

Virtual Workshop on Gainful Utilization of Stone Waste and Slurry

Sustainable Building Materials & Technologies utilizing Stone Waste



केन्द्रीय भवन अनुसंधान संस्थान

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Institute

VISION

To be a world class research & knowledge base and centre of National Importance for providing innovative solutions to all aspects of building science & technology.

MISSION

To carry out research, development and innovation (RD&I) in solving problems of national challenges and render assistance to industries in planning, design, materials, construction and capacity building, including disaster mitigation in buildings to achieve safe, sustainable, resilient, smart, comfortable, functionally efficient construction with speed, productivity, environmental preservation, energy efficiency and economy.



Aligning with National Missions and SDG Goals



- Affordable Housing
- Alternative Building Materials
- Environmentally Friendly Latrines
- Waste Water Disposal Techniques
- Post disaster shelter
- Skill Development
- Green Buildings
- Solar cooling technologies
 - Disaster Early Warning Systems
 - Instant Shelters
- C&D waste Utilization
- Alternative building materials from Stone waste and Agro industrial waste
 - Nano Engineered Concrete
 - Green Coatings
 - Waste Water Disposal and Sanitation
 - Indoor Air Quality Monitoring
- Intelligent Infrastructure
- Structural Health Monitoring



Activities of Organic Building Materials Group



- Value added products from stone waste and process development
- Alternatives to wood and to other building products and process development.
- Recycling of plastic waste for building applications through value addition
- Agro-industrial waste utilization
- Protective and decorative coatings and finishes
- Sealants, adhesives and water proofing systems for building applications
- Health assessment of existing structures and preventive measures for service life enhancement.
- Suitability assessment of materials for specific end applications



Outline



- ❖ Introduction
- ❖ Building product from Kota stone cutting waste and slurry
- ❖ Product/Technology
- ❖ Demonstration & Extension Activities
- ❖ Deployment with Stakeholders
- ❖ Recyclability of Marble Waste to Develop Low Cost- Green Building Products
- ❖ Socio-economic Impact
- ❖ Conclusion



Introduction

- Growth in industrial and agricultural activities continued to throw away huge quantities of wastes and by-products
- Depletion of high grade raw materials, land filling and environmental issues make it imperative to recycle in a gainful manner
- Research activities of CSIR and other Institutes have now established that the wastes could form secondary resource materials for the production of alternate building materials with effective saving in natural resources, energy, minimizing pollution and labour



Major waste productions in India

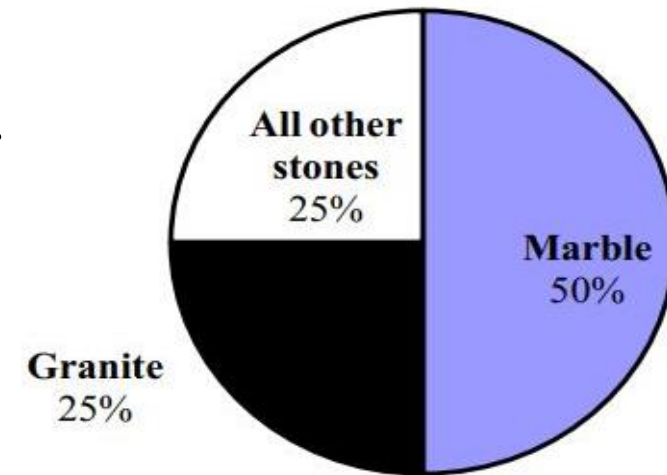


Waste	Industry	Annual generation (m. tonnes)	Technologies/ potential uses in building materials
Fly ash	Thermal power station	220	Blended cement, bricks, alternative binder to cement etc.
Slag	Iron and steel	15	Blended cement, aggregates
By- product gypsum	Fertilizer/phosphoric/ HF	5	Plaster, building blocks, fibrous board etc.
Mine-tailings	Zinc ,copper etc. beneficiation plant	6	Calcium silicate bricks/blocks, fine aggregate , cellular concrete
Stone waste	Stone processing	40-50	Paving blocks & tiles, cellular concrete etc.
C&D waste	Building construction	27	Paving tiles and recycled aggregate concrete
Lime sludge	Paper/ sugar/ fertilizer etc	5	Lime, masonry mortars etc



Stone & Stone Waste

- For 2.5 million years, different types of natural rocks have been utilized by human and other hominids for different kinds of purpose.
- Geological mode of formation (igneous, metamorphic and sedimentary rocks); chemical composition (crystalline siliceous, calcareous and argillaceous rocks)
- Stone: Limestone, Granite, Marble, Sandstone etc.



Limestone

- The limestone shall be naturally occurring sedimentary rocks at least 70% by mass of calcium carbonate; normally in the polymorphic form of calcite.
- Limestone is a primary raw material in the manufacturing of ordinary Portland cement.
- The annual production of limestone in the country is 238 MT (10 MT Kota stone) compared to global production of 4500 MT.



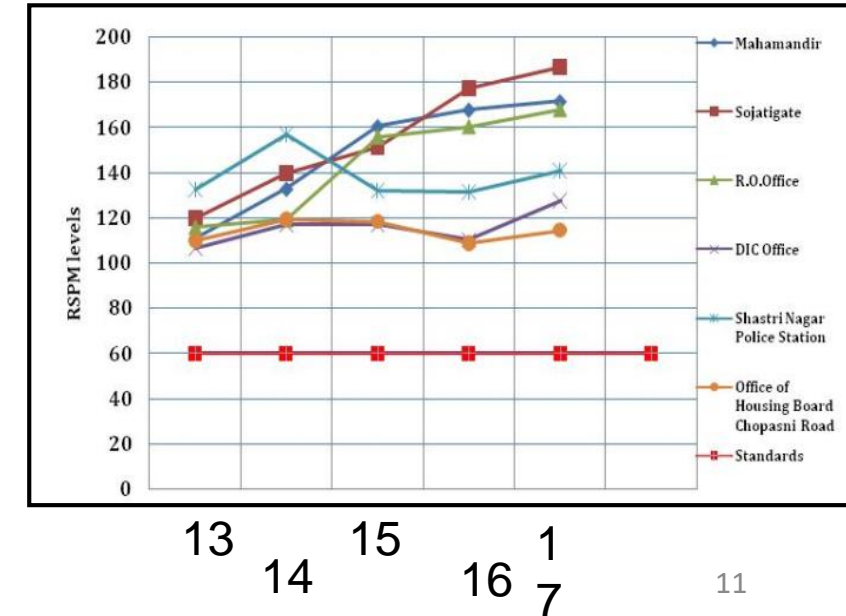
Low Grade Limestone Waste

- The processing of limestone by chain saw, diamond wire saws from quarries in a smaller size results in 50% waste generation approx. (4.5 MT per year).
- Disposal of this waste causes serious environmental problem including health hazard specifically asthma.
- The industry also suffer to store waste due to cost of its storage.



Problems

- The settled slurry is pumped out into adjacent agricultural lands.
- These micro fine slurry particles (D_{90} as $200\mu\text{m}$ and D_{50} as $5\mu\text{m}$) choke the drains in rainy season, create dust nuisance, affect productivity of fertile land due to decreased porosity.
- Due to long-term deposition, finer particles block the flow regime of aquifers, and affecting underground water availability.





Need for Research



- Looking to such huge quantity of wastes as minerals or resources, there is tremendous scope for setting up secondary industries for recycling and using such solid wastes in construction materials.
- Replacement of stone waste was done with fine aggregate as well as coarse aggregate; based on Particle Size Distribution and Packing Density to develop more compact-high strength and durable heterogeneous concrete mass.
- The replacement of stone powder waste (as an aggregates or dry powder/dust) with cement or aggregate in conventional concrete has improved properties of hardened concrete.
- Burning of fuel results in emissions of gaseous pollutants & ash into the environment, causing air pollution. Therefore; Lightweight Concrete, as a replacement of Brick is developed.
- Evaluation was done in terms of workability, compressive strength, strength performance factor, fresh and hardened density, drying shrinkage, microstructural characterization, thermal properties etc.

Product/Technology

- CSIR-CBRI developed a technology wherein **80-90% waste** is utilized in cementitious binder
- **Products developed:**
 - **Paver blocks** complying IS:15658
 - **Tiles:** complying IS: 1237-2012
 - **Lightweight blocks** satisfy IS: 2185 (IV)-2008

Excellent thermal insulation & good acoustic properties of CFC blocks
- **Capacity of plant:** ~ 5000 units/day
- **Profitability:** 30-35 %
- **Implemented in live construction**





Floor tiles



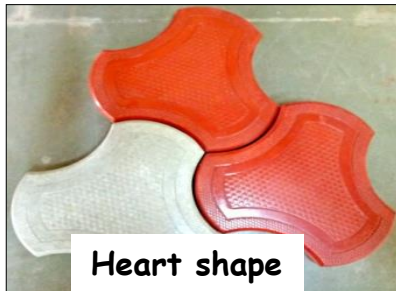
Thickness: 22-25 mm

Wall tiles

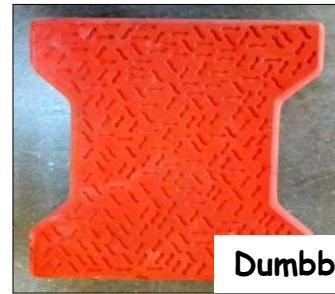


Thickness: 10-15 mm

Paver blocks



Heart shape



Dumbbell shape



Zig Zag shape



Thickness: 50-100 mm



Cost Comparison with Existing



Item	Cost per unit (INR)		Cost Advantage
	Kota stone based	Commercial	
Flooring tile (300 x 300 x 22-25 mm)	15.0	22.0	32%
	18.0	30.0	40%
Wall tile (L:150-300 mm, B:75-150 mm, thickness:10-15 mm)	1.75- 7.0	2.25-9.0	22%
Paver block (L:200-280 mm, B:120-280 mm, thickness:50-100 mm)	15.0- 20.0	18.0-25.0	17 to 20%
CFC block (400 x 200 x 200 mm)	15-20	30-35	40-50%

- Industrial meet arranged with Kota stone Manufacturer Association at Kota and CSIR-CBRI, Roorkee.
- Product displayed at Rajasthan Start-Up Fest, Jaipur.
- Demonstration given to Entrepreneurs



Commercialization

Rajasthan State Pollution Control Board, Jaipur



Deployment with Stakeholders

• Stakeholders

- Rajasthan State Pollution Control Board, Jaipur
- Kota Stone Small Scale Industry Association (approx. 250 industries)



• Start-Up Company setting up

- Two plants has been set-up in Kota by Govt. with the production Capacity of 8,000 for flooring tiles, 3,500 rough pavers and 5,000 blocks/day.
- Utilizing approx. 100 tonnes Kota stone waste per day.



• Involvement of More Industries (~ 30 Nos)

M/s Jai Mata Industries, Kota, M/s Roongta Industries M/s Inderprasth Udyogic Kshetra, M/s Kota, Ambika Industries, Kota, M/s Shri Ganesh Industries, Kota, M/s Tyagi Stones, Kota, M/s Vinayak Enterprises, Kota, M/s Garg Stones, Kota, M/s Navneet Industries, Kota, M/s Dev Stones, Kota etc.



Recyclability of Marble Waste to Develop Low Cost-Green Building Products





LETTER FROM STATE POLLUTION CONTROL BOARD, UDAIPUR



Regional office
Rajasthan State Pollution Control Board
F-470, Near UCCI Building, M.I.A, Udaipur.

☎ 0294-2491269

No.: RPCB/RO U/UDR/

312

Dated : 24.8.18

The Member Secretary
RSPCB
Jaipur

Sub:- Regarding initiation of project "Use of Marble waste to develop value added green building materials for sustainable development".

Sir,

With reference to above, as done in RO Kota wherein technology developed by CBRI, Roorkee regarding building products using Kota Stone Waste has been transferred to RPCB, Jaipur in 2017, it is suggested that same work may be undertaken to develop value added green building material out of marble waste. It is brought to your knowledge that Dr. Rajni Lakhani of CBRI, Roorkee has sent a report to this office on the matter and is enclosed. She had visited the two marble waste dumping sites in Mar 18 and one of the sites at Chitrakoot Nagar (Dormant disposal site) is suitable for the above work as discussed with her. Looking to the fact that CBRI has already forwarded its proposal and shall support the project with technical inputs, it is suggested that the research work may be given to them at the earliest on the same lines as done at RO Kota in reference to Kota Stone Slurry for the conservation and prevention of environment of the area.

Yours Faithfully

K/23/18
(Dr. B.R. Panwar)
Regional Officer

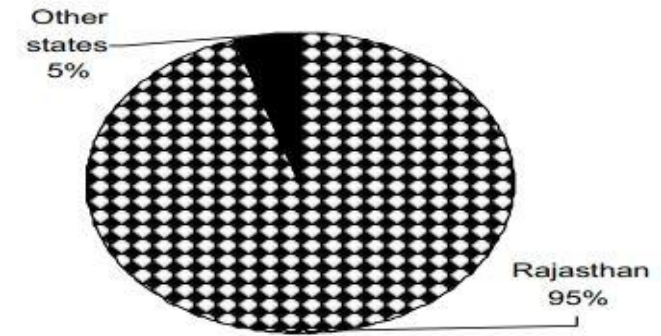
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Initiative Taken

- * Visited the sites near Udaipur (Chitrakoot Nagar (dormant disposal site) & Iswal village (active disposal site) located in Girwa Tehsil of Udaipur district) to explore the possibility of use of marble waste in building products.
- * Optimization & characterization of the raw materials



- India accounts for about 10% of marble produced globally. India is the third largest producer of marble in the world with Rajasthan contributing at 95% to this quantity (DMG, Rajasthan, 2001).



- Rajasthan has around 4000 marble mines and about 1100 marble gang saws (processing plants).
- The stones obtained from the quarries are usually dumped in empty pits in the forest area; thereby creating huge amounts of waste.
- Almost half of the marble produced in the world is quarried from four countries, namely Italy, China, India and Spain.
- According to a report issued in 2011 by the Department of Mines and Geology, Rajasthan, about 15.7 MT marble was excavated; due to which 5-6 MT of MS was generated in Rajasthan.

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- The waste & overburden is dumped on forestland, Roads, riverbeds, pasture lands & agricultural fields leading to widespread environmental degradation.
- 6 districts (Makrana, Jaipur, Kishangarh, Rajsamand, Chhitorgarh, Udaipur) are the places where marble waste are found in abundance.
- **At large scale- No viable solution demonstrated till date.**



Waste Generation during the Marble Production



Products Made Till Date



1. Ceramic tiles
2. Concrete roofing sheets
3. Particle boards and panels
4. Paint and plasters
5. Concretes
 - Lean cement concrete
 - Bituminous concrete mix
 - Self compacting lightweight concrete
 - Pervious concrete
 - Polymer concrete
 - Structural concrete

-Value addition of Marble Stone Cutting Waste & Slurry to develop various building products i.e.

- ❖ Mosaic/ concrete tiles (flooring/wall)
- ❖ Autoclaved aerated concrete (AAC) blocks
- ❖ Bricks
- ❖ Paver blocks

- Scale up of the developed process up to pilot level

Present TRL Level - 5

Proposed TRL Level - 9

Mosaic/ Terrazzo Tiles





Properties of developed Mosaic/Terrazzo Tiles



Properties of Tiles	General Purpose	Heavy Duty	IS: 1237
Dimensions (mm)	As per Standard	As per Standard	200X200 } Thickness 22 mm 250X250 } 300X300 } Thickness 25 mm 400x400 }
Water Absorption (%)	5.0	4.0	10, Max.
Wet Transverse Strength (N/mm ²)	3.5	5.0	3.0, Min.
Resistance to Wear (mm)	0.10	0.08	2.0-3.5, Max.
Straightness (%)	0.44	0.35	1.0, Max
Perpendicularity (%)	0.30	0.20	2.0, Max
Flatness of Tile Surface (mm)	0.44	0.40	1.0, Max

Paver Blocks



Casting of paver blocks



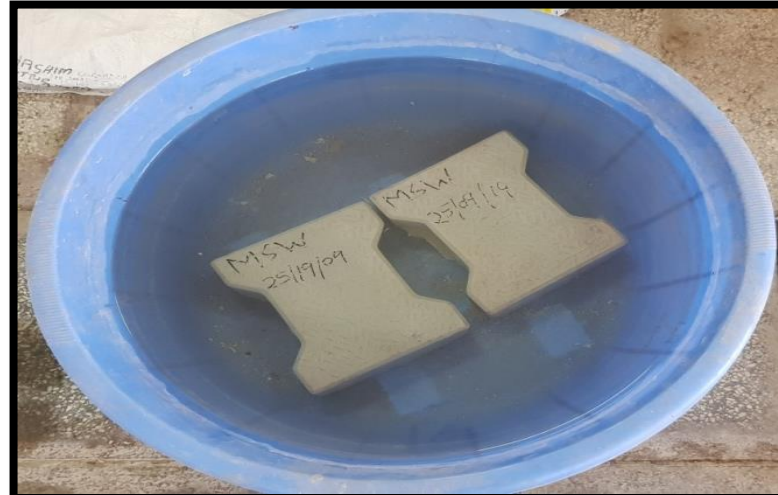
Stacked paver blocks



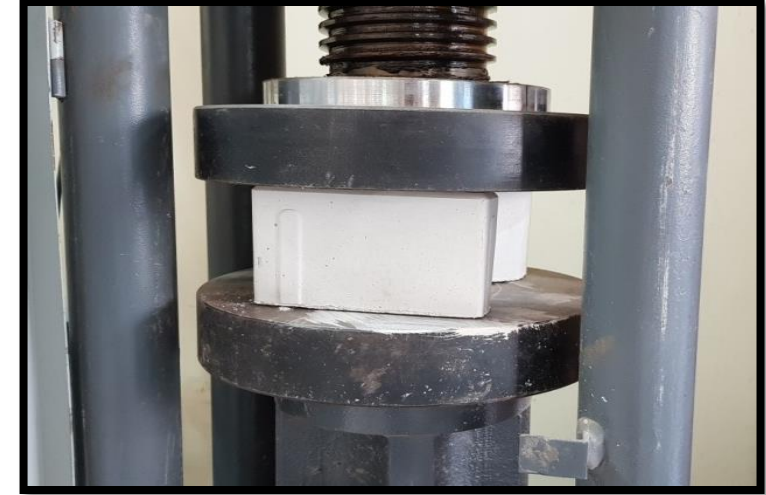
Paver blocks using marble slurry



Abrasion testing machine



Water absorption test



Compressive strength test

Raw Material



Binder



MP



MFA



Adm. and Water



Mixing



Mix fill in brick mold



Demolding



Water Curing



End Product



Work in Progress

- **Process optimization of light weight concrete blocks (CLC & AAC)**
- **Determination of physico-mechanical properties**

Glimpses of Industry Meets



Ramganj mandi



Kota



CSIR-CBRI , Roorkee



Start up fest, Rajasthan



Visit of Chief Minister - Rajasthan

Industry Meet



Entrepreneur from Jhalawar, Rajasthan on 10th Nov.2020



Entrepreneur from Udaipur, Rajasthan on 18th Jan.;2021



For allotment of Stands & other information regarding MARMOMAC 2020 please contact:

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Indian Representative for MARMOMAC 2020

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Utilization of Kotastone / Marble Waste for Sustainable Development of Stone Industry

Kotastone /marble waste, a byproduct of stone industry which is available in huge quantity is creating environment nuisance in terms of air/water pollution and human health. These waste are inert and of no use in the existing form. Several Govt. initiatives have been taken for effective utilization of stone wastes for various applications. These efforts are limited only at academic level.

CSIR- Central Building Research Institute Roorkee has accepted the herculean task of utilization of stone waste for making building products at commercial scale. Dr. (Mrs.) Rajni Lakhani, Head Organic Building Materials Group and her team under the leadership of Dr. N. Gopalakrishnan, Director, CBRI has developed a process know-how based on the pilot scale manufacturing trials and implementation in live condition. Performance of Paving Blocks laid at institute premises is satisfactory.

Laboratory investigations were made for the characterization of stone waste. Based on the properties, mix proportioning of Paving Blocks, Flooring/Wall Tiles and Cellular Light Weight Concrete Blocks was made meeting the specifications of IS: 1237, IS: 15658, IS: 2185 (iv) and IS: 6598 respectively.

Paving Blocks, Flooring/Wall Tiles and Cellular Light Weight Concrete Blocks have been manufactured using the existing plant equipment and machinery. The process is simple and economical.



Building Products from Stone Waste



Manual laying of Paver blocks in Institute Premises (M30)



Pilot Plant

Phone No.: +91-1332-272243
Email : director@cbriemail.com

Fax : +91-1332-272272
Website : www.cbri.res.in

Socio-economic Impact

- Value addition of stone waste will be done in terms of cost, strength & thermal comfort.
- Stone industry which is diminishing in size/production due to mining constraints; will be revived.
- New small scale industries shall be established to make value added products from stone wastes that will help to generate some employment.

- *Saving of Natural Resources*
- *Reduces CO₂ Emission by cement replacement*
- *'Swachh Bharat Abhiyaan' by Waste Utilization*
- *Save Environment by reducing Air, Water and Land Pollution*



Aligning with National Missions and SDG Goals



Conclusions

- Based on the research efforts, there could be ways and means to dispose off the waste and relieve pressure on land and environment
- Manufacturing of building materials from wastes and by-products would reduce pollution and energy consumption levels compared to traditional process using basic raw materials

Acknowledgements

1. Er. Rajesh Kumar, Scientist
2. Mr. Shahnavaaz Khan
& other project staff...



Facilities Available



UTM 2T



Environment chamber



UV Chamber



UTM-100T



Dilatometer

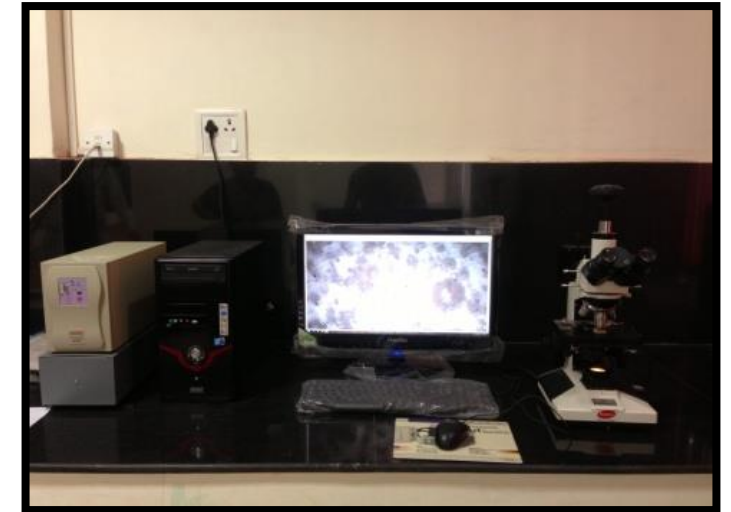


Image analyzer

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Corrosion analyzer



Dual humidity chamber



एक कदम स्वच्छता की ओर

Thank You