:1	Ratio is kept same but methods are changed.		
	1. Dry mix: coco peat and shadu mati both should first be mixed in dry state and then the dough should be made.		

	2. Wet mix: The block should be made of Shadu clay and coco peat. In this specific block, Shadu Mati dough should be mixed with the wet coco peat obtained from the process of squeezing the water out after keeping it in water for 1 hour. Because, The researchers state that coir pith (coco peat) is an exceptional moisture-retention material. When it is treated and pre-soaked, it directly enhances "internal curing" within the core of the mixture. This internal moisture retention maintains a uniform hydration state throughout the block, which is scientifically proven to "reduce or completely rid of certain crack problems like thermal shrinkage	https://www.sciencedirect.com/science/article/abs/pii/S2214785320408405	
Application	Reason		
1:1			
Adobe bricks	Ideal for forming unbaked insulation bricks.		
3:1			
Acoustic & Thermal Insulation Panels	Superior sound-dampening qualities, ideal for interior office barriers or home theater backdrops.		
Environmental impact			
Any gas emissions ?	No		
Cost			
Shadu mati			
Coco peat			

User group			
Urbanites and villagers	Coco peat blocks and processed Shadu mati are vastly more available in urban areas through commercial supply chains, whereas raw, unprocessed forms are tied closer to specific rural geographical region		

COCO COIR PROPERTIES	Description	Reason	Link of Research paper from where data is taken
Mechanical and structural properties			https://www.sciencedirect.com/science/article/pii/S0926641019300904
Shrinkage Compensation	Highly compensated	By arresting microscopic shifts in the clay as it loses moisture, the fibers prevent surface micro-cracks from expanding into deep structural fractures.	
Compressive strength	Increases (if 0.75% fibre is added)	The maximum value of unconfined compressive strength and secant modulus obtained in clay with coconut fiber reinforcement is 0.75% of the mixed soil weight.	https://www.researchgate.net/publication/353312129_Unconfined_Compressive_Strength_of_Clay_Strengthened_by_Coconut_Fiber_Waste
Tensile strength	Increases	The fibrous network of the coir distributes drying stresses evenly throughout the block, reinforcing the clay against pull-apart forces.	
Granular packing	Coco peat interrupts packing	Pure Shadu mati consists of flat, microscopic clay platelets packed tightly together. When relatively massive, highly textured, cylindrical macro-particles of coir are mixed, this interrupts the close,	

		continuous packing of the clay particles.	
Plasticity	Decreases if the proportion of coir fibres are increased	When large fibres are mixed in good proportion, it increases plasticity. but when the coir proportion is increased, the clay binding and workability properties reduces.	https://www.scribd.com/document/595788384/Experimental-Study-On-Stabilization-Of-Clay-Soil-Using-Coir-Fibre
Thermal and moisture properties			
Thermal mass and breathability	Moderate thermal mass and breathability	Stores slightly less heat, but slows down heat movement.	
Hydrophilic Sensitivity (water loving)	High	Coir fibers create an interconnected network of micro-channels. When the dry block touches water, the coir fibers act like natural wicks, actively pulling water deep into the core of the block via capillary action. The block absorbs water much faster than a pure clay block.	
Porosity changes	Moderate	Interconnected fibrous pores let the block "breathe".	
Chemical and surface properties			
Alkalinity and inertness	Neutral and chemically inert	The block is chemically inert, but it is highly biologically active and physically reactive.	
Surface "Dusting" Tendency:	Reduces	The coir fibers act like thousands of tiny anchors right up to the surface skin of the block. They lock the loose clay particles in place, physically preventing them from sloughing off as loose	

		dust.	
Outer surface texture	Rough	Coir fibres makes the surface rougher.	
Ratios	Reason	Research paper referred	
Shadu clay: Coco coir= 4:3	For non-structural insulation panels, increasing coconut fiber content, such as a 4:3 volume ratio, reduces dry density and improves thermal insulation performance. While decreasing compressive strength, this high-fiber, non-load-bearing design maximizes thermal benefits through internal air pores	https://www.sciencedirect.com/science/article/pii/S2405844024147834	
Application	Reason		
Thermal insulation panels			
Environmental impact			
Any gas emissions ?	No		
Cost			
Shadu mati			
Coco coir			
User group			

Villagers and urbanites	Raw materials originate entirely in rural coastal areas but are heavily processed, distributed, and purchased within urban centers.		
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Tapioca starch

Property	Description	Reason	Link of Research paper from where data is taken
	Incorporating it into plaster mixtures significantly increases wet mix viscosity to reduce sagging, lowers final drying shrinkage by 5%, and increases both early compressive strength by up to 20% and substrate bond strength by roughly 60%	Adding tapioca starch makes wet plaster thicker so it does not slide off walls, helps it stick 60% tighter, makes it 20% stronger as it hardens, and stops it from shrinking and cracking.	https://www.researchgate.net/publication/382922664_Experimental_Study_on_the_Effects_of_Tapioca_Starch_on_Cement_Mortar_Quality_Improvement

Fenugreek water

Property	Description	Reason	Link of Research paper from where data is taken
	The paper also contains the information about organic final coatings	The addition of fenugreek water is known to improve the plaster's workability and adhesion. e solution is prepared by grinding the seeds and soaking the resultant powder overnight. is is then mashed and sieved to remove particles. e water is added to the plaster before application.	https://www.researchgate.net/publication/385796356_Traditional_Building_Knowledge_in_Indian_Lime_and_Earthen_Plasters

Dink (Guggul/ Gum Arabic)

Property	Description	Reason	Link of Research paper from where data is taken

The associated microstructural research found that GA creates a continuous biopolymer film that bridges and binds clay particles, with hydrogen bonding contributing to the clay–GA interaction.	It was shown that with the increase of GA content the flexural strength (maximum by 150%) and axial compression strength (no more than by 170%) improved.	https://www.science-direct.com/science/article/abs/pii/S2352710226010570?utm_source=chatgpt.com
		https://www.researchgate.net/publication/378976029_Assessment_of_the_Mechanical_and_Thermal_Properties of Local Building Materials Stabilised with Gum Arabic in the Draa-Tafilalet Region South-East Morocco
		https://www.science-direct.com/science/article/abs/pii/S0950061822036819
		https://www.science-direct.com/science/article/abs/pii/S0950061824040078

- Observation tables

https://docs.google.com/spreadsheets/d/1sKdcBzlttsuy7kJpxF2F8ZSGmqi4ljD/e/dit?usp=drive_link&oid=106031339386393516528&rtpof=true&sd=true

Blocks

1. Shadu mati_SM

Sr. no.	Size (lxwxh)	Materials	Proportion (in volume)	Volume (cups)	Water required (cups)	Curing time (days)	Weight of Block in kg (in wet state)	Weight of Block in kg(In dry state)
1	3.5" x 3.5" x3.5"	Shadumati	1	10	4	3	1	0.81
2	The block is made only out of Shadu clay.							
4	Observations							

	Separate each layer of the corrugated sheet. Soak it for 2 hours in water. After 2 hours and grind it to make its pulp consistency.							
4 Observations								
Mix	The rough texture of the paper mache made it very difficult to blend evenly with the shadu mati when kneading the dough.							
Wet weight	Lighter than R1, R2, R3 and C1							
Dry weight	Lighter than R1, R2, R3 and C1.							
Shrinkage	No shrinkage and cracks.							
Bonding	Its cohesive property with Shadu Mati was low in quality, but the block made is moderately stable.							
Dusting	Moderate							
Fungus growth	There is no fungus growth found on block.							
Efflorescence	No efflorescence.							
Surface finish	Slightly rough than R1, R2 and R3.							
5 Inference								
	The fibers in corrugated pulp resists uniform blending, making kneading difficult. However, this fibrous grid effectively anchors the clay particles to eliminate shrinkage cracks, while trapped internal micro-voids significantly reduce the final dry weight, producing a lightweight block.							
7. Shadu mati + Coco peat_CP1								
Sr. no.	Size (lxwxh)	Materials	Proportion (in volume)	Volume (cups)	Water required (cups)	Curing time (days)	Weight of Block in kg (in wet state)	Weight of Block in kg (In dry state)
1	3.5" x 3.75" x3.5"	Shadu mati	1	6	4	3	1	0.95
		Coco peat	1	6				
2 The block is made of Shadu clay and coco peat. In this specific block, shadu mati and coco peat are mixed in their dry state and then water is added as required to make a dough.								
3 Why Coco peat?								
	Coco coir provides long, hairy fibers for skeletal strength. It might provide structural strength to the block while reducing the weight of the block.							

Mix	It was comparatively (compared to CP1) less hard to mix, as coco peat has very less cohesive property. Also, as the coco peat was already wet earlier, while mixing it with clay dough, lesser water required.
Wet weight	Moderate
Dry weight	Lesser than CP1.
Shrinkage	No shrinkage and cracks.
Bonding	Its cohesive property with Shadu Mati was low in quality, but the block made is moderately stable.
Dusting	Low
Fungus growth	There is no fungus growth found on block.
Efflorescence	No efflorescence.
Surface finish	slightly rough.

5	Inference
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Pre-soaking coco peat successfully controls water demand and particle distribution, serving as an efficient volume extender that forces massive weight reduction (55% mass loss). Despite low material cohesion, the spongy peat matrix absorbs internal drying stresses, eliminating shrinkage cracks to deliver a remarkably lightweight, moderately stable block.

9. Shadu mati + Sawdust_SD1

Sr. no.	Size (lxwxh)	Materials	Proportion (in volume)	Volume (cups)	Water required (cups)	Curing time (days)	Weight of Block in kg (in wet state)	Weight of Block in kg (In dry state)
1	3.5" x 3.5" x 3.5"	Shadu mati	1	8	4	2	0.85	0.65
		Sawdust	1	8				
2	The block is made of Shadu clay and Sawdust. In this specific block, Shadu Mati dough is mixed in equal proportion.							
3	Why Sawdust?							
	Sawdust acts as a lightweight organic filler, a structural binder. It can also act as an ingredient which might help in reducing the weight of block. Also, It is the most generated waste in the furniture and architecture industry, which makes it sustainable in using in the applications.							
4	Observations							

Mix	Adding ricehusk makes the shadu clay mix very hard to knead than any other additive because of its sharp structure.							
Wet weight	Lesser.							
Dry weight	Very lightweight.							
Shrinkage	No shrinkage and cracks.							
Bonding	Its cohesive property with Shadu Mati was moderate in quality. But, Shadu mati formed moderately bonded lightweight block.							
Dusting	Moderate							
Fungus growth	There is no fungus growth found on block.							
Efflorescence	No efflorescence.							
Surface finish	Highly rough.							
5	Inference							
	The rigid, sharp structure of rice husk increases internal friction, making kneading difficult and resulting in a highly rough surface. However, it acts as an effective micro-structural grid that eliminates drying cracks, while its high water evaporation creates porous internal air gaps, confirming its potential as a lightweight thermal barrier.							
12. Shadu mati + Cow Dung_CD1								
Sr. no.	Size (lx wxh)	Materials	Proportion (in volume)	Volume (cups)	Water required (cups)	Curing time (days)	Weight of Block in kg (in wet state)	Weight of Block in kg(In dry state)
1	3.5" x 3.5" x3.5"	Shadu mati	1	6	1	3	0.95	0.7
		Cow Dung	1	6				
2	The block is made of Shadu clay and Cow Dung. In this specific block, proportion of shadu mati and cowdung has been kept equal.							
3	Why Cow dung?							
	Cow dung might act as organic reinforcing agent and filler.							
4	Observations							
Mix	Adding cowdung in equal proportions makes the shadu clay mix very easy to knead than any other additive because of its soft nature. As cow dung naturally contains a lot of water content, the need for the extra water is reduced.							

	Jute sheet possess high tensile strength, a porous mesh structure and natural flexibility. Their lightweight yet robust nature significantly improves structural ductility while remaining highly cost-effective and environmentally sustainable. Also, because of its porous nature, shadu mati mixture might bond nicely with sheet.						
5	Observations						
Mix	In making of the dough with equal proportions of Shadu mati and Rangoli, as they both are in same proportions, it becomes hard to create a dough, because rangoli reduces clay binding property slightly. But addition of enough water create a good dough.						
Surface	smoother.						
Weight	The panel is heavy in weight.						
Shrinkage	The panel has not developed any cracks.						
Bonding	The panel is bonded with jute sheet. (moderately stable)						
6	Inference						
	Panel is stable for the thickness. It should be explored in lesser thickness. And fibres can be added to reduce weight.						
Panel 1.1_Shadu: Rangoli= 1:1_Jute_12mm							
Sr. no.	Thickness	Materials	Proportion	Volume (cups)	Water required (cups)	Curing time	Weight of panel
1	12 mm	Shadu mati	1:1	9	4	2-3 days	Not stable
		Rangoli		9			
		Jute sheet as reinforcement	1' x1' x 0.5mm				
2	The 12 mm thick sandwich panel is constructed using a core of jute sheet, clad on both the top and bottom with a 6 mm layer of dough of shadu mati and rangoli.						
3	Why Rangoli?						
	As per the analysis of blocks created, the Shadu mati+ Rangoli block had created smooth finished surface, which is necessity in making panel.						
4	Observations						

Mix	In making of the dough with equal proportions of Shadu mati and Rangoli, as they both are in same proportions, it becomes hard to create a dough, because rangoli reduces clay binding property slightly. But addition of enough water create a good dough.						
Surface	smoother.						
Weight	The panel is heavy in weight.						
Shrinkage	After the block is dried, as the thickness of the panel is less, and both the layers are 6mm thk, the panel started cracking a lot and ultimately failed because of its brittleness.						
Bonding	The panel does not get bonded with the jute sheet and both the layers of the shadu mati and rangoli mixture came out and got separated from jute sheet.						
6	Inference						
	Another fibre option should be explored to prevent from cracking.						
Panel 1.2_Shadu: Rangoli: Sawdust= 3:1:1_Jute_20mm							
Sr. no.	Thickness	Materials	Proportion	Volume (cups)	Water required (cups)	Curing time	Weight of panel
1	20 mm	Shadu mati	3:01:01	12	6	2-3 days	1.7kg- Not stable
		Rangoli		4			
		Sawdust		4			
		Jute sheet as reinforcement	1' x1' x 0.5mm				
2	The 20 mm thick sandwich panel is constructed using a core of jute sheet, clad on both the top and bottom with a 10 mm layer of dough of shadu mati and rangoli.						
3	Why Rangoli?						
	As per the analysis of blocks created, the Shadu mati+ Rangoli block had created smooth finished surface, which is necessity in making panel.						
4	Why Sawdust?						
	Shadu mati proportion has been increased in this panel, as cracks were developed when both shadu mati and rangoli proportion were same. And to further reduce the possibility of cracking sawdust is intriduced as fibre, which might reinforce the panel.						

4	Observations						
Mix	In making of the dough of shadu clay along with rangoli, sawdust in lesser proportion, it becomes comparatively less hard, because rangoli reduces clay binding property slightly.						
Surface	Slightly rougher than previous only rangoli and shadu mati panels.						
Weight	The panel is slightly less heavy in weight.						
Shrinkage	After the panel is dried, the panel started cracking slightly , but did not failed completely.						
Bonding	The panel moderately bonded with the jute sheet and both the layers of the shadu mati.						
6	Inference						
	Another fibre option should be explored to completely prevent from cracking.						
Panel 1.3_Shadu: Rangoli: Coco coir= 3:1:1_Jute_10mm							
Sr. no.	Thickness	Materials	Proportion	Volume (cups)	Water required (cups)	Curing time	Weight of panel
1	10 mm	Shadu mati	3:01:01	9	4	2-3 days	1.05kg
		Rangoli		3			
		Coco coir		3			
		Jute sheet as reinforcement	1' x1' x 0.5mm				
2	The 10 mm thick sandwich panel is constructed using a core of jute sheet, clad on both the top and bottom with a 10 mm layer of dough of shadu mati and rangoli.						
3	Why Rangoli?						
	As per the analysis of blocks created, the Shadu mati+ Rangoli block had created smooth finished surface, which is necessity in making panel.						
4	Why Coco coir?						
	Shadu mati proportion has been increased in this panel, as cracks were developed when both shadu mati and rangoli proportion were same. And to further reduce the possibility of						

	cracking Coco coir of 25-50mm length is introduced as fibre, which might reinforce the panel more effectively than sawdust.						
4	Observations						
Mix	In making of the dough of shadu clay along with rangoli, coco coir in lesser proportion, it becomes comparatively less hard, because rangoli reduces clay binding property slightly.						
Surface	Fibres came out of surface make it more rougher.						
Weight	The panel is lightest among all earlier options.						
Shrinkage	After the panel is dried, the panel did not shrink at all.						
Bonding	The panel bonded well with the jute sheet and both the layers of the shadu mati.						
6	Inference						
	Coco coir acted as good additive and reinforcement fibre for panel, which prevented it from cracking.						
Panel 2_Shadu: Rangoli= 1:1_Canvas_20mm							
Sr. no.	Thickness	Materials	Proportion / Size	Volume (cups)	Water required (cups)	Curing time	Weight of panel
1	20mm	Shadu mati	1:1	10	4	2-3 days	2.3kg
		Rangoli		10			
		Canvas sheet as reinforcement	1' x1'x 0.75mm				
2	The 20 mm thick sandwich panel is constructed using a core of canvas sheet, clad on both the top and bottom with a 10 mm layer of dough of shadu mati and rangoli.						
3	Why Rangoli?						
	As per the analysis of blocks created, the Shadu mati+ Rangoli block had created smooth finished surface, which is necessity in making panel.						
4	Why Canvas sheet?						
	Jute sheet possess high tensile strength, a porous mesh structure and natural flexibility. It might hold the mixture together in a panel. The porous, woven "tooth" of the canvas sheet gives the wet shadu mati clay a physical surface to grip onto. When the liquid clay is applied, it penetrates the fabric weave and locks into place as it dries.						

5 Observations							
Mix	In making of the dough with equal proportions of Shadu mati and Rangoli, as they both are in same proportions, it becomes hard to create a dough, because rangoli reduces clay binding property slightly. But addition of enough water create a good dough.						
Surface	smoother.						
Weight	The panel is heavy in weight.						
Shrinkage	The panel has not developed any cracks.						
Bonding	The panel is bonded with canvas sheet. (moderately stable)						
6 Inference							
	Another options of panels with reduced thickness can be explored to reduce weight and material.						
Panel 2.1_Shadu: Rangoli= 1:1_Canvas_15mm							
Sr. no.	Thickness	Materials	Proportion	Volume (cups)	Water required (cups)	Curing time	Weight of panel
1	15 mm	Shadu mati	1:1	9	4	2-3 days	Not stable
		Rangoli		9			
		Canvas sheet as reinforcement	1' x1' x 0.75mm				
2	The 15 mm thick sandwich panel is constructed using a core of canvas sheet, clad on both the top and bottom with a 7 mm layer of dough of shadu mati and rangoli.						
3 Why Rangoli?							
	As per the analysis of blocks created, the Shadu mati+ Rangoli block had created smooth finished surface, which is necessity in making panel.						
4 Observations							
Mix	In making of the dough with equal proportions of Shdu mati and Rangoli, as they both are in same proportions, it becomes hard to create a dough, because rangoli reduces clay binding property slightly. But addition of enough water create a good dough.						
Surface	smoother.						
Weight	The panel is moderately heavy in weight.						

Weight	The panel is heavy in weight .
Shrinkage	The panel developed many cracks.
Bonding	After the block is dried, the panel layers on both the sides of the bamboo mat got separated from bamboo mat. The panel does not get bonded with the bamboo mat. Hence, the mixture had poor adherence to bamboo mat .
6	Inference
	But it may have failed because, rangoli was added which might be reducing its adhesiveness to mat..hence, only shadu mati panel aslo needs to be tried.

Plaster

Plaster 1_ Shadu clay (Single layer)

1 Why only Shadu clay?

To test how pure shadu clay behaves when applied as plaster. (as thin material)

2	Observations
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Type of brick	Fly ash brick		Clay brick		Notes
Thickness of plaster	0.5-1mm	2-3mm	0.5-1mm	2-3mm	
Mix	Good, workable		Good, workable		
Cracks	High	Very high	High	Very high	The lesser the thickness, the lesser the cracks
Fungus growth	No	No	No	No	
Dusting	Yes (Moderate-high)	Yes	Yes	Yes	
Surface finish	Slightly rough		Slightly rough		
Peel off	Moderate	Very high	Very high	Very high	
Efflorescence	No	No	No	No	

6	Inference
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Pure shadu clay plaster cannot work on both the materials.

Plaster 2_Shadu clay : Rangoli= 3:1 (Single layer)

1 | Why Rangoli?

	As per the analysis of blocks created, the Shadu mati+ Rangoli block had created smooth finished surface, which is necessity in plaster finish.						
2	Role of Shadu Clay, Rangoli in plaster?						
	Shadu clay as a binder.						
	Rangoli as a mineral filler, to produce a smoother, finer and lighter-coloured surface.						
3	Why proportion- Shadu clay : Rangoli= 3:1						
	If the proportion of rangoli powder is too high (above 40%), dusting happens.						
4	Observations						
Type of brick	Fly ash brick		Clay brick		Notes		
Thickness of plaster	0.5-1mm	2-3mm	0.5-1mm	2-3mm			
Mix	Good, workable		Good, workable				
Cracks	Minor 2-4	Many hairline cracks	Moderate	High			
Fungus growth	No	No	No	No			
Dusting	Yes (Low)	Yes (Low)	Yes	Yes			
Surface finish	Smooth	Rough, uneven	Slightly uneven				
Peel off	No	Yes- Very low.	No	Yes- Moderate			
Efflorescence	No	No	No	No			
6	Inference						
	0.5-1mm thick Plaster of this mix can become workable if coated properly with 2 layers- on Fly ash brick.						
Plaster 3 _Shadu clay : Rangoli : Tapioca starch = 3:1:1 (Single layer)							
1	Why Rangoli?						
	As per the analysis of blocks created, the Shadu mati+ Rangoli block had created smooth finished surface, which is necessity in plaster finish.						
2	Why Tapioca starch?						

	Tapioca starch is the viscous gel like substance which can act as Polymer film/binding network.						
3	How the Tapioca starch is prepared?						
4	Role of Shadu Clay, Rangoli in plaster, Tapioca starch?						
	Shadu clay as a binder.						
	Rangoli as a mineral filler, to produce a smoother, finer and lighter-coloured surface.						
	Tapioca starch as an organic binder, which might reduce cracks.						
5	Why proportion- Shadu clay : Rangoli : Tapioca starch = 3:1:1						
	Shadu clay acts as a binder and rangoli proportion has been derived from earlier observations. Starch is needed to be in the same proportion as rangoli as per research.						
6	Observations						
Type of brick	Fly ash brick		Clay brick		Notes		
Thickness of plaster	0.5-1mm	2-3mm	0.5-1mm	2-3mm			
Mix	Good, workable		Good, workable				
Cracks	Low	High	High	Very high	The lesser the thickness, the lesser the cracks		
Fungus growth	No	No	No	No			
Dusting	No	No	No	No			
Surface finish	Moderately smooth	Highly uneven and rough	Rough	Rough			
Peel off	Yes-Low	Yes- High	Yes- High	Yes- High	When the surface peel off happened on fly ash bricks, both the surface of contact of fly ash brick and plaster developed sponge like porous structure of white colour.		
Efflorescence	No	No	Yes	Yes	Salt efflorescence remained on brick surface(Probably because of Tapioca starch) after the surface peel off.		
7	Inference						

	Only starch addition create cracks and gives very rough finish, peel off, makes it highly unstable.						
Plaster 4_Shadu clay : Rangoli : Sawdust= 3:1:1 (Single layer)							
1 Why Rangoli?							
	As per the analysis of blocks created, the Shadu mati+ Rangoli block had created smooth finished surface, which is necessity in plaster finish.						
2 Why Sawdust?							
	Sawdust acts as a lightweight organic filler, a structural binder. Also, It is the most generated waste in the furniture and architecture industry, which makes it sustainable in using in the applications.						
3 Role of Shadu Clay, Rangoli, Sawdust in plaster?							
	Shadu clay as a binder.						
	Rangoli as a mineral filler, to produce a smoother, finer and lighter-coloured surface.						
	Sawdust acts as Ultra fine chopped fibre to prevent hairline cracks.						
4 Why proportion- Shadu clay : Rangoli : Sawdust= 3:1:1							
	Shadu clay acts as a binder and rangoli proportion has been derived from earlier observations. Fibres are needed to be in the same proportion as rangoli as per research.						
5 Observations							
Type of brick	Fly ash brick		Clay brick		Notes		
Thickness of plaster	0.5-1mm	2-3mm	0.5-1mm	2-3mm			
Mix	Good, workable		Good, workable				
Cracks	No	Moderate	No	Yes- Low			
Fungus growth	No	No	No	No			
Dusting	Very low	Very low	Very low	Very low			
Surface finish	Slightly rough		Slightly rough				
Peel off	No	No	No	No			
Efflorescence	No	No	No	No			
6 Inference							
	Use of sawdust in the mixture of shadu clay and rangoli for plaster, makes it suitable for further plaster mix developments.						

Plaster 5_Shadu clay : Rangoli : Sawdust: Tapioca starch= 3:1:1:1 (Single layer)							
1	Why Rangoli?						
	As per the analysis of blocks created, the Shadu mati+ Rangoli block had created smooth finished surface, which is necessity in plaster finish.						
2	Why Sawdust?						
	Sawdust acts as a lightweight organic filler, a structural binder. Also, It is the most generated waste in the furniture and architecture industry, which makes it sustainable in using in the applications.						
3	Why Tapioca starch?						
	Tapioca starch is the viscous gel like substance which can act as Polymer film/binding network.						
3	Role of Shadu Clay, Rangoli in plaster, Tapioca starch?						
	Shadu clay as a binder.						
	Rangoli as a mineral filler, to produce a smoother, finer and lighter-coloured surface.						
	Sawdust acts as Ultra fine chopped fibre to prevent hairline cracks.						
	Tapioca starch as an organic binder, which might reduce cracks.						
4	Why proportion- Shadu clay : Rangoli : Tapioca starch: Sawdust = 3:1:1 :1						
	Shadu clay acts as a binder and rangoli proportion has been derived from earlier observations. Fibres and tapioca starch are needed to be in the same proportion as rangoli as per research.						
5	Observations						
Type of brick	Fly ash brick		Clay brick		Notes		
Thickness of plaster	0.5-1mm	2-3mm	0.5-1mm	2-3mm			
Mix	Slightly hard to blend in with each other		Slightly hard to blend in with each other				
Cracks	Minor no. - hairline cracks	Moderate nos. - visible cracks	Moderate nos. - visible cracks	High nos.- visible cracks			

Fungus growth	No	No	No	No			
Dusting	No	No	No	No			
Surface finish	Slightly rough	Rough-uneven	Rough	Very rough			
Peel off	No	Yes- High	No	No			
Efflorescence	No	No	No	Yes-Moderate	Bubbles grown on 2mm plaster surface-fly ash bricks		
6	Inference						
	0.5mm plaster on fly ash brick can be explored with this mix.						
Plaster 6_Shadu clay : Rangoli : Fenugreek water = 3:1:1 (Single layer)							
1	Why Rangoli?						
	As per the analysis of blocks created, the Shadu mati+ Rangoli block had created smooth finished surface, which is necessity in plaster finish.						
2	Why Fenugreek water?						
	The addition of fenugreek water is known to improve the plaster's workability and cohesion.						
3	How the Fenugreek water is prepared?						
	Refer the procedure below.						
4	Role of Shadu Clay, Rangoli and Fenugreek water in plaster?						
	Shadu clay as a binder.						
	Rangoli as a mineral filler, to produce a smoother, finer and lighter-coloured surface.						
	Fenugreek water as a natural binder and thickener.						
5	Why proportion- Shadu clay : Rangoli : Fenugreek water = 3:1:1						
	Shadu clay acts as a binder and rangoli proportion has been derived from earlier observations. Binder is needed to be in the same proportion as rangoli as per research.						
6	Observations						
Type of brick	Fly ash brick		Clay brick		Notes		

Thickness of plaster	0.5-1mm	0.5-1mm	
Mix	Good, workable	Good, workable	However, when applied to a fly ash brick surface, this plaster mix is comparatively difficult to apply and does not adhere as easily as the other mixes.
Cracks	Yes - Moderate	Yes - High	
Fungus growth	No	No	
Dusting	No	No	
Surface finish	slightly rough with cracks	Rough	
Peel off	Yes- High	Yes- Low	
Efflorescence	No	No	
7	Inference		
	Fenugreek water addition generate a lot of cracks on the surface of water, providing very rough surface finish.		
Plaster 7_Shadu clay : Rangoli : Dink= 3:1:0.3 (Single layer)			
1	Why Rangoli?		
	As per the analysis of blocks created, the Shadu mati+ Rangoli block had created smooth finished surface, which is necessary in plaster finish.		
2	Why Dink?		
	Gond functions as a natural biopolymer binder/stabilizer that improves the interaction between the other 2 materials.		
3	How the Dink is prepared?		
	Refer the procedure below.		
4	Role of Shadu Clay, Rangoli and Dink in plaster?		
	Shadu clay as a binder.		
	Rangoli as a mineral filler, to produce a smoother, finer and lighter-coloured surface.		
	Dink as a natural binder.		
5	Why proportion- Shadu clay : Rangoli : Dink= 3:1:0.3		
	3% Dink can be considered a useful dosage: enough gum to modify particle bonding and strength without going directly to the highest dosage tested in the research.		

6		Observations					
Type of brick	Fly ash brick	Clay brick			Notes		
Thickness of plaster	0.5-1mm	0.5-1mm					
Mix	Good, workable	Good, workable			The mix was very easy to work with and was easy to apply on both brick surfaces.		
Cracks	Yes - Very low.	Yes - Very low.					
Fungus growth	No	No					
Dusting	No	No					
Surface finish	Smooth	Smooth					
Peel off	No	No					
Efflorescence	No	No					
7		Inference					
		The addition of dink enhanced the binding quality of the Shadu- Rangoli mix and generated a comparatively smooth plaster layer with very less no. of cracks. Hence, dink can be considered strongly for plaster mix exploration.					

Tapioca starch procedure:

1. Wash and clean- 1 cup Sabudana Rinse 3-4 times under cold running water
2. Deep Soaking (Crucial)- Transfer rinsed Sabudana into a deep bowl and add 3 cups of water. Let them soak undisturbed for-at least 6-8 hours(or overnight) (Sabudana should expand completely)
3. Grind into a slurry- Pour the fully plumped sabudana leftover so with any left water directly soaking kitchen blender. Blend on high speed for 2 minutes until it transforms into a uniform, thick, milky white liquid.
4. Heat and cook- Pour the blended white liquid into a saucepan. Add another 2 cups of water to thin it down so it does not sorch. Place the pan on low to medium heat. Stir continuously with a wooden spoon. As it heats, the opaque white liquid will slowly transform into a viscous, completely. translucent, sticky gel. Once it reaches a gentle boil and becomes fully clear, turn off the heat. into a
5. Strain and cool- While the mixture is still warm, pass it through a fine - mesh kitchen strainer or cheesecloth to catch any unblended rubbery chunks. Let the strained translucent liquid cool down to room temperature. It will thicken significantly into a smooth, heavy paste as it cools.

Natural Gum procedure:

Materials
Natural gond (edible gum / gum arabic type): 1 part

Water: 5–10 parts
Method
Break the gond into small pieces.
Soak it in water for 8–12 hours, preferably overnight.
The gond will swell and soften.
Heat the soaked mixture gently while stirring.
Continue until the gum dissolves into a thick, slightly sticky solution.
Strain it through a fine cloth to remove undissolved particles.
Allow it to cool before mixing into the plaster.

Fenugreek water procedure:

The solution is prepared by grinding the fenugreek seeds and soaking the resultant powder overnight.

This is then mashed and sieved to remove particles. The water is added to the plaster before application.

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