INDUSTRIAL HOUSING IN INDIA

THE WALL AS AN INDUSTRIAL CRAFT

FLY-ASH ‘STACK-CRETE ‘

BUILDING TECHNOLOGY GRADUATION WORK

FIRST MENTOR: IR. ARIE BERGMSA
SECOND MENTOR: DR. IR. ARJAN VAN TIMMEREN
THIRD MENTOR: IR. H.R. SCHIPPER

PRASHANTH RAGHUNATH
1. Housing shortage - urban population
The Problem

- Slow
- Lack of quality
- Unhygienic site environments
- Dearth of skilled labour

Existing Housing supply system - RCC Frame + CMU infill
### 2. The Problem of Flyash
The Problem of Flyash

- More than 170 million MT of ash generated every year
- Presently 65,000 acres of land occupied by ash ponds
THE PROBLEM STATEMENT(S)

“...A pre-fabricated method of assembling a load bearing wall with prefinished exterior surface for housing is lacking in India, to facilitate quicker supply of low rise housing for middle class and upper middle class in Urban and semi-urban India”

“The potential of Fly-ash, an industrial waste, is heavily under-utilized at present in building industry”

THE GOAL

“To develop a prefinished load bearing facade element, maximising the use of flyash, which could be assembled on site for faster supply of housing in urban and semi-urban India”
DANISH PRECAST HOUSING SYSTEM
Preface Sandwich wall panels
Insulated Concrete Forms
Calcium Silicate Blocks
Load bearing prefabricated façade element

Pre-finished exterior surface

Quick assembly

Bulk utilization of flyash
Basic Wall Structure

Design Requirement
**Introduction**

**Stack Crete**

**Manifestations**

**Conclusions**

**References**

**Concept**

<table>
<thead>
<tr>
<th>Dimensional Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
</tr>
<tr>
<td>200</td>
</tr>
<tr>
<td>300</td>
</tr>
<tr>
<td>400</td>
</tr>
<tr>
<td>500</td>
</tr>
<tr>
<td>600</td>
</tr>
<tr>
<td>700</td>
</tr>
<tr>
<td>800</td>
</tr>
<tr>
<td>900</td>
</tr>
<tr>
<td>1000</td>
</tr>
</tbody>
</table>

**Concept**

- Minimum Joints
- Standardisation
- Ergonomics of Product Handling
- Transportability

**Structure**

**Materials**

**Details**

**Production**

**Assembly**
**DIMENSIONAL STUDY**
Introduction

Stack Crete

Manifestations

Conclusions

References

Concept

Structure

Materials

Details

Production

Assembly

Basic module

Component size

Dimensional study
STACK CRETE

Structure

Introguction

References

Concept

Materials

Details

Production

Assembly

Conclusions

Wall = 2850

b_{eff} = t - \frac{x_2}{2} - \frac{x_1}{2} = t - x
MAX. LIMIT OF SLENDERNESS RATIO = 27

FOR OVERALL WALL THICKNESS 150 mm
THE PANEL
CS + H = CSH + CH

Cement Concrete

Cement Concrete + Flyash (S)

CSH + CSH

CS + H = CSH + CH

Cement Concrete

Cement Concrete + Flyash (S)

CSH + CSH

references
<table>
<thead>
<tr>
<th>S. No</th>
<th>Properties</th>
<th>CCA</th>
<th>FACA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shape</td>
<td>Angular</td>
<td>Spherical</td>
</tr>
<tr>
<td>2</td>
<td>Specific gravity</td>
<td>2.75</td>
<td>1.3</td>
</tr>
<tr>
<td>3</td>
<td>Bulk density (Kg/ m³)</td>
<td>1685</td>
<td>913</td>
</tr>
<tr>
<td>4</td>
<td>Size (mm)</td>
<td>4.75mm to 20mm</td>
<td>4.75mm to 20mm</td>
</tr>
<tr>
<td>5</td>
<td>Crushing value (%)</td>
<td>24.94</td>
<td>25.6</td>
</tr>
<tr>
<td>6</td>
<td>Impact Value (%)</td>
<td>23.86</td>
<td>21.6</td>
</tr>
</tbody>
</table>
REPLACEMENT OF SAND WITH FLY ASH
**Thermal Performance**

\[ U \text{ Value} = 1.03 \text{ W/m}^2\text{-K} \]
Protection from Outside and from Cavity → Tongue and Groove Joint

Final design - Two stage protection system
Façade Fragment
Plan @ Level 2.4m from floor level

Plan @ @level 1.0m from floor level

Façade Fragment plans
THE DIFFERENT PANELS

- Corner Panel
- Standard Panel
- Top Panel
- Left Jamb Block
- Right Jamb Block
1. MODULAR SIZE

2. MINIMUM GAPS

3. POSITION TOLERANCE

4. MINIMUM DEDUCTION

5. MAXIMUM SIZE

6. MANUFACTURING TOLERANCE

7. MINIMUM SIZE

8. MAXIMUM DEDUCTION

TOLERANCES

750 MM

746 MM

744 MM
Modular divisions

Dilatation joint
FLOOR FINISH TO ARCH. SPECS

PRECAST CONCRETE RIB IN ELEVATION

FLYASH CONCRETE FILLING

PRECAST FLOOR PANELS

STACK CRETE STANDARD PANEL

TURN BUCKLE TO ADJUST FOR LEVELS

FLYASH CONCRETE INFILL (could be reinforced if necessary)

STACK CRETE TOP PANEL
DETAIL - JAMB

- FLYASH CONCRETE INFILL
- GASKET/CAULKING
- STACK CRETE LEFT JAMB BLOCK
- ALUMINIUM FRAME
- ALUMINIUM
PROCESS
Stack Crete

References
Concept
Structure
Materials
Details
Production
Assembly

Introduction
Manifestations
Conclusions
Method 1

Stack Crete

References | Concept | Structure | Materials | Details | Production | Assembly
Stack Crete
Method 2 - Pretension
1. Timber Form Finish

2. Coloured Concrete Panels
3.4. Brick/Stone Embedded Panels
5. Sand blasted finish

6. Timber finish panels
7,8. TILED FINISH
INTRODUCTION

STACK CRETÉ

MANIFESTATIONS

CONCLUSIONS

HOUSING

RELIEFS AND TEXTURES

FAÇADE COMPOSITIONS
Eliminates need for scaffolding work from outside

High strength to weight ratio
Self weight and rebate sufficient to keep the wall stable immediately after dry stacking

Dimensional and compositional standardisation

Low embodied energy

The target group can be extended to non-urban and non-residential projects also
Eliminates need for scaffolding work from outside

High strength to weight ratio
Self weight and rebate sufficient to keep the wall stable immediately after dry stacking

Dimensional and compositional standardisation

Low embodied energy

The target group can be extended to non-urban and non-residential projects also
Eliminates need for scaffolding work from outside

High strength to weight ratio
Self weight and rebate sufficient to keep the wall stable immediately after dry stacking

Dimensional and compositional standardisation

Low embodied energy

The target group can be extended to non-urban and non-residential projects also
Introduction

Stack Crete

Manifestations

Conclusions

Eliminates need for scaffolding work from outside

High strength to weight ratio
Self weight and rebate sufficient to keep the wall stable immediately after dry stacking

Dimensional and compositional standardisation

Low embodied energy

The target group can be extended to non-urban and non-residential projects also
Eliminates need for scaffolding work from outside

High strength to weight ratio
Self weight and rebate sufficient to keep the wall stable immediately after dry stacking

Dimensional and compositional standardisation

Low embodied energy

The target group can be extended to non-urban and non-residential projects also
INTRODUCTION | STACK CRETE | MANIFESTATIONS | CONCLUSIONS

- **ARCHITECT** → **DESIGN** → **PRODUCT / MATERIAL SPECIFICATION** → **CONTRACTOR** → **EXECUTION**
- **PRODUCT** → **MARKETING** → **ARCHITECT** → **PRODUCTION** → **EXECUTION**

**PROTOCOL**
Thank you