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Ministry of Science & Technology,
Ministry of Earth Sciences,
Govt. of India

सत्यमेव जयते

Azadi Ka Amrit Mahotsav

Proceedings of

INDUSTRY MEET-2022

Waste to Wealth

Civil Infrastructure and Engineering Theme

5, 7, 11, 14 & 15 July 2022

Organized by

सीएसआईआर- एम्प्री
CSIR-AMPRI

INDUSTRY MEET-2022: WASTE TO WEALTH

(CIVIL INFRASTRUCTURE AND ENGINEERING THEME)

Date: 5, 7, 11, 14 & 15 July 2022

Organized by CSIR- AMPRI, Bhopal

Dr. Avanish K Srivastava
Director, CSIR-AMPRI, Bhopal

सीएसआईआर- एम्प्री
CSIR-AMPRI

Dr. Asokan Pappu
Chief Scientist, CSIR-AMPRI, Bhopal &
Coordinator, CIE-WW

In association with

Dr. N. Anandavalli
Director, CSIR-SERC, Chennai &
Theme Director, CIE

Dr. Vibha Malhotra Swaney
Head TMD, CSIR, New Delhi

Dr. Devendra Kumar
Principal Scientist, CSIR, New Delhi

Dr. Rajneesh K Gupta
Principal Scientist, CSIR, New Delhi

Participating Organizations

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Proceedings of
INDUSTRY MEET-2022
Waste to Wealth
Civil Infrastructure and Engineering Theme

Edited by:

Dr. Avanish Kumar Srivastava
(Director, CSIR-AMPRI, Bhopal)

Dr. Asokan Pappu
(Chief Scientist, CSIR-AMPRI, Bhopal)

Mr. Ranjan Chaturvedi
(Senior Research Fellow, CSIR-AMPRI, Bhopal)

i-CEN 40, 42, 44, 46 & 47
5th , 7th , 11th , 14th & 15th July 2022

वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्
COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH
(विज्ञान एवं प्रौद्योगिकी मंत्रालय, भारत सरकार)
MINISTRY OF SCIENCE & TECHNOLOGY, GOVT. OF INDIA

Ministry of Science & Technology,
Ministry of Earth Sciences,
Govt. of India
सत्यमेव जयते

Azadi Ka Amrit Mahotsav

FOREWORD

As we all know, waste is a wasted resource, but gainful utilization of these wastes as a raw material is a challenging need to achieve clean India and make in India Mission. The annual generation of solid wastes generated in India is about one billion tons. Out of which, about 500 million tons are organic wastes arising from agro and domestic sector and the remaining about 50% is inorganic wastes, arising from industrial sector. Safe management of huge quantity of these solid wastes is a real problem to safeguard our environment. To address these challenges, efforts are being made for efficient recycling of all these solid wastes and converting them into a wealth for a sustainable and environmental sound management. Scientists from CSIR labs have developed many know-how processes, products and technologies to maximize the use of waste materials and convert them in to value added products.

Advances in scientific innovations on solid waste management have resulted in introducing alternative composite materials for use in civil and construction industries. Several technologies have been developed by CSIR- institutes for waste recycling with great commercial opportunity. These technologies have direct impact to Clean India, Make in India, Skill India and Waste to Wealth program of Government of India. Now, there is a need to consolidate the efforts already made by CSIR institutes to commercialize marketable technologies for cross sector and pan industry waste exchange. This I connect- industry meet is being organized to provide a common platform to industries, entrepreneurs, and start-ups to gain the knowledge on solid waste recycling technology and create new business on waste management.

Realization of all these technologies would contribute to sustaining a greater use of country's resources and provide a sustainable solution to maintain clean and green environment followed by enhancing the economy of our country. We trust, participation to this industry meet, learning from plenary & keynote speakers and technology presenters, gaining knowledge from the speakers and special invited and experts on Waste to Wealth will accelerate to address the immediate need on Waste to Wealth in Civil Infrastructure Engineering. The outcome of this meet is expected to open avenues for R&D transformation to increase Nation's economy, enhance employment, improve livelihood of poor's, safeguard & sustain the balanced eco system thus to contribute in achieving Government of India Goal on *Atmanirbhar Bharat* and United Nation Sustainable Development Goals thus celebrating *Azadi ka Amirth Mhotsav*.

Dr. Asokan Pappu
Coordinator, iCEN 40, 42, 44, 46 and 47
Nodal Scientist, CSIR CIE-WW
Chief Scientist, CSIR-AMPRI, Bhopal
Date: 15 July 2022

Dr. Avanish Kumar Srivastava
Director, CSIR-AMPRI
Bhopal, M.P.
Date: 15 July 2022

सीएसआईआर – प्रगत पदार्थ तथा प्रक्रम अनुसंधान संस्थान (एम्प्री)
CSIR - Advanced Materials and Processes Research Institute (AMPRI)
वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्
Council of Scientific and Industrial Research
(वैज्ञानिक और औद्योगिक अनुसंधान विभाग के तहत एक स्वायत्त निकाय, विज्ञान और प्रौद्योगिकी मंत्रालय, भारत सरकार)
(An autonomous body under the Department of Scientific & Industrial Research, Ministry of Science & Technology, Govt. of India)

डॉ. अवनीश कुमार श्रीवास्तव
निदेशक

Dr. Avanish Kumar Srivastava
Director

Message

It is my great pleasure and honor for me to organize a mega-series of iconic 75 Industry connect (i-connect) events on Waste to Wealth (WW) under the Civil, Infrastructure, and Engineering (CIE) theme at CSIR-AMPRI, Bhopal to showcase the achievements in various S&T areas, especially for application in civil and infrastructure sector from 5th to 15th July 2022. The objective of this event is to foster a strong *Atma Nirbhar Bharat* by providing indigenous technology on waste to wealth by forging a partnership with industries. Various plenary talks and a keynote address from industries including Steel Research and Technology Mission, NovoCrete, NTPC Limited, Re-Sustainability Solutions Pvt, Ltd Hyderabad, Advanced Construction Technologies (P) Ltd., Chennai, HUDCO, New Delhi, MSME, New Delhi, MSME, Haryana and plywood industries. In this program, various technological presentations (TRL > 6) from scientists of CSIR Labs including AMPRI, Bhopal, CBRI, Roorkee, IMMT, Bhubaneswar, NML, Jamshedpur, CRRI, Delhi, SERC Chennai, and CSIR TMD, New Delhi are actively participating and sharing their technologies.

The four days sessions will be conducted on the 5th, 7th, 11th, 14, and 15th of July to create a significant pathway for transforming CSIR technologies and creating a new platform for connecting industries, entrepreneurship, and startups for a collaborative program and long-term association for mutual benefits. A panel discussion is scheduled on 15th July (i-CEN-47) to deliberate the opportunities for conversion of waste to wealth and create an industry interface for facilitating entrepreneurs and startups. A large number of delegates from industries, professionals, entrepreneurs and startups, and stakeholders are expected to join in this panel discussion along with the scientific paternity of CSIR to deliberate on S&T and industry intervention to create a business opportunity in achieving the Government of India Mission on *Atmanirbhar Bharat.*

I extend my sincere thanks to the Ministry of Science &Technology and Ministry of Earth Sciences, Govt of India for their joining efforts to organize this unique mega event. I also thank DG, CSIR, Directors of participating CSIR laboratories, CSIR TMD, New Delhi, and nodal director and coordinator of the CIE theme for their active involvement to make this program an effective and fruitful event. I wish for a very grand successful event.

(Avanish K Srivastava)

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CSIR-SERC
ENGINEERING SUSTAINABLE STRUCTURES

सी एस आई आर – संरचनात्मक अभियांत्रिकी अनुसंधान केन्द्र
(वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्)
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डॉ. (श्रीमती) एन. आनंदवल्ली
निदेशक

CSIR – STRUCTURAL ENGINEERING RESEARCH CENTRE
(Council of Scientific & Industrial Research)
CSIR Road, Taramani, Chennai – 600 113, INDIA

Dr. (Smt.) N. Anandavalli, PhD, FIE, M.ASCE
Director

MESSAGE

The Ministry of Science and Technology and Ministry of Earth Sciences, Government of India is organizing 75 i-connect (Industry Connect) events to celebrate Azadi ka Amrit Mahotsav and forge partnerships with industries. The 'i'-Connect event on Waste to Wealth (WW) theme under Civil Infrastructure and Engineering (CIE) is scheduled on 5,7,11 and 13 July 2022 on virtual mode with an aim to facilitate entrepreneurship and create business opportunities.

Growing industrialization and population leads to generation of huge quantity of solid wastes. India produces about one billion tons of solid wastes from industrial, agricultural, municipal and other sources. Already accumulated wastes and their increasing annual production are the major source of pollution and become a challenge due to its heterogeneous characteristics and complexity in recycling. To save energy, create employment, enhance the economy and safeguard our environment, efficient recycling all these Wastes in to Wealth (WW) especially to convert them into Civil Infrastructural and Engineering (CIE) materials is now a paramount importance and focused in this industry meet.

I also take this opportunity to record my appreciation and thankfulness to Dr. Jitendra Singh, Honourable Minister for Science and Technology & Earth Sciences and Vice President, CSIR, Dr. V. K. Saraswat, Niti Aayog, Prof. Ajay Kumar Sood, Principal Scientific Advisor, Dr. Rajesh Gokhale, Secretary, DSIR, DG, CSIR and Secretary, DBT, Dr. S. Chandrasekar, Secretary, DST and Dr. Ravichandran, Secretary, MoES for their unstinted support in organizing such a mega event.

It is my great pleasure to extend a warm welcome to all the participants and delegates of this i-connect event on Waste to Wealth. I wish the event a grand success.

I also take this opportunity to place on record my appreciation to Dr. Anjan Ray, Director, CSIR-CBRI, Dr. Avinash Srivastva, Director, CSIR-AMPRI, Dr. Ranjana Agarwal, Director, CSIR-CRRI, Dr. Indranil Chattoraj, Director, CSIR-NML, and all the members of the organizing team for the efforts towards successful conduct of this grand event. My special appreciation to Dr. Asokan Pappu, Chief Scientis and Nodal CIE for Waste to Wealth, Dr. Vibha Malhotra Sawhney, Head, TMD, Shri. Devendra Singh, Principal Scientist, TMD for the tremendous efforts they have put in to ensure success of the Convention.

N. Anandavalli

[N. Anandavalli]
Director, CSIR-SERC and CIE Theme Director

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सीएसआईआर- एम्प्री
CSIR-AMPRI

Dr. Asokan Pappu
Chief Scientist, Head GEM&AM Division & Nodal Scientist, CIE-WW Theme

डॉ. असोकन पप्पू
मुख्य वैज्ञानिक, विभाग प्रमुख (GEM&AM),
नोडल वैज्ञानिक (CIE-WW Theme)

CSIR- Advanced Materials and Processes Research Institute
(Council of Scientific & Industrial Research)
(An autonomous body under the Department of Scientific and Industrial Research, Ministry of Science and Technology, Government of India)

सी एस आई आर - प्रगत पदार्थ तथा प्रक्रम अनुसंधान संस्थान
(वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद)
(वैज्ञानिक तथा औद्योगिक अनुसंधान विभाग के अंतर्गत एक स्वायत्त निकाय,
विज्ञान एवं प्रोद्योगिकी मंत्रालय, भारत सरकार)

MESSAGE

I have the great pleasure and honor of coordinating a mega-series of *i-Connect* events on Waste to Wealth (WW) under the Civil Infrastructure and Engineering (CIE) theme at CSIR-AMPRI, Bhopal on virtual mode to highlight the advancement in the civil and infrastructure sector, from July 5 through July 15, 2022. The i-Connect is being organized with the support of Ministry of Science and Technology and Ministry of Earth Sciences, Government of India to establish collaboration between institutions and industries to foster a strong interface for achieving *Atmanirbhar Bharat* and celebrate *Azadi ka Amrit Mahotsav.*

The i- Connect 2022 event, i-Cen 40, 42, 44, 46 and 47 addresses on Waste to Wealth under Civil Infrastructure and Engineering theme. There are four technical session namely (i) High-performance civil infrastructure materials and structures developed using inorganic industrial wastes (i-Cen 40, 5 July 2022); (ii) Alternative building materials and structures using silica rich wastes (i-Cen 42, 7 July 2022); (iii) High volume use of industrial inorganic wastes for civil infrastructure engineering (i-Cen 44, 11 July 2022); (iv) Industrial and agro wastes recycling technologies in green building materials (i-Cen 46, 14 July 2022) and (v) Panel discussions and concluding session on waste to wealth in CIE (i-Cen 47, 15 July 2022) have been scheduled in this i-connect with a focus for R&D transformation. Each technical session consists of one plenary talk, one keynote presentation from industry and ministry followed by four CSIR technology presentations by CSIR Scientists. On the last day of this industry meet a panels discussion has been scheduled on waste to wealth in CIE: S & T and industry intervention to achieve *Atmanirbhar Bharat*.

On behalf of Director, CSIR-AMPRI and my personal behalf, I sincerely welcome all invitees, keynote & plenary speakers, technology presenters, industries, entrepreneurs, startups, stakeholders, guests and participants to this mega i-connect event on Waste to Wealth in CIE which is scheduled on 5th, 7th, 11th, 14th and 15th of July 2022 on virtual mode.

I am honored to express my gratitude to the Ministries of Science & Technology and Earth Sciences, Government of India for the directives and working together to plan this mega event. I am very fortunate to have ever source of guidance and support from Dr. Avanish K Srivastava, Director, CSIR-AMPRI, Bhopal. His guidance in organizing this i-connect event is highly admired and acknowledged. I am extremely thankful to Dr. N. Anandavalli, Director, CSIR- SERC, Chennai & Theme Director of CIE for the constant support and motivation. Special thanks to the Director General, CSIR, New Delhi; Dr. Anjan Ray, Director, CSIR- IIP, Dehradun & CSIR-CBRI, Roorkee; Dr. Ranjana Aggarwal, Director, CSIR-NIScPR, New Delhi & CSIR-CRRI, New Delhi; Dr. Indranil Chattoraj, Director, CSIR-NML, Jamshedpur; Dr. Suddhasatwa Basu, Director, CSIR-IMMT, Bhubaneshwar and Dr. Vibha Malhotra Swaney, Head, CSIR-TMD, New Delhi for their active involvement and contributions. I am also thankful to Dr. Devendra Kumar, Principal Scientist; Dr. Rajneesh K Gupta, Principal Scientist and other scientists and officials of CSIR, New Delhi for their active participation and moral support. I believe the outcome of this industry meet is expected to accelerate CSIR technologies on Waste to Wealth and create opportunities for entrepreneurship, facilitate startups with industry, stakeholders, and line ministry support with the great success.

Dr. Asokan Pappu
Coordinator, i-CEN 40, 42, 44, 46 & 47

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Dr. N. Anandavalli
Director
CSIR-SERC, Chennai

Dr. Anjan Ray
Director
CSIR-CBRI, Roorkee &
CSIR-IIP, Dehradun

Dr. Suddhasatwa Basu
Director
CSIR-IMMT, Bhubneshwar

Dr. Indranil Chattoraj
Director
CSIR-NML, Jamshedpur

Dr Ranjana Aggarwal
Director
CSIR-NIScPR, New Delhi

Dr. Ashok Kumar
Outstanding Scientist
CSIR-CBRI, Roorkee

Speaker - Industry & Ministry

(Plenary & Keynote Speakers)

Dr. Mukesh Kumar
Director, Steel Research and Technology Mission,
New Delhi

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NTPC Vindyachal,
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Sr. Consultant
NovoCrete,
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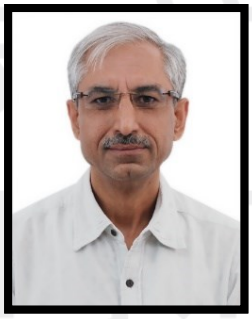
Dr. B. Chakradhar,
VP - Consultancy,
Re Sustainability Ltd,
Hyderabad

Mr. Mohan Ramanathan
Managing Director
ACT Pvt Ltd.,
Chennai



Shri Mukesh Gulati
Executive Director,
Foundation for MSME Cluster, New Delhi

Smt. Vaishali P. Surawar
Chief Sustainability Officer
Hindalco Industries Limited,
Mumbai

Dr. K.K. Goyal
Director
MSME & Startups,
New Delhi

Smt. Amneet P Kumar, IAS
Director General
MSME, Haryana

Panelists - Stakeholders

Shri V.P. Singh Walia
Joint Director
Dist MSME Centre, Haryana

Dr. P. Jagan
Regional Director
CPCB, Bhopal

Dr. Deepak Bansal
Joint GM
HUDCO, New Delhi

Dr. Ruhi Haque
SDO
MP Forest, MP

Panelists - Industries

Shri R.K. Solanki
GM
MB Power, MP

Dr. Amit Chatterjee,
Director R&D
Vedanta Ltd, Mumbai

Dr. Uttam Pawaskar
Head Civil
Tata Power, Mumbai

Shri Sanjay Sharma
GM Tech
Abellon, Gujrat

Dr. Amit Rai
Vice President Buss. Dev &
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Gurugram

Shri Baburao Kadam
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Devkai Foods Industry,
Haryana

Shri Arvind Dubey
Spl. Correspondent
ABC News India,
New Delhi

Mohd. Tazim Rawat
Architect
Synthesis Design Studio,
New Delhi

CSIR Technology Presenters

Dr. J Prabhakar
Chief Scientist
CSIR-SERC, Chennai

Dr. Asokan Pappu
Chief Scientist
CSIR-AMPRI, Bhopal

Dr. Manish Mudgal
Sr. Pr. Scientist
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Dr. A K Sinha
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Ministry of Science & Technology,
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Govt. of India

Azadi Ka Amrit Mahotsav

Waste to Wealth

Civil Infrastructure and Engineering Theme

Day 1: Session Theme

High-performance civil infrastructure materials and structures from inorganic industrial waste

(i-CEN – 40, 5th July 2022)

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Govt. of India

Azadi Ka Amrit Mahotsav

Day 1: Technology Presentation Title

Disaster resistant lightweight prefabricated building systems

(Dr. J. Prabhakar, Chief Scientist, CSIR-SERC, Chennai)

Organized by

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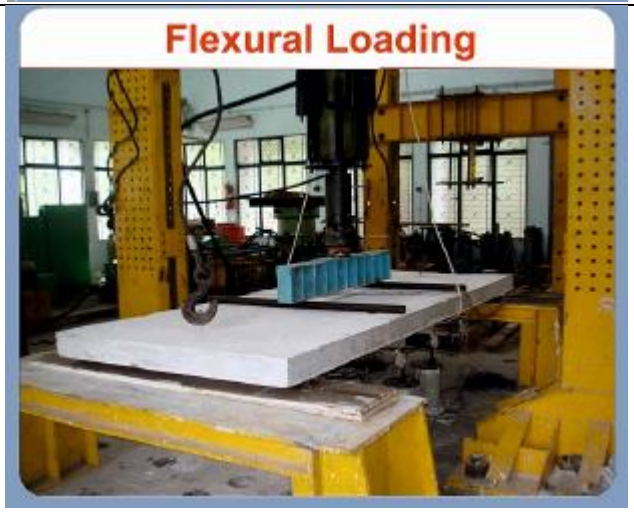
CSIR-AMPRI

TECHNOLOGY PROFILE

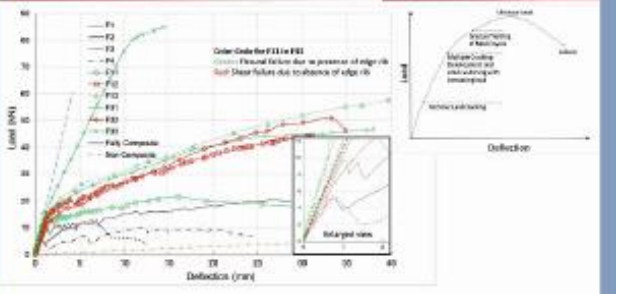
Pre-engineered Precast Lightweight Large Wall and Roof Panels for Mass Housing

A Innovative Technology for the Construction of Affordable Buildings

Due to increasing population and migration from rural to urban areas, future cities of India will require smart real estate for urban infrastructure development. Towards this, CSIR-SERC has developed and is continuing to develop Pre-engineered Precast Lightweight Large Wall and Roof Panels for Mass Housing. The light weight panels have a sandwich construction with expanded polystyrene as core and self-compacting concrete skins. The performance of these light weight panels have been evaluated for flexural, axial and seismic actions.



COMPARISON OF FLEXURAL BEHAVIOUR OF PANELS WITH FERROCEMENT PANEL

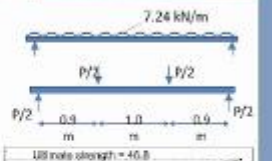


Load Deflection Curves of CSPs follow tri-linear relationship up to the Ultimate Load similar to Ferro-cement Panels under Bending

Capacity of Roof Panel Required for a Normal Construction

Limit State of Strength

Live load	= 2 kN/m² (IS 875 Part -2)
Dead load	= 1.26 kN/m²
Dead load (screed)	= 0.6 kN/m²
Total load	= 3.86 kN/m²
Factored load	= 1.5 x 3.86 = 5.79 kN/m²
Factored load per m width	= 5.79 x 1.25 = 7.24 kN/m



Required maximum bending moment:

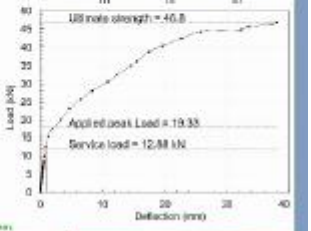
$BM_{max} = wl^2 = 7.24 \times 3.1^2 = 8.70$ KNm

Equivalent load under four-point bending:

$\frac{P \cdot 2 \times 8.70}{0.9} = 19.33$ KN

Deflection limit as per IS456:2000:

$\frac{l}{350} = \frac{3250}{350} = 9.3$mm



Panel P31 is selected to be used as floors in the housing system

Flexural Behaviour Under Punching Load

S.No	ID	Geometry	Dimension, mm	BM, Kn-m	Ult. Load, kN
1	FP1	Square	1220 x 1220 x 150	8.30	32.30
2	FP2	Rectangle	3000 x 1220 x 150	17.20	35.00

- Cracks pattern indicates that the shear connectors are effective
- Cracks are due to tensile stress and hence it is clear that the top wythe is not subjected to only compressive stress as in cylindrical bending of plates.
- If these cracks are due to local punching, further cracks may not form at large diameter.

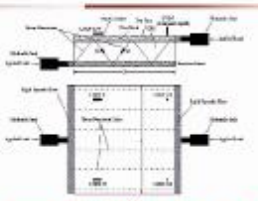
DEVELOPMENT OF WALL PANELS

Sl. No.	Specimen ID	Slenderness Ratio	Axial Compressive Strength	Design Axial Compressive Strength*	Failure Pattern
		(l/t)	(P_{test})	(P_{test_d})	
* 100 x100 mm mesh opening			(kN)	(kN)	
1	PA2*	20	1332	888.0	Buckling
2	PB1*	30	1358	905.3	
3	PB2*		1207	804.7	
4	PC1	20	1147	764.7	
5	PC2		1072	714.7	
6	PD	30	1212	808.0	

*with safety factor = 1.5.

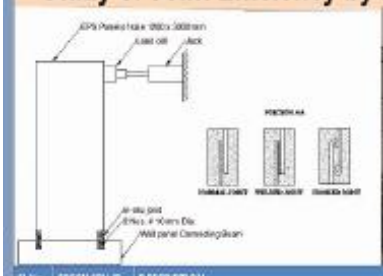
100mm thick panels failed due to buckling at mid-height of the panels and 150mm thick panels failed due to buckling near the loading edge of the panels.

SHEAR (THROUGH-THE-THICKNESS) BEHAVIOR



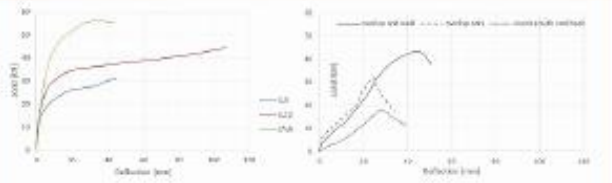
- For panels with insulation layer, the ultimate load of 100mm thick panel is nearly two times the ultimate load of 150mm thick panel.
- For panels without insulation layer, the ultimate load of 100mm thick panel is nearly three times the ultimate load of 150mm thick panel.
- For 150mm thick panels. the ultimate load resisted by the panels with insulation layer is nearly 90% more than that of the panels without the insulation layer
- For 100mm thick panels, The ultimate load resisted by the panels with insulation layer is nearly 25% more than that of the panels without the insulation layer

Study of Joint Efficiency by Lateral Load Test



Sl.No	SPECIMEN ID	DESCRIPTION
1	Panel-1	Wall and plinth beam connected by 8 nos of 8mm ϕ rod
2	Panel-2	Wall and plinth beam connected by 3 nos of 12mm ϕ rod
3	Panel-3	Wall and plinth beam connected by 3 nos of 8 mm ϕ rod, test was done both lateral and axial load.
4	Panel-4	Wall and plinth beam connected by 2 nos of 10mm ϕ rod through lapping and welding
5	Panel-5	Wall and plinth beam connected by 2 nos of 10mm ϕ rod through lapping
6	Panel-6	Wall and plinth beam connected by 2 nos of 10mm ϕ rod through lapping with hooked at ends

Study of Joint Efficiency by Lateral Load Test



Specimens	Ultimate Lateral Load, kN	Capacity of Joints in Axial Tension, kN		Capacity of Joints in Shear, kN
		Theoretical	Experimental	Theoretical
Panel-L1B	50.00	87.46	84.28	61.76
Panel-L1T2	44.58	186.76	121.69*	131.09
Panel-LA1B	55.62	87.46	156.00	61.76

* - Failure happened in beam. Recorded capacity is Axial Tension – 41.20 kN and 42.10 is Shear

Important features unique to the development

- Sandwich panels have low thermal conductivity, moderate compressive strength and excellent shock absorption ability
- The lightweight panels cast using self-compacting concrete resulted in faster casting and better quality control
- Building with sandwich panel results in two third weight reduction compared to the conventional ones
- Amenable for prefabrication

Benchmarking

- Technology developed to cast the top and bottom skins in single casting- considerable reduction in the panel production time.
- A prototype G+1 building constructed made of sandwich panels withstood 0.5g PGA without any damage.

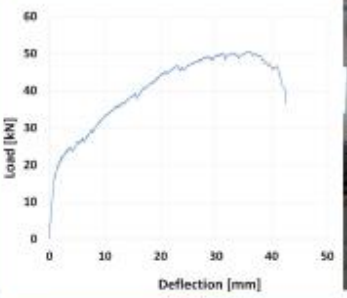
Societal Impact

- Meeting mass housing demand through speedy and quality construction
- Leads to pollution free construction
- Wastage of materials minimized compared to the conventional construction practices
- Use of industrial wastes in huge quantities resulting in sustainable construction

Full Scale Test of Combined wall and slab panel

Study on the Joints for Connecting Wall Panel and Beam

Study on Roof Slab Placed Eccentrically on the Wall Panel

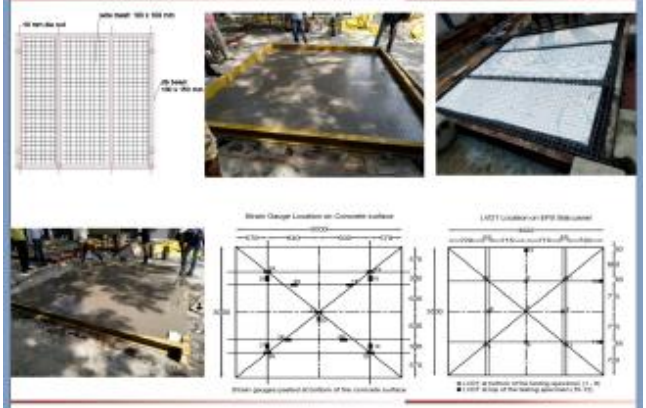


Failure Pattern of the Slab Specimen

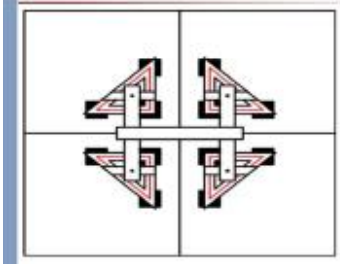
Failure Observed only in Slab

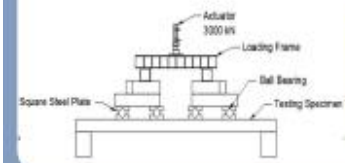
Joints for Connecting wall and Connecting beam found safe

DEVELOPMENT OF LARGE ROOF PANEL

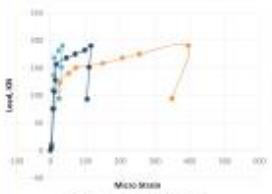


EXPERIMENTAL SETUP BASED ON YIELD LINE THEORY

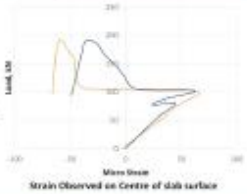




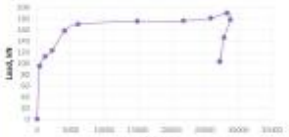
OBSERVATION FROM TEST RESULTS



Strain Observed on Wire mesh



Strain Observed on Centre of slab surface



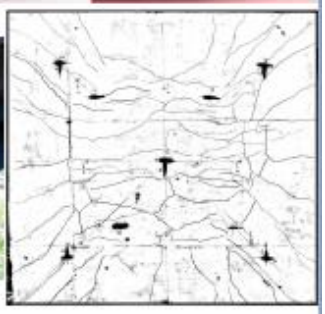
Strain Observed on Rebar of the RC Band (Mid-Span)

Strain Observed in wire mesh shows the increase in strain at mid-span compare to support region

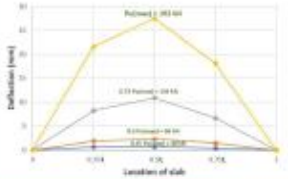
The first crack appeared at 91kN which clearly indicate the strain observed in concrete surface at mid location

Maximum strain recorded on rebar provided in RC band at mid-span

CRACK PATTERN IN THE SLAB



BEHAVIOUR OF CONVENTIONAL RCC SLAB



Live load	= 2 kN/m² (IS 875 Part -2)
Floor Finish	= 1 kN/m²
Dead load	= 2.0 kN/m²
Total load	= 5.0 kN/m²
Factored load	= 1.5 x 5.0 = 7.5 kN/m²

Required Actuator Load

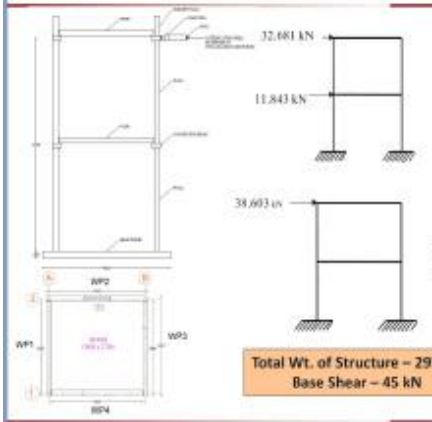
= 7.5 x 3 x 3 = 67.50 kN

Deflection at service load 45.0 kN = 0.68 mm

Deflection limit as per IS456:2000:

The deflection is within the limit.

Typical Scheme of G+1 Building for Pushover Testing



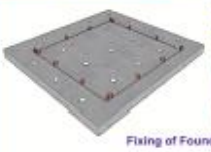
Lateral loads calculated based on Seismic coefficient method.

Proposed to apply load only at top floor.

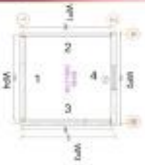
Accordingly the load at the first floor is transformed to top floor, which gives equivalent moment and worked out to be 38.603 kN

Total Wt. of Structure – 297 kN
Base Shear – 45 kN

Assembly of G+1 Building System with Pre-cast Light Weight Large panels



Fixing of Foundation Slab to Assemble G+1 Building



Lifting of wall panels

Ground Floor Assembly

First Floor Assembly

Assembly of G+1 Building System with Pre-cast Light Weight Large panels

Erection of Wall Panels and panels supported by Props

Erection of Roof Slab in 2nd Floor

Parapet Wall Erection

Typical Position of Strain Gauges

Panels Gap filled with Polyurethane Foam

Assembled G+1 Building

Lateral Load on G+1 Building

Live load over roof

Lateral load application

Position of Laser LVDTs

Testing Team

Comparison of pushover curve

Crack Pattern

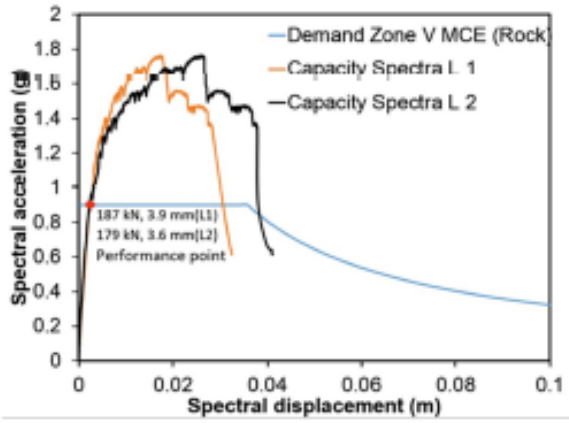
Cracks on GF wall at loading side

Cracks on GF wall inside at loading side

Cracks on GF wall at West side

Cracks on GF wall at North side

Performance Point



Instrumentation

- Non-contact laser based displacement sensors
- Acceleration pick-ups
- Strain Gauges pasted on the reinforcement bars
- High speed video camera system to measure the displacement

Loads considered during Shake Table Test

The free vibration response of the structure was collected from the pulse loading. The natural frequency for the tested structure was found to be 6.68 Hz in X-direction (along the door panel) and 7.32 Hz in the Y-direction (along the window panel)

The sequence of application of earthquake motion in the seismic test consists of gradually increasing PGA levels, namely, 0.08 g, 0.16 g, 0.24 g, 0.36 g, 0.50 g and also for 0.50g with high frequency seismic input

The accelerations of 0.08g, 0.16 g, 0.24 g and 0.36 g corresponds to the Maximum Considered Earthquake (MCE) of the expected PGA of structures situated in Zone-II ,III, IV and V respectively

In order to check over strength capacity of the structure, the structure was further subjected to 0.5 g of PGA compatible to IS:1893 code spectrum and again 0.5 g of PGA (synthetic acceleration time history) having high frequency seismic input

Observations

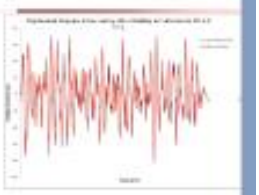
No Damages and Cracks were noticed

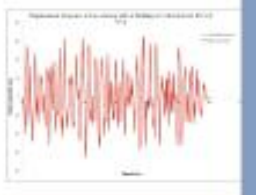
The overall drift at 0.5 g was 0.15 % in X-direction and 0.2 % in Y- direction

Displacement amplification was 1.03 and 1.02 in X and Y-directions

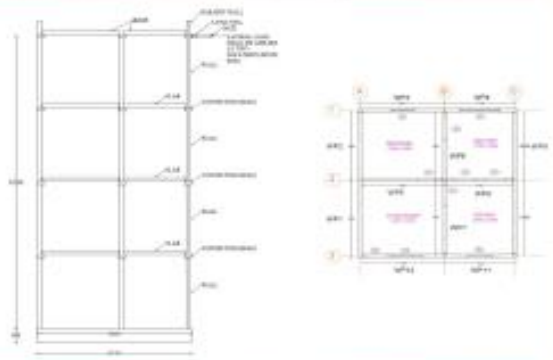
The inter-storey drift (at 0.5g, which is more than the MCE level acceleration of 0.36g) is found to be 0.14 % and 0.21 % in X and Y-directions respectively as against an allowable drift of 0.4 %

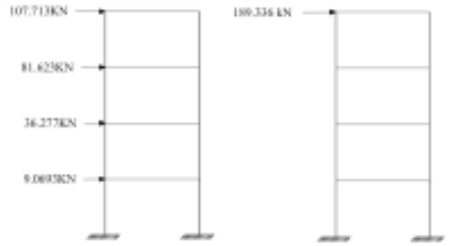
The strain in the reinforcements at PGA level of 0.5 g was less than 0.20 % of proof strain





PUSHOVER STUDY OF G+3 BUILDING

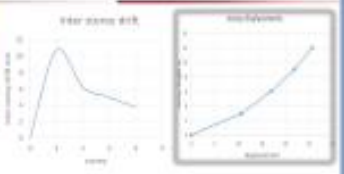




- The lateral loads calculated based on Seismic coefficient method.
- It is proposed to apply load only at top floor.
- Accordingly the load at all the floor is shifted to top floor which gives equivalent moment and worked out to be 189.336 KN.

PERFORMANCE POINT AND INTER STOREY DRIFT

S.NO	STOREY HEIGHT mm	INTER STOREY DRIFT mm	STOREY DISPLACEMENTS mm
1.	3300	10.68	10.68
2.	3300	5.231	15.911
3.	3300	4.969	21.88
4.	3300	3.8	25.68



As per IS 1893 (part 1) code clause 7.11.1 the inter storey drift of a structure shall not exceed 4% times the height of the storey (120mm)

As per FEMA 440, the performancepoint of the building is found at 51.71 ton and 13.717mm. The capacity curve intersects the demand curve in the linear region, so the structure designed is safe

EXPERIMENTAL STUDY OF G+3 BUILDING LATERAL LOAD STUDY

Preparation of Reinforcement Cage in the EPS Panel

Stack of Reinforcement cage of wall panels

Preparation of mold and pouring bottom layer of concrete

TRANSPORTATION OF PANELS IN TRUCKS

TRANSPORTATION OF PANELS IN TRUCKS

Buildings with Light Weight Panels

CLRI Crèche Building

Experimental Demo Building at SERC

KV School Building at CLRI, Adyar

AP Hud Hud Cyclone Building

Technology Transferred to

M/s. Synergy Trishlington, Mohali, Chandigarh.
M/s. Consortium Techno Solutions Pvt. Ltd., Hydrebad.
M/s. Level9 Biz Pvt. Ltd., Mohali, Chandigarh.

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Day 1: Technology Presentation Title

Manufacturing high performance & hybrid composite wood using inorganic wastes

(Dr. Asokan Pappu, Chief Scientist, CSIR-AMPRI, Bhopal)

Organized by

सीएसआईआर- एम्प्री
CSIR-AMPRI

Utilization of Marble, Stone, Granite & other Mineral wastes for Manufacturing Hybrid Green Composite Materials

CSIR-AMPRI Technologies for Entrepreneurship

CSIR-AMPRI

OPPORTUNITIES

- Transforming waste in to wealth
- Create entrepreneurship, start-up, employment and enhance the economy
- Contribute to Atmanirbhar Bharat
- Technology is ready for commercialization

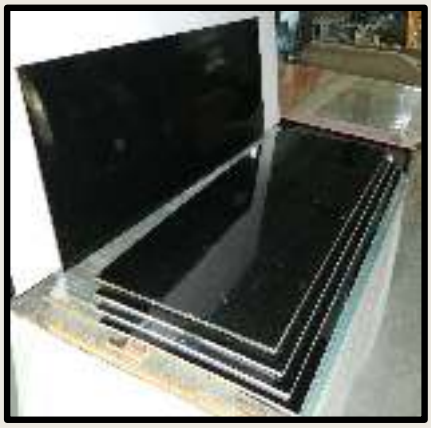
CSIR-AMPRI

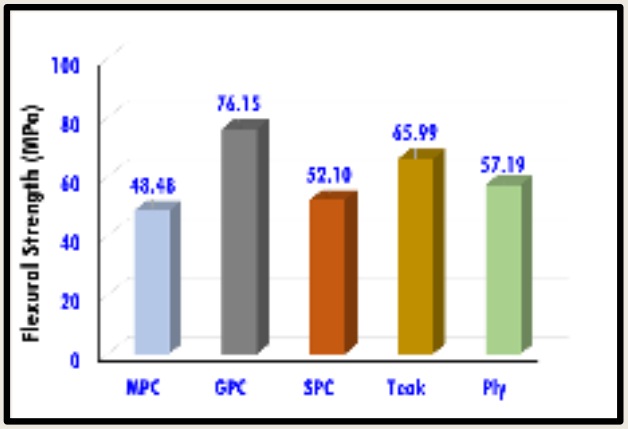
Hybrid Building Materials & Manufacturing Division,
CSIR-Advanced Materials and Processes Research Institute (AMPRI)
Bhopal – 462026 (M.P.)

Hybrid Composite Material from Marble, Granite & Stone Waste

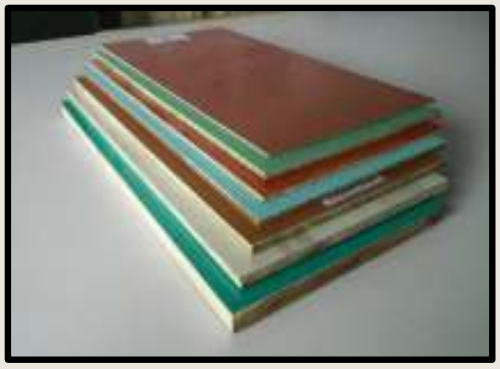
CSIR-Advanced Materials and Processes Research Institute (AMPRI), Bhopal has developed technology for making Advanced Hybrid Composite Wood as an alternative to timber and synthetic wood from waste stream.

Granite Waste Composites





Stone Waste Composites

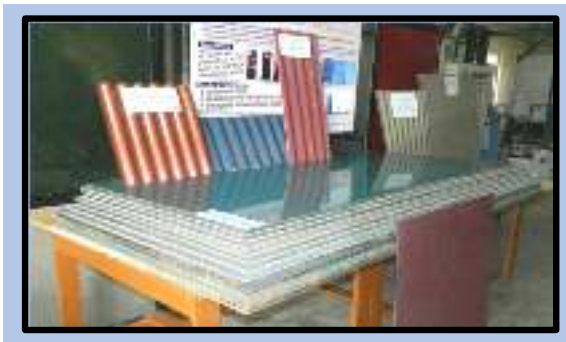


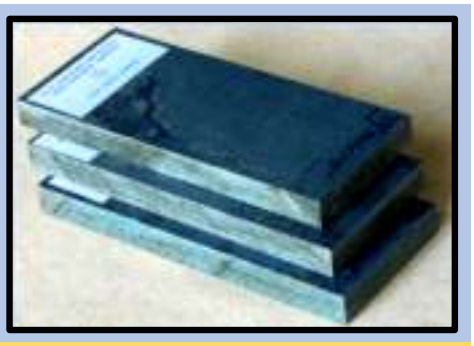
Alternative to: Timber, MDF, Particle Board, Plywood, Teak wood, Plastic, New wood

Multifunctional applications:

Floor & Wall Tiles, Partition Panels, Furniture and Architectural Cladding Panels

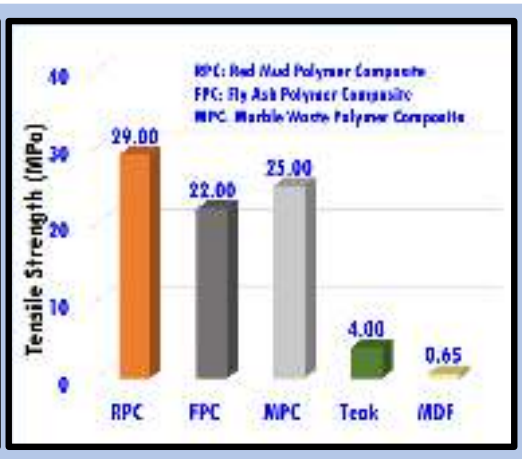
Hybrid Composite Material from Fly ash





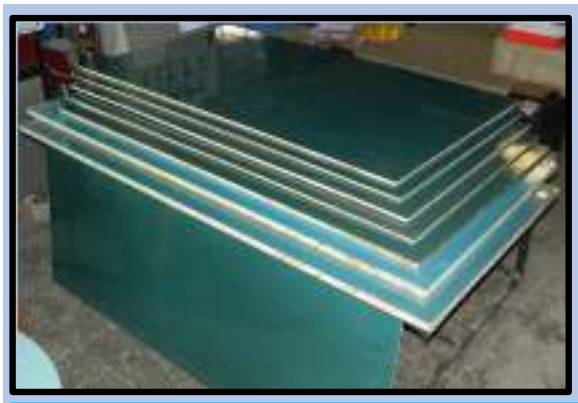
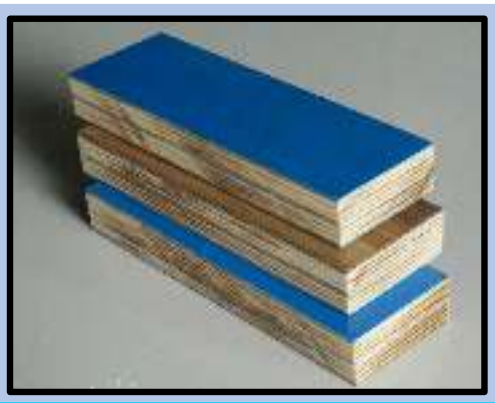
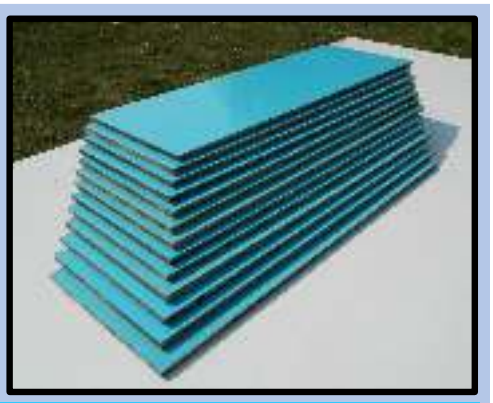
Societal Impact : This is a new class of green composite material. Commercialization of this technology would lead to employment generation, of both rural and urban masses and the population living near the TPP. This technology will further help to achieve the target of Atmanirbhar Bharat.

Hybrid Composite Material from Red mud/Bauxite


Avoid deforestation, save energy and environment, reduce global warming and contribute to Clean India & Make in India programs

Hybrid Sandwich Composite Material from Agro/Industrial Wastes

Applications: Door, Furniture and Modular kitchen materials

Uniqueness of Technology:

- Durable, cost effective and maintenance free product
- Ecofriendly products & technology
- Resistance to moisture, termite, fungus, corrosion & weather
- Fire self-extinguishing nature

Performance of Hybrid Composite Materials

Material	Tensile Strength (MPa)	Tensile Modulus (GPa)	Flexural Strength (MPa)	Flexural Modulus (GPa)	Impact Strength (kJ/m^2)	Water Absorption (%)	Density (g/cm^3)
Marble	12.8-89.4	4.4-6.2	37.2-136.0	6.3-12.9	2.7-14.8	0.09-0.56	1.56-1.63
Granite	26.7-38.8	3.7-4.5	44.9-76.2	7.9-9.0	1.5-2.8	0.09-0.10	1.68-1.75
Stone	21.0-31.3	3.6-5.0	52.1-55.6	7.7-9.1	1.3-2.4	0.15-0.19	1.50-1.69
Fly ash	20.0-23.0	-	80.0-92.0	-	2.4-3.6	1.15-1.35	1.60-1.68
Red mud	18.0-24.0	-	78.0-95.0	-	2.0-3.5	1.15-1.50	1.60-1.76
Sandwich	23.2-37.5	2.6-7.2	53.2-66.5	7.1-8.0	9.1-19.4	8.70-28.9	0.82-1.26

Beneficiaries: Building & Civil Infrastructure, Transport Industry, Furniture Industry, Marble, Granite & Stone Industry, Thermal Power Plants, Aluminum Mining Industry

High Performance Composites from different Mineral Wastes

Applications: Roofing Sheets, Architectural Cladding Panels, Furniture

Technology is ready for commercial scale manufacturing medium and high density hybrid green composite boards and roofing sheets

IPR Status:

Two international Patents Granted: (i) A glossy finish sandwich composite and process for preparing the same (Grant No. 201811047389, WO 2020/121319A1) & (ii) High performance glossy finish green composites with variable density and an improved process for making there of (Grant No. 201811016873. W02019/211862A1)

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CSIR-AMPRI

Day 1: Technology Presentation Title

Fly ash based advanced geopolymer concrete for infrastructural applications

(Dr. Manish Mudgal, Sr. Principal Scientist, CSIR-AMPRI, Bhopal)

Organized by

सीएसआईआर- एम्प्री
CSIR-AMPRI

Red Mud based Advanced Gamma Ray Shielding Aggregate & Heavy Density Concrete

सीएसआईआर- एम्प्री
CSIR-AMPRI

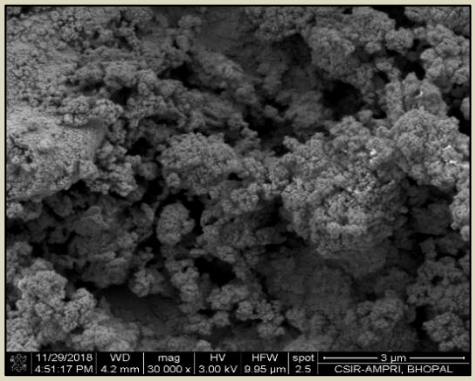
Red Mud : Aluminium Industry Waste

- World Generation ~ 175 Million T /Yr
- India Generation ~ 9 Million T/Yr

RED MUD

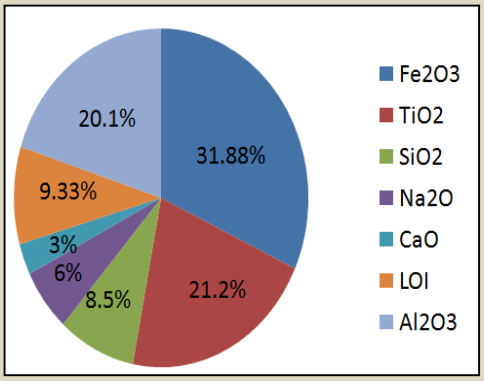
Chemical Analysis of Red Mud (HINDALCO, Renukoot)

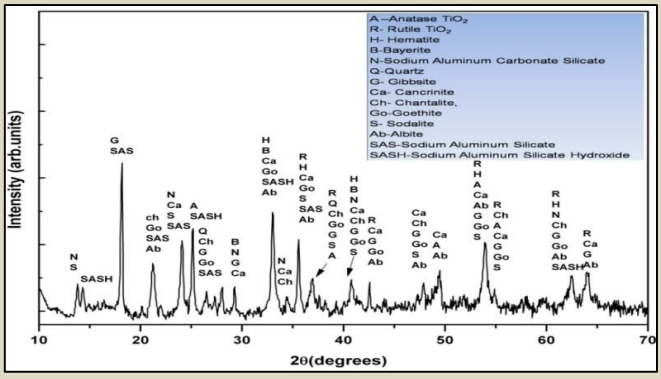
Constituents	%
Fe_2O_3	34
TiO_2	16
SiO_2	8
Na_2O	4
CaO	2.7
Al_2O_3	25.9
V_2O_5	0.03
LOI	9



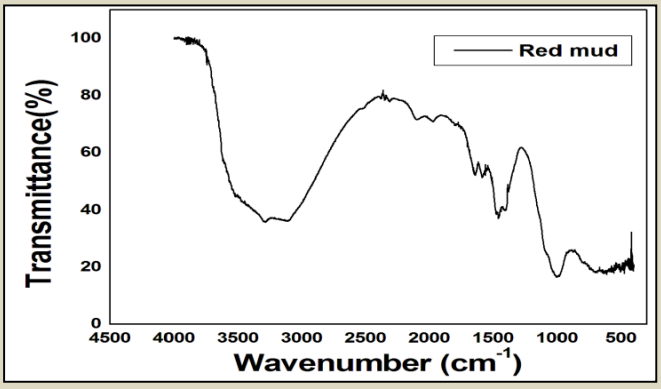
FE-SEM of Red Mud

Typical Chemical Composition





XRD of Red Mud



FTIR of Red Mud

Introduction :

Conventionally shielding concrete are based on a merely physical mixtures of iron metal shots, hematite ores and cement etc. Further, the large variations in the densities of these constituents requires very special cares in obtaining homogeneous shielding matrix. The multi-component, multi phases containing **advanced Syntheitic shielding aggregates** is developed by chemically formulating, mineralogically designing & Ceramics Processing of industrial waste namely red mud from aluminum industry.

The developed Synthetic Shielding aggregates were used for making radiation shielding concrete which can replace conventional Hematite Ore aggregate concrete.

Development of Red Mud based Synthetic Aggregate

Radiation Shielding Mechanism :

The ceramic processing of the red mud with appropriate additives enable formation of varieties of ceramic phases with multi elemental compositions and multi layered crystal structure namely, barium aluminates- called celsian and silicates of barium, iron, titanium namely bafertisite - possessing radiation shielding properties.

Development of Radiation Shielding Concrete using Red Mud based Aggregate

Salient Technical Features

- **Non Toxic – Lead free & Hematite Ore Free**
- **Specific Gravity of developed Red Mud based Synthetic Aggregates : 4.12**
- **Density of Advanced Radiation Shielding Concrete: 3640Kg/m^3**
- **Compressive Strength : 35 MPa**
- **Flexural Strength : 4.5 MPa**
- **Shielding – High energy Radiation : Gamma Rays**
- **Attenuation factor for Gamma Source ^{137}Cs : 5.73 & ^{60}Co:4.29**
  - **12 % higher than Hematite ore based concrete for ^{137}Cs**
  - **10 % higher for ^{60}Co (BARC)**

Radiation Attenuation Test Results for Developed Concrete (Tested at BARC, Mumbai)						
S. N	Sample Details	Dimensions (cm.)	Density (Kg/m^3)	Gamma Attenuation Factor ^{137}Cs	Gamma Attenuation Factor for ^{60}Co	Digital X-ray (300 KeV) Exposure
1	Hematite Ore Cement Concrete	30X30X 7.2	3372	5.01	3.73	
2	Red Mud based Synthetic Aggregate Concrete	30X30X 7.2	3658	5.72	4.22	

Summery : Radiation Shielding Concrete Technology

- The high density M-30 grade cement concrete mix design was developed using advanced red mud based synthetic aggregates.
- The mix design was carried out as per IS-10262-2019 by taking different compositions.
- The advanced cement concrete slabs of dimensions 30cmx30cmx7.2cm was casted in the laboratory and the sample were cured for 28 days.
- The density of developed concrete found to be 3658 kg/m3 which is at par with Hematite ore aggregate concrete.
- The samples were exposed to digital X-Ray (300 KeV) at Bhopal and radiation attenuation properties carried out at BARC, Mumbai for Gamma rays using ^{137}Cs & ^{60}Co radio active source.
- The result shows that the developed Synthetic Aggregate based Cement Concrete achieved around 10 to 12% higher attenuation for high-energy Gamma radiation source, i.e. ^{137}Cs as compared to conventional hematite ore-based Cement concrete & 8-10 % higher attenuation for high energy Gamma radiation source i.e. ^{60}Co as compared to conventional hematite ore based Cement Concrete

APPLICATIONS

Developed Radiation Shielding concrete having Gamma ray shielding properties have applications in :

- Nuclear Power Plants
- Bunkers for Strategic Sector
- Medical Diagnostic Installations

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Day 1: Technology Presentation Title

Utilization of Jarofix for road embankment construction

(Dr. A.K. Sinha, Sr. Principal Scientist, CSIR-CRRI, New Delhi)

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CSIR-AMPRI

JAROFIX WASTE MATERIAL FOR THE ROAD CONSTRUCTION

Jarosite is a waste material produced during extraction of zinc from its ore by hydrometallurgy operation. After mixing 2% cement and 10% lime, it becomes a stable material called “Jarofix”. Presently, it is being dumped near the plants without uses. About 60 million tons jarofix is already dumped as hillocks (60 m high) at Chittorgarh and Udaipur, Hindustan zinc limited. Accordingly, CSIR-CRRI has carried out detailed physical, chemical and geotechnical investigation on jarofix for application in road construction and inferred that it has potential for road construction.

- **Transforming solid wastes into wealth**
- **Cost effective Construction**
- **Contribution to Atmanirbhar Bharat**
- **Technology is ready for commercialization**

GEOTECHNICAL ENGINEERING DIVISION

CSIR-CENTRAL ROAD RESEARCH INSTITUTE (CRRI)

NEW DELHI-110025, INDIA

JAROFIX WASTE MATERIAL FOR EMBANKMENT & SUBGRADE CONSTRUCTION

GEOTECHNICAL CHARACTERISTICS OF JAROFIX AND MIX

Geotechnical Parameters	Embankment Jarofix	Sub Grade Jarofix: Soil (50:50)
Max. particle size, mm	> 1	> 75
LL, %	59	34
MDD, kN/m^3	16	18
OMC, %	35	20
FSI, %	10	5

JAROFIX WASTE MATERIAL AS A RETINED FILL OF FLYOVER CONSTRUCTION

Mix of jarofix:soil (30:70) was used as a retained fill for the construction of different flyovers along National Highway- 76, Udaipur -Chittorgarh section.

FIELD STUDY AND PERFORMANCE MONITORING OF JAROFIX

A pilot study was carried out by using jarofix in the construction of embankment and subgrade with or without mechanical (local soil) stabilisation at State Highway- 9, Chittorgarh to Udaipur section. Three sections were constructed using jarofix, mix of jarofix:soil and soil (standard section). Pavement performance monitoring was carried out by measuring structural and functional behaviour for three years.

PERFORMANCE EVALUATION RESULTS

Parameter/ Embankment Fill	Modulus of Elasticity, MPa	In-situ CBR, (%)	BI, mm/km	Deflection, mm
Jarofix (100%)	13	13-20	3362-3838	0.49-0.699
				.699
				-0.67

CONCLUSIONS (TRL- 8)

- Jarofix material should be used in the construction of embankment.
- This material should be also used in the construction of subgrade and as a retained fill of flyover stabilised with local soil.
- Conventional construction techniques/quality control procedures can be adopted for application of jarofix in the construction of road.
- Performance of this material is as good as soil.
- No sprinkling of water is needed during construction as natural moisture content is about OMC.

PUBLICATIONS

A.K. Sinha, V. G. Havanagi and J.T. Shahu (2021). Stabilised jarofix waste material for road construction. International Journal of Pavement Engineering, Vol.22 (7), 882-893.

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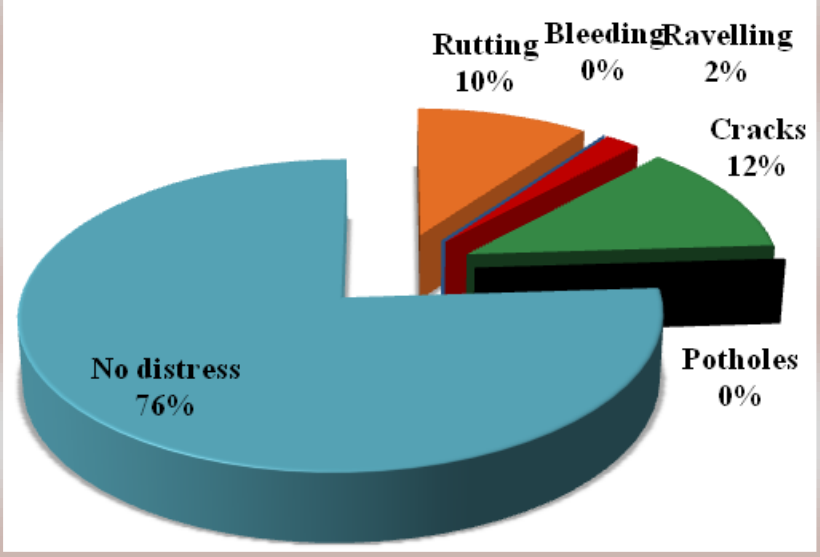

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A.K.Sinha, V.G. Havanagi, V.K.Arora, A. Ranjan and S. Mathur. (2012) Recycling Jarofix waste as a construction material for embankment and sub grade. International Journal of Solid Waste Technology and Management, vol. 38(3), pp 169-181.

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Ministry of Earth Sciences,
Govt. of India

Azadi Ka Amrit Mahotsav

Waste to Wealth

Civil Infrastructure and Engineering Theme

Day 2: Session Theme

Alternative building materials and structures using silica rich wastes

(i-CEN – 42, 7th July 2022)

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CSIR-AMPRI

Day 2: Technology Presentation Title

Utilization of phosphogypsum for road construction

(Dr. A.K. Sinha, Sr. Principal Scientist, CSIR-CRRI, New Delhi)

Organized by

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CSIR-AMPRI

PHOSPHOGYPSUM WASTE MATERIAL FOR ROAD CONSTRUCTION

Phosphogypsum is a waste material generated from different fertilizer industries during the production of sulphuric and phosphoric acids by using sulphur and rock phosphate ores. It is mixed with 1.5% hydrated lime and becomes stable material which is called Neutralised Phosphogypsum. Its production is 12 million tons/year and already deposited about 100 lacs ton at PPL Odisha. Presently, about 40 % is being utilised and remaining dumped in designated pond near the generating plant. Accordingly, CSIR-CRRI has carried out detailed physical, chemical and geotechnical investigation on phosphogypsum for application in road construction and inferred that it has potential for road construction.

OPPORUNITITES

- **Transforming solid wastes into wealth**
- **Cost effective Construction**
- **Contribution to Atmanirbhar Bharat**
- **Technology is ready for commercialization**

GEOTECHNICAL ENGINEERING DIVISION

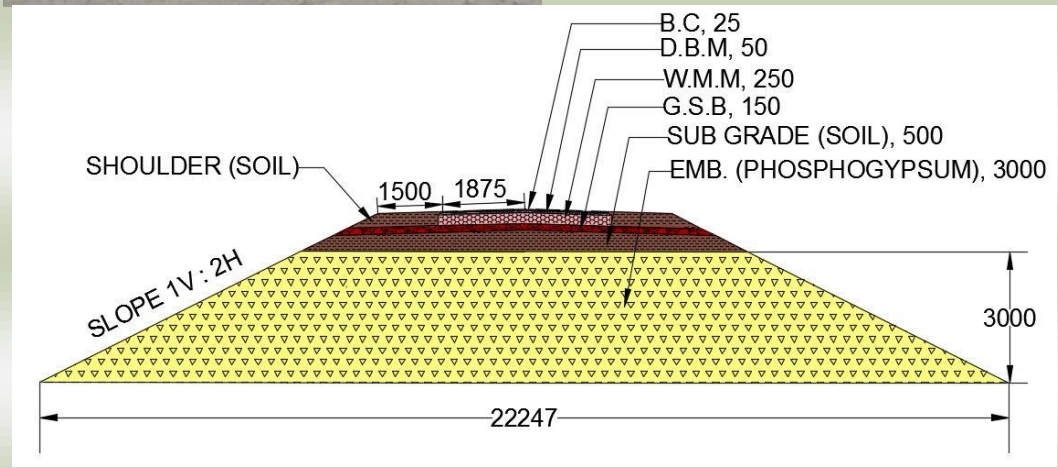
CSIR-CENTRAL ROAD RESEARCH INSTITUTE (CRRI)

NEW DELHI-110025, INDIA

PHOSPHOGYPSUM WASTE MATERIAL FOR EMBANKMENT, SUBGRADE AND GRANULAR SUB BASE CONSTRUCTION

CHARACTERISTICS OF PHOSPHOGYPSUM

Geotechnical Parameters	Value
Grain Size Analysis	<75µ=84%
Liquid Limit, %	49
MDD, kN/m^3	14.8
OMC,%	17
FSI, %	0
CBR, %	26



FIELD STUDY AND PERFORMANCE MONITORING OF PHOSPHOGYPSUM

A pilot study was carried out by using phosphogypsum in the construction of single lane embankment with or without slope cover with soil, subgrade, granular sub base and standard section using conventional materials in the campus of PPL, Odisha. Five sections were constructed using phosphogypsum. Pavement performance monitoring was carried out by measuring structural and functional behaviour for three years.

FIELD AND PERFORMANCE EVALUATION RESULTS

Parameter/ Embankment Fill	Modulus of Elasticity, MPa	In-situ CBR, %	BI, mm/km	Deflection, mm
Phosphogypsum	16-26	24-32	2084-3761	0.643-0.809
Conventional Soil (sand)	11-21	12-16	3430-3599	0.853-0.928

CONCLUSIONS

- Phosphogypsum waste material should be used in the construction of embankment, subgrade and granular sub base.
- Conventional construction techniques/quality control procedures can be adopted for application of phosphogypsum in the construction of road.
- Performance of this material is as good as soil.
- No sprinkling of water is needed during construction as natural moisture content is more than OMC.

PUBLICATIONS

A K Sinha, V G Havanagi and G.S.Parvathi (2019). Phosphogypsum waste material for road construction. National seminar on alternative highway construction material, Ranchi, Jharkhand.

V. G. Havanagi, A. K. Sinha and G.S.Parvathi (2018). Feasibility study of phosphogypsum in road construction. Indian Geotechnical conference Bangalore.

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Day 2: Technology Presentation Title

Quick repairing material by geopolymerisation

(Mr. Rohit B Meshram, Sr. Scientist, CSIR-NML, Jamshedpur)

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CSIR-AMPRI

Quick Repairing Material

Green Sustainable Process

CSIR-NML

Recycling of Industry Waste

HIGHLIGHT

Workability: 15 - 30 minutes

Ready for light traffic in 4-6 hours

Open to heavy traffic in 12 hours

Secondary & Resource Utilization Group
Metal Extraction & Recycling Division
CSIR-National Metallurgical Laboratory (NML)
Jamshedpur- 831007, India.

CSIR-NML

TECHNOLOGY READY FOR COMMERCIALIZATION: TRL-8

- An environment friendly, cost effective and time-saving solution to potholes, edge deformation, trench work etc.
- Metallurgical and thermal power plant waste are used as primary raw materials.
- Technology successfully transferred to Industry.
- Received CSIR-NML "Altekar Award for Best Technology" in 2018.

Product Datasheet

Setting Time (in minute)	Compressive Strength (in MPa)			Shrinkage
	1 Day	7 Days	28 Days	
Min. 40	*Min. 20*	*Min. 40*	*Min. 50*	*Nil*
Min. 30	*Min. 25*	*Min. 45*	*Min. 55*	*Nil*

- Less cost compared to available products.
- Import substitution.
- High shelf life, can be stockpiled for months.

Application areas-

- Repairing of the common defects occur in roads such as pot holes, cracks and uneven patches.
- Repairing of cracks in wall and other structures.

MORE DETAILS

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Day 2: Technology Presentation Title

Toilet unit using thin precast concrete segmental panels

(Dr. K.N. Laksmikandhan, Sr. Scientist, CSIR-SERC, Chennai)

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CSIR-AMPRI

CSIR-SERC Technology

PRECAST FERROCEMENT TOILET CORE UNIT (PREFER TOCO)

Novel solution to construct Precast, lightweight, rapid-built and durable toilet super structures

CSIR-Structural Engineering Research Centre (CSIR-SERC) has developed precast ferrocement prototype toilet core units to construct sanitation requirements. The present technology aimed to satisfy the industrial requirements on construction of toilets for the Swachh Baharat mission. The present technology combines the site work for base work and the precast ferrocement technology for superstructure. The precast toilets developed with good design, convenient size, with high quality and strength. The technology is well suitable for mass production of toilets. The precast toilet comes with ferrocement water tank and septic tank.

FEATURES / HIGHLIGHTS

High quality	Precise technology
Corrosion resistant	Rapid construction
Suitable for Indian/Western closet	Good ventilation
Stable integrated system	Aesthetic look
Low cost toilet (Less than Rs.10000)	Speedy Construction
Technology with Fully or Partly precast with minimum site work	
Easy maintenance	Longer Life span

TECHNICAL DETAILS

- Four types of precast ferrocement toilet systems have been developed to scatter different affordability.
- Reduced Cement usage by replacing with Industrial Wastes like Fly ash, Granulated blast furnace slag of up to 30 percent. Improved durability and strength.
- The type1 and type4 PreFer TOCO model components are prefabricated entirely and assembled at site. These technologies offer high ventilation and air circulation. Suitable for single and multiple integrated units.
- The type2 and type3 PreFer TOCO are partly precast and partly cast at site for local resource utilization reduced components number and cost effectiveness.
- The type2 super structure is a segmental type, where “c” with lips and lightweight sandwich roof have been assembled and firmly integrated with foundation.
- The type3 super structure is a ferrocement wall panels comes with end ribs. The wall panels have integrated to form a self-stable structure.
- The lightweight sandwich roof panel is placed over this stable wall structure.

Type1-Assembling

Type1-Single toilet core unit
(Cost of toilet: Rs.16000)

Type1-Multiple toilet core Unit
(Cost of 2 toilet units: Rs.28000)

Type2-Assembling

Type2-Assembling

Type2-Single unit (Cost
of 1 unit Rs.22500)

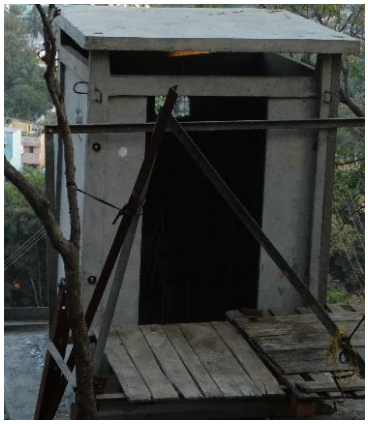
Type2-Assembled
Multiple Units
(Cost of 2 units Rs.22500)

Type3-Model1 Assembling

Type3-Model2 Assembling

Type3-Single Toilet Unit
(Cost of 1 unit Rs.9000

Type4- Single Toilet Units (Dry joint mechanism)
(Cost of 1 unit Rs.9000)



Type4- Modified for Security Cabins
(Cost of 1 unit Rs.6000)

APPLICATIONS

- Alternate Technology for conventional brick masonry service core units
- Can be assembled in the existing old and new building
- Suitable for buildings with leaking service core area
- Multi skin Low cost housing technology

TECHNOLOGY TRANSFER

Type I Products are demonstrated at CSIR-SERC and SERC-TTRS.

Type-2 Products are transferred and demonstrated at CSIR-CLRI

Type-3 Products are demonstrated at CSIR-SERC and the technology is transferred to following

1. M/s. Lakshmi Srinivas Engineers, Plot No.101, Phase-I, road No.12, I.D.A., Mallapur, Hyderabad-500076.
2. M/s Fractal Enterprise, Door No. 58-15-11/4/1, Flot No. 601, Shantinagar, Vishakhapatnam, AP-530009.
3. M/s Natural Waste Management Technologies Pvt. Ltd, 3-28, Gollapalli, Nuzvid (Mandal) Krishna dist, AP, India- 521111

Type-4 Product are demonstrated at CSIR-SERC and SERC-TTRS

ALLIED TECHNOLOGIES AT CSIR-SERC

Cost effective precast shell integrated floor system

Lightweight EPS infilled building blocks

Lightweight low-cost SECROBuilt sandwiched panels for wall and flooring system for housing.

Lightweight Ferrocement water tank with thermal insulation

Precast Ferrocement water tanks – Precast as whole tank or assembled by multiple part for handy

Precast Ferrocement septic tank – single and multiple in series for continuous usage

Plastic waste bottles infilled wall and roof panels for commercial and housing buildings

Plastic waste carry bag infilled wall and roof panels for commercial and housing buildings

Coconut shell / Bamboo / Reed infilled wall and roof panels for commercial buildings

Ferrocement Compound Walls

CSIR–SERC
ENGINEERING SUSTAINABLE STRUCTURES

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Day 2: Technology Presentation Title

Eco-friendly geopolymer concrete blocks

(Dr. P. S. Ambily, Principal Scientist, CSIR-SERC, Chennai)

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CSIR-AMPRI

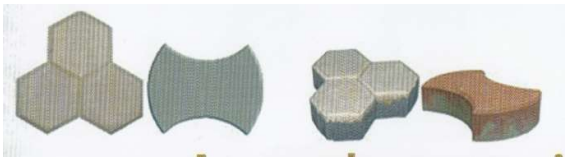
ECO-FRIENDLY GOEPOLYMER CONCRETE BLOCKS

A novel technology for producing eco-friendly geopolymer concrete (GPC) blocks with zero Portland cement

CSIR-Structural Engineering Research Centre (CSIR-SERC), Chennai has developed ambient temperature cured concrete blocks using geopolymer technology. These blocks are of different types - building blocks, paver blocks, hollow blocks and lightweight blocks. This technology offers a speedy, cost-effective and environment-friendly alternative to conventional Portland cement based blocks. The production of GPC blocks lead to a scientific, systematic and eco-friendly utilization of industrial wastes. The technology has been already demonstrated in pilot scale.

FEATURES / HIGHLIGHTS

- Environment-friendly and sustainable
- Complete replacement of Portland cement in concrete with cementitious materials such as fly ash and ground granulated blast furnace slag
- Water not required for curing
- Less energy requirement and low carbon footprint
- Good mechanical and durability properties
- High early strength
- Better life-cycle cost when compared to Portland cement based concrete



APPLICATIONS

- Alternate to conventional Portland cement based blocks
- Can be used in buildings, landscaping, container yards, foot paths, parking lots, pavements, etc.

TECHNOLOGY TRANSFER

- Technology transferred on non-exclusive basis to:
    1. M/s Kiran Global Geocements Private Limited, Chennai,
    2. M/s KPS Bricks, Erode, Tamil Nadu
    3. M/s Vasavi Concrete Solutions, Kurnool, Andhra Pradesh
- Technology is available for transfer to other interested players in the industry

Title: **Ecofriendly geopolymer concrete building / paver blocks**	**Author / Designation / Company:** **CSIR-Structural Engineering Research Centre, Chennai**
Creation Date: May 2009 **Technology Type:** Process / Design / Material / Software/ Others (specify) – ➢ **Process and the product: Ambient Temperature cured geopolymer concrete blocks**	**Desired Mode of Technology Offer:** Technology (Knowhow) Transfer / Production License / OEM Manufacturing / Joint Venture / Others ➢ **Technology Transfer**

Promotional Description:

This technology is for the production of an ambient temperature cured geopolymer concrete blocks. Some of the key features of the technology are:

- Blocks are of different types - building blocks, paver blocks, hollow blocks and lightweight blocks
- Speedy, cost-effective and environment-friendly alternative to conventional Portland cement-based blocks / bricks
- More versatile in terms of structural efficiency, durability and consumption of energy–intensive material
- Technology for converting waste to wealth

Geopolymer Concrete Paver Blocks

Technology Benefits Summary, Differentiation & Uniqueness:

- Ambient temperature cured geopolymer concrete completely eliminates the need of water for curing
- Portland cement free binder lead to reduction in the carbon footprint and embodied energy
- Eco-friendly utilization of industrial wastes
- Faster rate of strength development at early ages
- Sustainability by way of utilizing industrial wastes
- IS codal requirements satisfied: Building blocks (IS 2185(Part 1):2005 (Reaffirmed 2015), IS 2185(Part2):1983(Reaffirmed 2015)); Paver blocks (IS15658:2006 (Reaffirmed 2017))

Major Waste Material/materials Utilized

Fly ash, biomass ash, blast furnace slag, micronized biomass silica, copper slag, slag aggregates, recycled aggregates

Application & Potential Advantages:

- Alternative to conventional Portland cement based blocks
- Cost-effective and environmentally sound alternative to conventional walling materials
- Technology easily customizable to suit the special needs of micro- and small-scale building material producers and construction companies
- Large application areas including buildings, landscaping, container yards, foot paths, parking lots, etc.

Development Stage & Development Status Summary:

- The technology has already been transferred to an entrepreneur on non-exclusive basis and is readily available for customization, transfer and commercialization to the interested parties on non-exclusive basis.
- TRL 7

Intellectual Property / Patent Summary:

Not patented

Technical Details:

- Technology consists of the procedure along with the technical specifications for making ambient temperature cured geopolymer blocks using indigenous source materials (industrial byproducts) suitable for construction applications; based on the demand from the industry.
- Low water absorption
- Paver blocks:
  - Thickness: Min. 50 mm and Max. 120 mm
  - Grade: M30 – M55 suitable for non-traffic, light, medium, heavy and very heavy traffic
  - More affordable compared to conventional cement concrete paver blocks
- Building blocks:
  - Hollow (open and closed cavity); Solid; Lightweight (load bearing and non-load bearing)
  - Nominal dimensions
  - Length: 400, 500 or 600 mm
  - Width: Range between 50 and 300 mm
  - Grade: Up to M50
- Customisation possible for
  - Grade: Up to M100
  - Different geopolymeric source materials and
  - shape, size and other similar parameters

Collaboration Description, Terms & Restrictions & Seller Support (technical / training / documentation etc.):

- Technology on **Eco-friendly geopolymer concrete bricks/blocks** is available with CSIR-SERC
- Technology transfer will be affected on non-exclusive basis as per relevant CSIR guidelines applicable from time-to-time
- Standard documentation on the technology and training support by CSIR-SERC scientists form part of the technology transfer

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CSIR–SERC
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Ministry of Earth Sciences,
Govt. of India

Azadi Ka Amrit Mahotsav

Waste to Wealth

Civil Infrastructure and Engineering Theme

Day 3: Session Theme

High volume use of industrial inorganic wastes for road and civil infrastructure

(i-CEN – 44, 11th July 2022)

Organized by

सीएसआईआर- एम्री
CSIR-AMPRI

Day 3: Technology Presentation Title

Utilization of copper slag for road construction

(Dr A.K. Sinha, Sr. Principal Scientist, CSIR-CRRI, New Delhi)

Organized by

सीएसआईआर- एम्री
CSIR-AMPRI

COPPER SLAG WASTE MATERIAL FOR ROAD CONSTRUCTION

Copper slag is a waste material generated during extraction of copper metal from its ore. Presently, it has limited application of about 20 %. Its production is about 5000 tons/day and its total accumulation till date is about 7 million tons. Balance copper slag is dumped as a waste material in and around the plant premises. Accordingly, CSIR-CRRI has carried out detailed physical, chemical and geotechnical investigation on copper slag for application in road construction and inferred that it has potential for road construction.

OPPORUNITITES

- **Transforming solid wastes into wealth**
- **Cost effective Construction**
- **Contribution to Atmanirbhar Bharat**
- **Technology is ready for commercialization**

GEOTECHNICAL ENGINEERING DIVISION

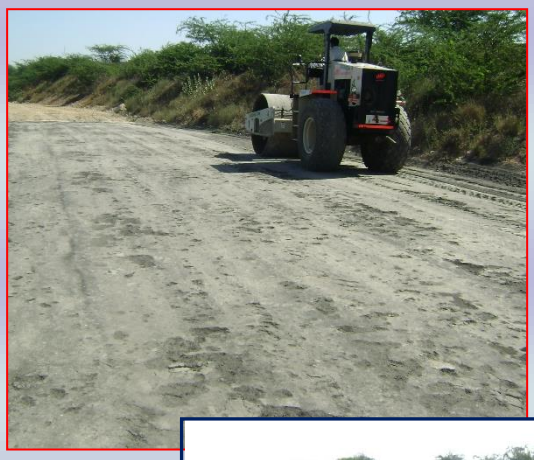
CSIR-CENTRAL ROAD RESEARCH INSTITUTE (CRRI)

NEW DELHI-110025, INDIA

COPPER SLAG WASTE MATERIAL FOR EMBANKMENT & SUBGRADE CONSTRUCTION

GEOTECHNICAL CHARACTERISTICS OF COPPER SLAG

Geotechnical Parameter	Copper Slag	Pond Ash	Copper Slag: Pond Ash (50:50)
Grain size, mm	> 75mm	> 75 mm	> 75 mm
Plasticity	NP	NP	NP
Classification	SP	ML	ML
MDD (kN/m^3)	23.2	12.4	18.8
OMC (%)	7	21	9
FSI (%)	0	0	0
CBR (%)	35	3	31



FIELD STUDY AND PERFORMANCE MONITORING OF COPPER SLAG

A pilot study was carried out by using mix of copper slag and pond ash in the construction of embankment near Sterlite Industry, Tuticorin along National Highway 45B (Madurai-Kanya Kumari Expressway), Tamil Nadu. Copper slag was mixed with pond ash in 50:50 proportions. Pavement performance monitoring was carried out by measuring structural and functional behaviour for three years.

FIELD AND PERFORMANCE EVALUATION RESULT

Parameter/ Embankment Fill	Modulus of Elasticity (MPa)	In-situ CBR (%)	BI (mm/km)	Deflection (mm)
Copper Slag + Pond Ash	13-17	22-32	1896-5197	0.307-0.547
Conventional section	11-14	NA	1920-4230	0.239-0.477

CONCLUSIONS (TRL-7)

- Copper slag waste material mixed with pond ash should be used in the construction of embankment and subgrade.
- Conventional construction techniques/quality control procedures can be adopted for application of copper slag in the construction of road.
- Performance of this material is as good as soil.

PUBLICATIONS

V.G. Havanagi, **A.K.Sinha** and A. Ranjan. (2015). Fine copper slag as an alternative marginal material for road construction. Journal of Indian Highways, vol. 44(1), pp 25-33.

V.K.Arora, V.G. Havanagi and **A. K. Sinha** (2013). Characterisation of copper slag and jarofix waste materials for road construction. Proceeding of international conference on world academy of science and technology. International science index issue 84, Melbourne, Australia, pp 1353-1358.

V.G.Havanagi, **A.K.Sinha**, A Ranjan and S. Mathur (2012). Characterisation of super fine copper slag for construction of embankment. Proceeding of Indian geotechnical conference, New Delhi, Vol.2, pp 878-881.

V. G. Havanagi, **A. K. Sinha,** V. K. Arora and S. Mathur (2012). Design and Stability analysis of copper slag embankment. Journal of Indian Highways, vol. 40(10), pp 17-23.

V. G. Havanagi, **A.K.Sinha**, Sudhir Mathur and Prema Prasad (2008). Experimental study on the use of copper slag wastes in embankment and pavement construction. Proceeding of National symposium on Engineering of ground and environmental geotechniques, Hyderabad, pp 259-264.

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Day 3: Technology Presentation Title

Eco- friendly X-ray radiation shielding leadfree redmud doors & panels

(Dr. M K Gupta, Scientist, CSIR-AMPRI, Bhopal)

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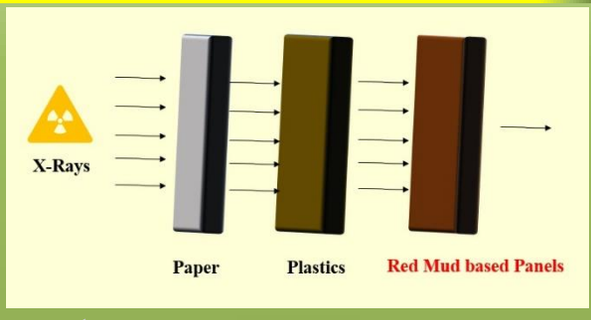
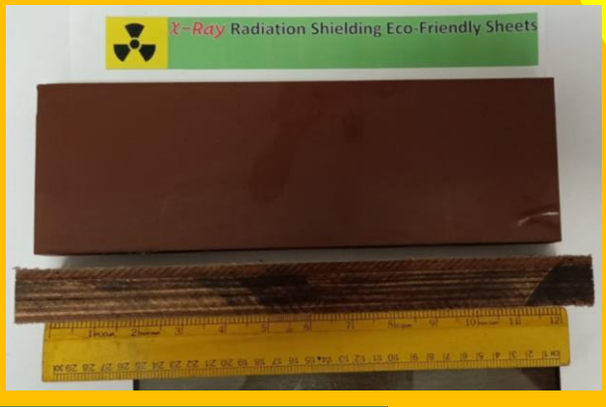
CSIR-AMPRI

Eco-Friendly X-Ray Radiation Shielding Lead Free Green Doors and Panels

Recycling Technology for Bulk Use of Bauxite Red Mud Waste for High End Application





Opportunities

- Low Energy consuming high performance polymeric radiation shielding materials
- Create start-up, entrepreneurship & employment generation
- Transforming red mud into high value added product
- Technology is ready for commercialization
- An efficient cost-effective X-ray radiation shielding products

HYBRID BUILDING MATERIALS AND MANUFACTURING GROUP
CSIR-ADVANCED MATERIALS AND PROCESSES RESEARCH INSTITUTE (AMPRI)
BHOPAL-462026 (M.P.), INDIA

CSIR-AMPRI Developed X-Ray Radiation Shielding Panels

RED MUD WASTE PARTICULATES

Red mud, a solid waste produced in the process of alumina production from bauxite. More than 13 million tons of red mud is generated annually in India only. (e. g. NALCO, HINDALCO) Fe_2O_3 ~ 30.9 %, Al_2O_3 ~ 14 %.

Red Mud is produced during the process for alumina production and about 1- 2.5 tons of red mud is generated per ton of alumina produced which is 6.25% of world's total generation India produces about 13 millions ton.

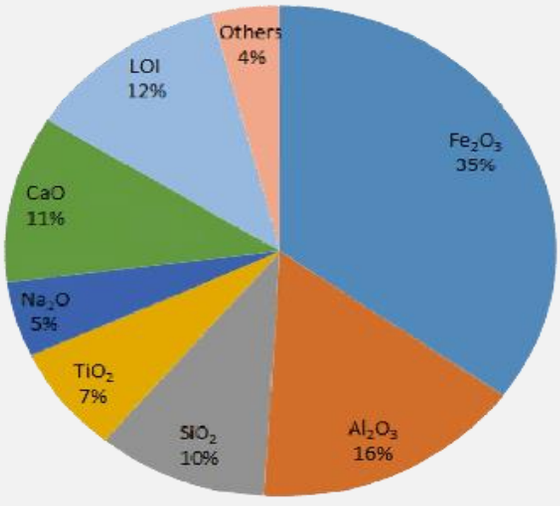
Properties of Red Mud

Raw Materials: ❑ Red Mud ❑ Polymer

Input : 3 Tons Bauxite

Output

Alumina (1Ton) **Red Mud (1.3-1.5 Tons)**



MANUFACTURING PROCESS

Processing of the Raw red mud wastes

↓

Processed red mud wastes in polymeric system

↓

Casting of composites under compression

↓

Moulding

↓

Final products

Testing and quality assessment

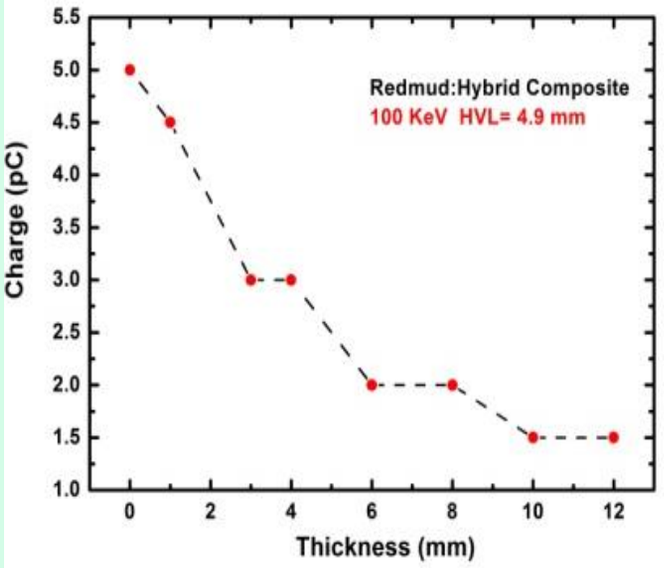
↓

X-Ray Radiation Shielding Panles

Full Scale X-Ray Radiation Shielding Panel 12 mm Thick

CSIR-AMPRI Developed X-Ray Radiation Shielding Panels

Performance of Red-Mud X-Ray Radiation Shielding Panels



Physical Properties	Values
Particle size (µm)	0.5 - 170
Bulk density (g/cc)	1.25 - 1.8
Specific gravity	2.2 - 3.4
Porosity (%)	45 - 68
pH	4 - 12.5
Water holding capacity (%)	< 45
Electrical conductivity (µmohs / HP)	450 - 800

X-Ray Attenuation Coefficient

$$I = I_0 e^{-(\mu/\rho)\rho x}$$

Product Performance

Density: 1.4– 1.6 g/c

Tensile Strength: 25 -120 MPa

Flexural Strength: 35-120 MPa

Water Absorption: 0.25- 0.30 %

Peak Voltage (kVp)	Lead HVL mm	Concretes (mm)	AMPRI Radiation Shielding Product mm
100	0.27	15.10	4.9

Novelty

- Durable and stronger, Lead Free
- High strength to weight ratio
- Resistance to weather, termite, corrosion
- Fire retardant, Self Extinguishing
- Maintenance Free, Green composite
- Cost-effective than lead panels
- Multifunctional applications in Hospital and Nuclear Sector

Environmental & Social Impact

- Converting red mud into high end products
- Carbon sequestration, control air and water pollution
- Contribution to reduce global warming and climate change issues
- A new class of material to X-Ray room and health care system

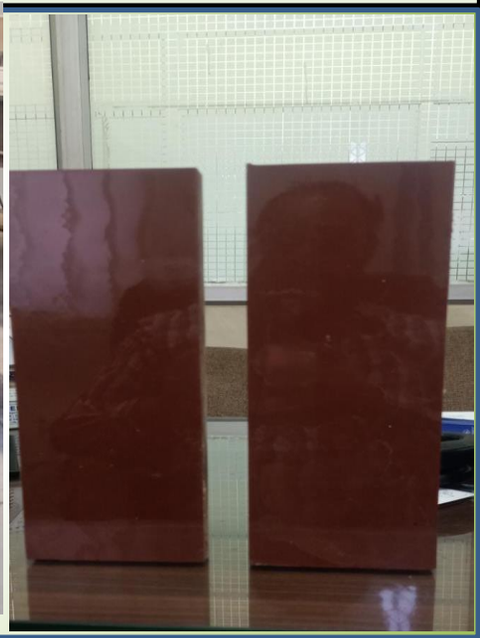
CSIR-AMPRI Developed X-Ray Radiation Shielding Panels

TECHNOLOGY READY FOR COMMERCIALISATION: TRL-6

- Technology transfer for commercialization of the technology
- Demonstration of full scale radiation shielding door at KGMU, Lucknow and product validation at KGMU and AERB.
- Convert lab research & Create start-up industries
- All essential testing have been done as per the BIS and ASTM standard and confirmed the suitability for potential applications.
- Energy saving & eco friendly products and technology

Commercial Opportunities

- Transforming bauxite red mud waste into wealth for medical sectors
- Convert lab research & Create start-up industries
- Enhance economy & employment
- Process know-how, Make In India, Aatma Nirbhar Bharat



Radiation Shielding Red Mud Door

IPR Status

Title: Radiation Shielding Red Mud Based Hybrid Composite Panels And Process For Preparing The Same

Inventor: Manoj Kumar Gupta, Asokan Pappu, Sanjai Kumar Singh Rathore, Avanish Kumar, Srivastava, Teerthraj Verma, Anit Parihar

Patent Number: 0052NF2019. PD040919PCT, Filed In USA, India and Europe (19 Feb, 2020)

CREATE BUSINESS FROM RED MUD ON CSIR-AMPRI TECHNOLOGY

CSIR-AMPRI facilitate R&D business for large scale utilization of red mud wastes for manufacturing durable hybrd X-Ray radiation shielding doors/panels

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Ministry of Earth Sciences,
Govt. of India

Azadi Ka Amrit Mahotsav

Day 3: Technology Presentation Title

Cost effective durable water tanks using flowable cement mortar

(Dr. J. Prabhakar, Chief Scientist, CSIR-SERC, Chennai)

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CSIR-AMPRI

COST-EFFECTIVE WATER TANKS FOR DOMESTIC NEEDS

A novel idea to construct cost-effective, easy-to-build and durable water tanks using flowable cement mortar and thin precast concrete panels

CSIR-Structural Engineering Research Centre (CSIR-SERC), Chennai has developed cost-effective, easy-to-build and durable water tanks for domestic needs. The tanks can be easily constructed with flowable cement mortar without the need of skilled artisans. The tanks can also be built using thin precast concrete panels that do not require any lifting mechanism for placing on the roof.

- **Ferrocement products have several applications and advantages even though these products are not being used by the construction industries due to their construction difficulties.**
  - **To construct this product requires highly skilled labor of artisan type which is the major problem.**
  - **The cost of raw materials is low as compared labor cost (35:65).**
- **To over come the difficulties of construction of water tank using highly skilled person of artisan type, it was proposed to develop flow-able cement mortar for ease of construction.**

Mix proportion

Cement	- 1.0
GGBS	- 0.5
Fine Agg.	- 2.0
W/C	- 0.4
HSP	- 0.6%

Reinforcement : Weld mesh of size 25mm x 25mm with 2.3mm dia. wires

Reinforcement detail

Shuttering and Pouring of Mix

Curing of Water Tank

Shifting of Tank by Lifting

Tank placing under ground

Tank is ready for operation

Total Weight of Tank - 4.5 T, 3 times less than Conventional RCC Tank

Cost of the tank – Rs. 40,000, 3 times less than Conventional RCC Tank

water tank is filled with water and no leakage is observed over the period of two years

Water Tank with Pre-cast concrete panels

Technical Features

- Cost-effective and durable
- Addresses sustainability issues
- Lightweight
- Simplified construction technique
- Can be cast in various sizes

Advantages

- Domestic needs met at affordable cost
- Shifting of water tank is possible
- Ease of construction
- 1000 lts. to 10,000 lts. capacity is water tanks are possible
- Use of Industrial Wastes/by-products
- Replacement of plastic tank

Unique Selling Pre-position

- Product developed is cost-effective compared to all other water tanks commercially available.
- The developed water tank is durable and sustainable compared to plastic tanks commercially available in the market.

Contribution to Sustainable Construction

- Use of fly ash in flow-able cement composite.
- The technology will help to improve the living style of the rural people by providing hygienic environment.
- Effective use of raw materials as wastage is minimized.

Eco friendly, Simplified production technique, Cost-Effective, Sustainable product and High Societal Impact

Technology Transferred to

M/s. Consortium Techno Solutions Pvt. Ltd., Hydrebad.

For Further Details please contact

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Day 3: Technology Presentation Title

Process know how for making building components from construction & demolition wastes

(Dr. Santha Kumar G, Sr. Scientist, CSIR-CBRI, Roorkee)

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CSIR-AMPRI

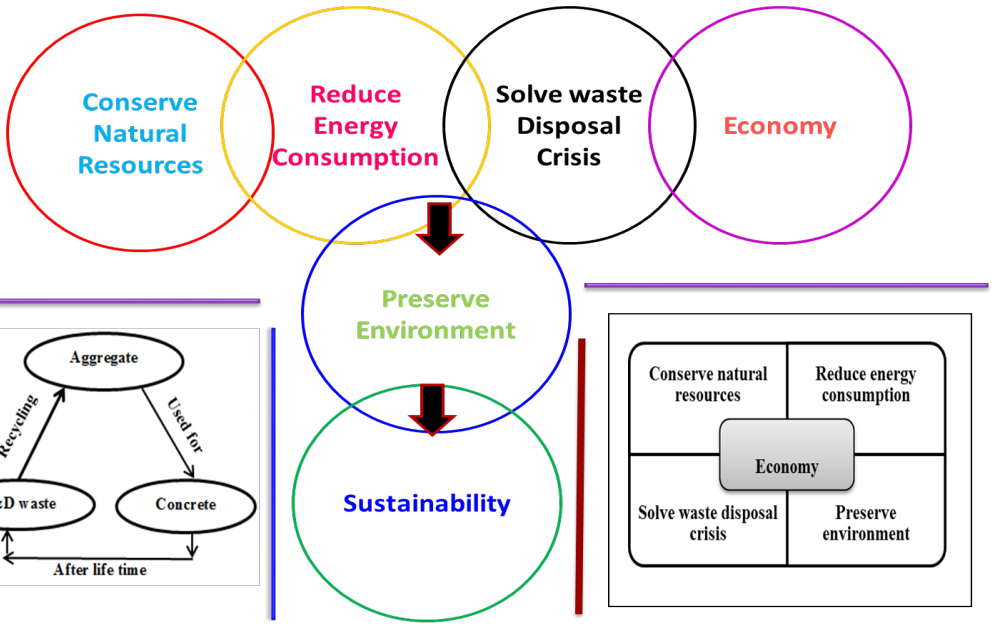
Construction & Demolition Waste as Raw Materials for Low Cost Construction Products

CSIR-Central Building Research Institute,
Roorkee, Uttarakhand (247667)

Construction & Demolition Waste




Benefits of Recycling & Reuse



Indian scenario of C&D waste

- MoHUA estimates that 100 million tonnes of C&D Waste is the closest approximation for nationwide generation (Source. Ready Reckoner released by BMTPC, 2018)
- According to survey of BMTPC, 165-175 Mnt per annum during 2005-2013

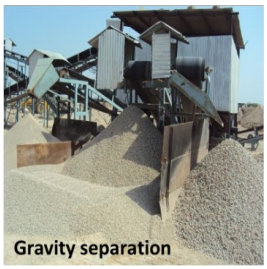
Country	No. of plants	Population (million)
India	4	1324.17
Germany	220	81.28
France	50	64.75
Netherland	70	16.99
UK	120	65.22
Belgium	60	11.43
Denmark	20	5.67
Italy	43	59.86

Major city	C&D wastes (tons/day)
Mumbai	2500
Delhi	4600
Bangalore	875
Hyderabad	750
Chennai	2500
Ahmedabad	700
Pune	750
Surat	400
Kolkata	2000

Indian Scenario :

Place	No. of Plants
Burari, Delhi	Total 4 Operating Plants
Sastri park, Delhi	
Ahmedabad, Gujarat	
Vikhroli, Mumbai	

Production Process of Recycled Aggregates



Why Recycling ?

✓ Global Warming

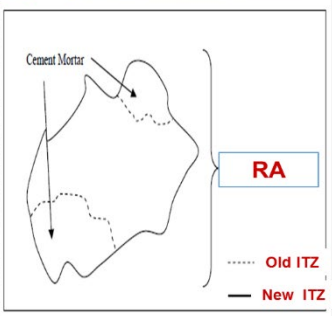
✓ Scarcity of raw materials

✓ Major issue of disposal of C&D wastes due to non availability of dumping ground

✓ Sustainability demand in construction sector

Basic Characteristics of RCA

- Large amount of loosely adhered mortar
- Porous in nature
- High absorption tendency
- Weak interfacial transition zone (Two ITZs)
- Presence of cracks, pores and fissures
- Poor grading



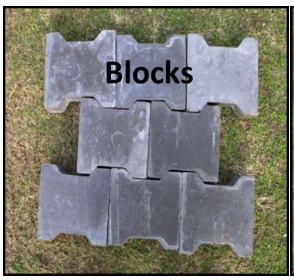
Paver Blocks from Natural and Recycled Aggregate (IS: 15658-2006)

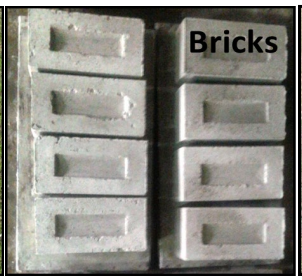
- Size of blocks: 200 x 160 x 80 mm
- Prepared by compaction technique
- Cured under water at 27 ± 2° C for a period of 28 days

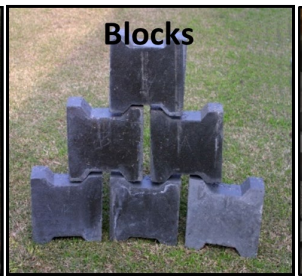
Blocks made with RCA & RFA

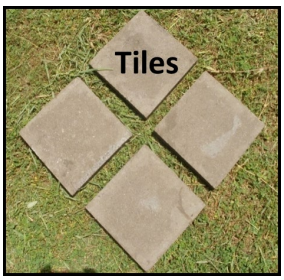
- Strength could be achieved up to 45 MPa at 100%of RA
- Strength of blocks prepared with RA is about 12% less as compared to control blocks
- It can also be recommended for medium traffic purpose as these are satisfying the minimum strength requirements of M-40 grade as per IS:15658.

Demolition wastes as Raw Materials for Low Cost building Products



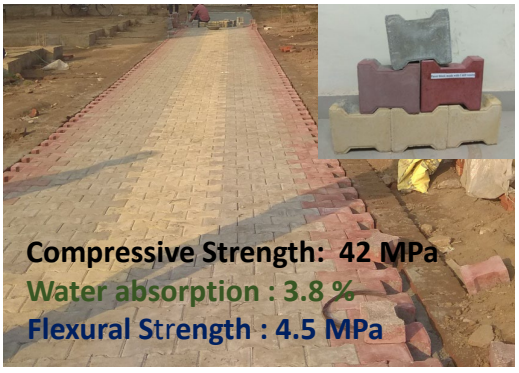






Demo park at CSIR-CBRI

Twenty thousand Paver block of size 200 mm x 160 mm x 80 mm have been casted using recycle aggregates and used in pavement of mass housing site



- 100% replacement of natural aggregate with recycle aggregates
- Prepared by compaction technique
- Cured under water at 27 ± 2° C for a period of 28 days

- It can also be recommended for medium traffic purpose as per IS:15658.

Commercialization of Technology

The efforts were made towards commercialization "Process know how to develop paver blocks and other building components from construction and demolition waste".

Recently this technology has been transferred to M/s Disha Ecoloc Pavers, Nagpur

For more details please contact

CBRI
केंद्रीय भवन अनुसंधान संस्थान, रुड़की
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Waste to Wealth

Civil Infrastructure and Engineering Theme

Day 4: Session Theme

Industrial & agro wastes recycling technologies in green building Materials

(i-CEN – 46, 14th July 2022)

Organized by

सीएसआईआर- एम्री
CSIR-AMPRI

Day 4: Technology Presentation Title

High volume use of Parali- paddy stubble (Agrowaste)- a raw materials for manufacturing hybrid particle boards

(Dr. Asokan Pappu, Chief Scientist, CSIR-AMPRI, Bhopal)

Organized by

सीएसआईआर- एम्प्री
CSIR-AMPRI

CSIR - AMPRI

AGRO WASTES (PARALI) POTENTIAL FOR MANUFACTURING HYBRID PARTICLE / FIBRE BOARDS

EVERGREEN COMPOSITE WOOD

Recycling Technology for Eco Products: Paddy stabble & Wheat straw fibres

OPPORTUNITIES

- Transforming agro wastes into wealth
- Create start-up, entrepreneurship & employment thus enhance the economy
- Contribute to Atmanirbhar Bharat
- Technology is ready for commercialization

ADVANCED CONSTRUCTION MATERIALS GROUP
CSIR-ADVANCED MATERIALS AND PROCESSES RESEARCH INSTITUTE (AMPRI)
BHOPAL - 462026 (M.P.), INDIA

HYBRID GREEN COMPOSITE PARTICLE BOARD FROM AGRO WASTES

CSIR-Advanced Materials and Processes Research Institute (AMPRI), Bhopal has developed a technology for large scale recycling parali (paddy straw/ stubble) and wheat straw for manufacturing Hybrid green composite particle / fibre boards in pilot scale. Optimized the process parameters and the process know-how and technology package is ready for commercial scale manufacturing. The developed composite materials are better alternative for particle board, MDF board and wood to use as an architectural cladding panels, partition wall, door and furniture.

Vision

- Transform agro wastes into hybrid particle borads
- Create business from parali
- Contribute to Make in India, Clean and Skill India program
- Provide holistic solution to agro-wastes management
- Enhance the rural livelihoods of the poor

Crop Residues Generation in india

States	Residues Generation (Million Tons / Year)
Punjab	50.75
Uttar Pradesh	59.97
Haryana	27.83
Maharashtra	46.45

Raw Materials : ■ Parali (Paddy Stubble/Straw) ■ Wheat Straw ■ Polymer

Processing agro wastes :

Paddy straw

Paddy straw fibre

Processed paddy straw

Processed fibre matrix

MANUFACTURING PROCESS

Raw paddy stubble / straw / agro wastes

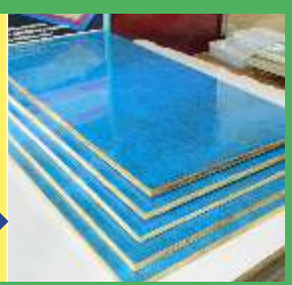
Processed agro wastes/ Paddy stubble / straw in polymeric system

Casting of composites under compression moulding

Final products

Testing and quality assessment

Unlaminated ← **Hybrid particle board from parali** → **Laminated**



TECHNOLOGY READY FOR COMMERCIALISATION: TRL-5

- Technology is ready for commercial scale manufacturing medium density and high-density hybrid composite particles / fibre boards
- All essential testing have been done as per the BIS and ASTM standard and confirmed the suitability for use in housing sector
- The quality and performance have been validated at IPIRTI, Bengaluru
- Energy saving & eco friendly products and technology


Hybrid particle boards made of paddy stubble (2m x 1m x 12mm)

Solution to Parali Burning

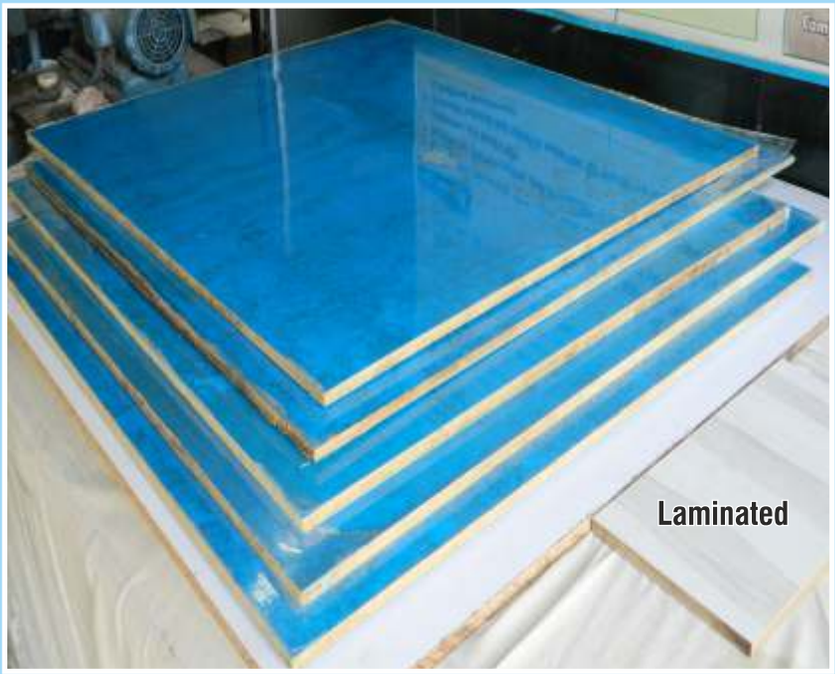
- Use of agro wastes and converting them into value added materials
- Providing holistic solution to stop burning parali / agro wastes
- Creating new employment and income to rural people and farmers
- Manufacture a new class of particle / fibre boards from agro wastes


Hybrid particle boards made of parali / paddy stubble / wheat straw (12-25mm thickness)

INTRODUCING A NEW CLASS OF ECO-FRIENDLY MATERIALS TO THE SOCIETY

Hybrid particle boards made of paddy straw in pilot scale at CSIR-AMPRI, Bhopal (2m x 1m x 19mm)


Unlaminated


Laminated


Sandwich composites made of wheat straw (30mm thickness)

PERFORMANCE OF HYBRID PARALI PARTICLE/ FIBRE BOARDS

Material performance (Average value)	Tensile Strength (MPa)	Tensile Modulus (GPa)	Flexural Strength (MPa)	Flexural Modulus (GPa)	Density (g/cm^3)	Thickness Swelling (%)	Water Absorption (%)	Termite Effect
Un-laminated Board	20.02–26.81	2.37–3.89	17.47–47.65	2.09–4.25	0.69–1.18	6.69–22.13	8.95–62.34	RT
Laminated Board	23.14–29.37	2.98–4.58	24.39–40.90	3.50–4.89	0.98_1.40	3.94–12.76	6.19–10.45	RT

RT - Resistance to termite

Parali particle boards : Flexural strength test specimens

Uniqueness of Parali Particle Boards

- Durable, weather resistant & cost effective
- Resistance to moisture, termite & corrosion
- Different colour, texture, surface finish can be made
- Better in quality as compared to particle board and MDF board

Environmental and Social Impact

- Use of renewable agro fibres to avoid synthetic fibres
- Carbon sequestration, control smoke & air pollution
- Contribution to reduce global warming and climate change issues
- A new class of material to housing sector

BENEFICIARIES: Housing, Civil Infrastructure, Furniture Industry, Farmers, Local Population of Delhi NCR, Haryana, Punjab etc.

IPR Status

Two International Patents (i) A glossy finish sandwich composite and process for preparing the same (Grant No.201811047389, WO 2020/121319 A1) and (ii) High performance glossy finish green hybrid composites with variable density and an improved process for making there of (Publication No. 201811016873. W02019/211862A1) filed.

Paddy straw particle boards

Sandwich board from paddy straw

Particle boards from parali

Sandwich boards from wheat straw

CREATE BUSINESS FROM PARALI ON CSIR-AMPRI TECHNOLOGY

CSIR-AMPRI facilitate R&D business for entrepreneurship, establishing new industries for large scale utilization of agro wastes for manufacturing durable hybrid green composite particle / fibre boards.

Hybrid parali particle boards

For more details

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Day 4: Technology Presentation Title

Advance paver blocks from copper tailings

(Dr. Akram Khan, Sr. Principal Scientist, CSIR-AMPRI, Bhopal)

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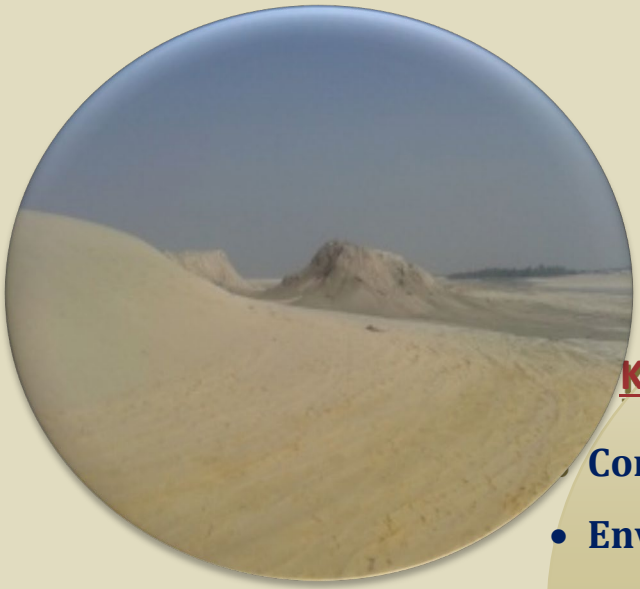
CSIR-AMPRI

ADVANCED PAVERS BLOCK FROM COPPER TAILINGS



KEY FEATURES

- Converting 'Waste to Wealth'.
- Environment friendly and economically viable new material.
- Opportunity to generate entrepreneurship and small scale business.
- Technology ready for commercialization.

INDUSTRIAL WASTE UTILIZATION, NANO & BIO MATERIALS DIVISION

CSIR- ADVANCED MATERIALS AND PROCESSES RESEARCH INSTITUTE (CSIR- AMPRI)
BHOPAL - 462026, (M.P.) INDIA

BACKGROUND

WHAT ARE COPPER TAILINGS?

Solid waste material left during the purification of the precious copper from the copper ores.

WHY COPPER TAILINGS?

- **More than 60 Million Tonnes of copper tailings stocked at Hindustan Copper Limited Malanjkhand, Dist. Balaghat (M.P.)**
- **Presently no application potential of copper ore tailings.**
- **Major problem of safe disposal, environmental hazard and utilization of copper tailings.**

WHY RIVER SAND REPLACEMENT?

- ✓ **Great demand for 'sand substitute' material.**
- ✓ **Prevention of 'Illegal Sand Mining' through novel approach.**

PROCESS FLOW CHART

SALIENT FEATURES

- ✓ Tailings contain around 85.0% Silica, 6.0% Alumina followed by Lime, Magnesia etc.
- ✓ Paver Blocks prepared according to M-25 Grade.
- ✓ Average Compressive Strength of Pavers Block made from copper tailings found to be 27.0 MPa as compared with conventional Pavers Block having Average Compressive Strength of 25.3 MPa.
- ✓ Developed process enables "in-situ" mineralization of toxic elements in advanced matrix ensuring safe utilization of copper tailings.

NOVELTY

- ✓ Replacement of river sand with copper tailings in the conventional concrete mechanism.
- ✓ Environment friendly and economically viable material.
- ✓ Addresses serious environmental concerns pertaining to illegal sand mining.

BENEFITS

- ✓ Product with remarkable benefits having total replacement (100%) of conventional river sand by use of copper tailings.
- ✓ Advanced copper tailings Pavers Block 10-15% economical than conventional Pavers Block.
- ✓ Product is easy to cast. Contains opportunities to generate small scale business.
- ✓ Being precast does not require additional efforts and complex engineering.
- ✓ 'Good Aesthetics and Value Added' product.
- ✓ Wider application spectrum for civil engineering and infrastructure application.

Technology Ready for Commercialization: TRL-6

TECHNOLOGY DEMOSTRATION

Around 5000 Pavers Block made from Copper Tailings made and demonstrated at Residential Premises of CSIR-AMPRI, Bhopal.

'Know-how' transferred on "Advanced Pavers Block from Copper Tailings" to M/s Hindustan Copper Limited, Malanjkhand, District Balaghat (M.P.)

Demonstration of CSIR-AMPRI'S 'Know-How' at Hindustan Copper Limited, Malanjkhand Site

पत्रिका PLUS

कॉपर माइनिंग वेस्ट से बनाया पेवर ब्लॉक

हिन्दुस्तान कॉपर लिमिटेड को एम्प्री ने हैंडओवर की टेक्नोलॉजी

माइनिंग में निकले वेस्ट में होते हैं हैवी मेटल्स

iam BHOPAL

एम्प्री ने सौंपी एडवांस पेवर्स ब्लाक बनाने की तकनीक

Dr. Avanish Kumar Srivastava

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	24 hrs	mould filled with materials

Day 4: Technology Presentation Title

Textile reinforced concrete prototyping technology

(Dr. Smitha Gopinath, Principal Scientist, CSIR-SERC, Chennai)

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CSIR-AMPRI

TEXTILE REINFORCED CONCRETE PROTOTYPING TECHNOLOGY

An all-in-one technology for production of various textile reinforced concrete products

Textile reinforced concrete (TRC) is an upcoming non-conventional construction material consisting of fine grained cementitious binder and non-metallic textile reinforcement. CSIR-Structural Engineering Research Centre (CSIR-SERC) has developed textile reinforced concrete prototyping technology (TRCPT), a precast technology to produce TRC components for which an Indian patent has been filed (Filing no.: 2751DEL2014). TRCPT can serve as an effective indigenous technological solution for pre-cast construction industry to achieve economical mass production of TRC products.

FEATURES / HIGHLIGHTS

- Completely avoids the conventional way of concrete construction, which makes use of moulds
- Various products for structural and non-structural applications can be produced from this single technology
- Less fabrication cost with increased production rate

TECHNICAL DETAILS

- Using this technology, prototyping is done by placing the TRC sheets over the shape to be constructed soon after the production, and it adapts to the specific configuration
- The mechanical properties of TRC products are controlled while producing the TRC sheet itself, and this convenience leads to less variability of its properties
- Scale up and scale down of this technology is possible for in-site applications
- TRCPT technology also helps to increase the speed of manufacture of TRC products

Production of TRC roofing sheet using TRCPT

Lining of a damaged canal using TRC produced from TRCPT

Demonstration of strengthening of RC beam using TRC produced from TRCPT

TRC products produced using TRCPT

APPLICATIONS

- Production of standalone components such as sandwich panels, facade elements, industrial flooring tiles, street furnitures, canopy structure partition walls, noise barriers, roofing elements, manhole covers
- Production of nonstructural components such as flower pots, wash basins, door and window frames, door panels, etc.

TECHNOLOGY TRANSFER

- Technology is available for transfer to interested players in the industry.

ALLIED TECHNOLOGIES AT CSIR-SERC

- Light-weight TRC tiles for wall/flooring applications
- Mobile construction unit for producing TRC products
- TRC non-load bearing panels
- TRC load bearing wall panel system

CSIR–SERC
ENGINEERING SUSTAINABLE STRUCTURES

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Day 4: Technology Presentation Title

Enhanced utilization of blast furnace slag (granulated) and fly ash in blended cement

(Ms. Rashmi Singla, Principal Scientist, CSIR-NML, Jamshedpur)

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CSIR-AMPRI

Enhanced utilization of blast furnace slag (granulated) and fly ash in blended cement

Significance of fly ash in PPC and GBFS in PSC

- Today, out of total cement produced, ~50% is PPC and ~25% is PSC
- Addition of FA and GBFS reduces the heat of hydration in cement and improves the durability of resulting concrete

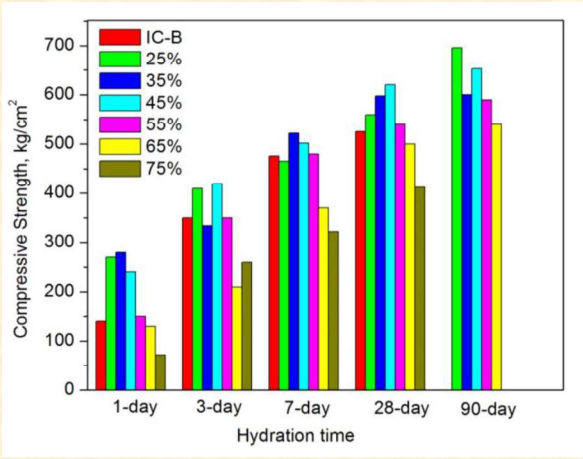
Inspite of all above, majority of cement plants are not able to use more than 25% fly ash (BIS allows up to 35% usage)
And not more than 65% GBFS in composition (BIS allows up to 70 % usage)

Challenges

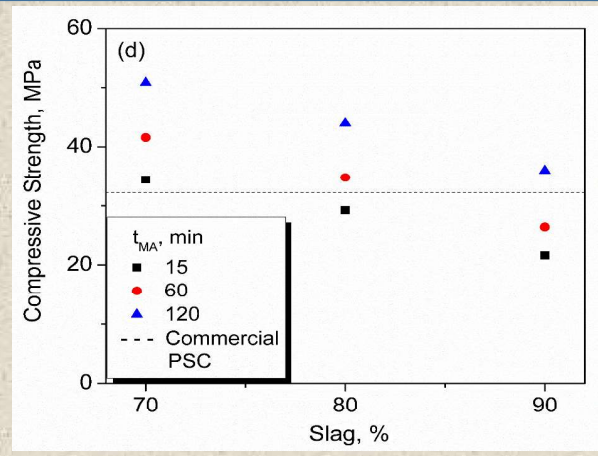
1. Can we use FA beyond 35% in PPC ?
2. Can we use GBFS beyond 70% in PSC ?

STRATEGY → **Mechanical Activation** →

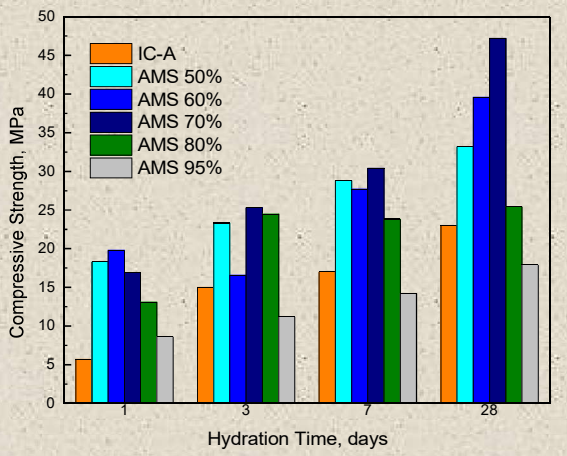
- Attrition mill (wet)
- Vibratory mill (dry)



With mechanical activation of fly ash, incorporation of fly ash up to 65% is possible



Vibratory milled slag for 15, 60 and 120 min mixed in various proportions with clinker



Attrition milled slag for 10 min mixed in various proportions with clinker

For more details >>

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Day 4: Technology Presentation Title

Manufacture of cold setting fly ash building brick

(Dr. S. M. Mustakim, Sr. Tech Officer, CSIR-IMMT, Bhubaneswar)

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CSIR-AMPRI

Cold Setting Fly Ash Brick Technology developed by CSIR-IMMT

CSIR-Institute of Minerals and Materials Technology, Bhubaneswar-751013

CSIR-Institute of Minerals and Materials Technology, Bhubaneswar is actively engaged in development of innovative, energy efficient green processes for utilization of various industrial and mining solid wastes in manufacture of building materials such as brick, block, concrete and aggregate etc. A considerable research work on fly ash has been done to develop processes for manufacture of cold setting building brick and block by mineral cementation method. The mineral polymerization reaction develops cementation property which is very effective to develop the binding strength in the product.

Under this R&D activity, CSIR-IMMT has also created pilot plant facility for brick and block manufacturing to demonstrate the process for development of commercial technology. This facility has been used for demonstration and training to the licensees during technology transfer for manufacturing of cold setting building brick and block. This process has been adopted commercially in MSME sector (17Nos.) and major industries (4Nos.) for manufacture of cold setting building brick containing up to 70 % fly ash. This is a new development for use of pozzolonic materials in manufacture of building bricks.

Mineral Cementation Process

Non-fired cost effective process, where oxides and hydroxides of SiO2, Al2O3, Fe2O3, CaO, MgO, alkali and sulphate bearing minerals react in presence of a novel chemical activator at atmospheric temperature and form hydrated chain silicate binding matrix which develops strength in the product like Portland cement.

Presently, this process has been transferred to 21 entrepreneurs in the country **on non-exclusive basis** for manufacture of bricks ranging from 10,000 to 1, 00,000 bricks/day.

We provide the composition of chemical bond material which will be used for brick making. The chemical for bond material is readily available in the market.

The details of the Mineral Cementation process are as follows:

a) The fly ash brick confirms to the BIS specification IS 12894:2002.
b) Bond material developed by CSIR-IMMT is used 12%-16% by weight of the fly ash mix for manufacturing of brick.
c) The process is flexible to use any types of fly ash (40-70%) along with bond and locally available waste materials including sand, stone dust, polish stone dust etc.
d) The brick requires only 2 to 3 times of water curing in 3 days of interval from date of manufacturing. The brick is ready for sale within 7-10days depending upon the fly ash quality and weather conditions.
e) It is possible to adopt hydraulic, vibration cum hydraulic, vibration cum hand mould press for manufacture of brick.
f) The cost of bond material for a brick of 230x110x75 mm size may range Rs2.20 to Rs2.40 depending on the quality of fly ash and other additives materials.
g) The bricks are lighter and strong having 75 to 120 kg/cm2 of wet crushing strength and 8 to 12% of water absorption.

Terms and conditions for transfer of fly ash brick manufacturing process

For Major Industries:

The technology cost for major Industries is Rs 5,00,000/- + GST @18% & Training and demo fee is Rs. 10,000 /- + GST @18%

The above charges are for process demonstration and training at IMMT Bhubaneswar.

Requirement of following original documents for signing of confidential agreement and technology transfer:

a) Deposit of Demand Draft of Rs. 6,01,800/- in favour of Director, CSIR-Institute of Minerals and Materials Technology, Bhubaneswar.
b) Copy of District Industries Centre (DIC)/MSME registration & ID proof of unit.
c) Rs.100/- Non-Judicial stamp paper (2nos) for signing of confidential agreement.
d) Letter Head/Pad and stamp of the unit.

For MSMEs:

The technology cost for Micro, Small and Medium Enterprise (MSME) Sector is Rs 50,000/- + GST @18% & Training and demo fee is Rs. 10,000 /- + GST @18%

The above charges are for process demonstration and training at IMMT Bhubaneswar.

This is a special consideration only for MSME units.
Requirement of following original documents for signing of confidential agreement and technology transfer (MSME units):

a) Deposit of Demand Draft of Rs. 70,800/- in favour of Director, CSIR-Institute of Minerals and Materials Technology, Bhubaneswar.
b) Copy of District Industries Centre (DIC)/MSME registration/UAN & ID proof of unit.
c) Rs.100/- Non-Judicial stamp paper (2nos) for signing of confidential agreement.
d) Letter Head/Pad and stamp of the unit

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M/s Bhatta Fly Ash Bricks
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M/s Ojas Blocks and Fly ash Bricks
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M/s D.N.Enterprises
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Haryana125110
Mob-9416489939

M/s NextGen Tech Impex Ltd.
Vill- Mahajpura, PO/PS- Bikram
Dist-Bikram, Dist-Patna
Bihar

If the party is interested for process demonstration of their own sample, then the party has to supply their sample, otherwise, we can show the demonstration on the raw materials (fly ash from NTPC, Kaniha, Odisha) available with us.

Depending upon the production capacity, the brick plants available in the market can be selected by the entrepreneur as per his own convenience.

Hope your organization can avail this opportunity by adopting this green and cost effective process for utilization of fly ash in manufacture of cold setting building brick as per BIS requirement.

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Ministry of Science & Technology,
Ministry of Earth Sciences,
Govt. of India
सत्यमेव जयते

Azadi Ka Amrit Mahotsav