Potential of Masonry for Housing Projects

S Raghunath
Professor, Department of Civil Engineering,
(NBA Accredited for 6 years : 2014-2020)
BMS College of Engineering, Bangalore 560019
www.bmsce.ac.in
raghunath.smrc@gmail.com
raghu.civ@bmsce.ac.in

NIVASA – an Architectural NGO
www.nivasa-ngo.org

Courtesy: M/s AXON Concrete Products

Engineered Hollow Concrete Block Masonry: Light weight, thin mortar joints, no plastering…

Reduction in materials requirement

BMS-SMRC

No form work needed till roof level, minimal wet work

BMS-SMRC

Masonry products and techniques developed at BMS-SMRC

BMS-SMRC

BMS-SMRC

Platinum rated villa

Project: ZED Earth, BCIL

BMS-SMRC

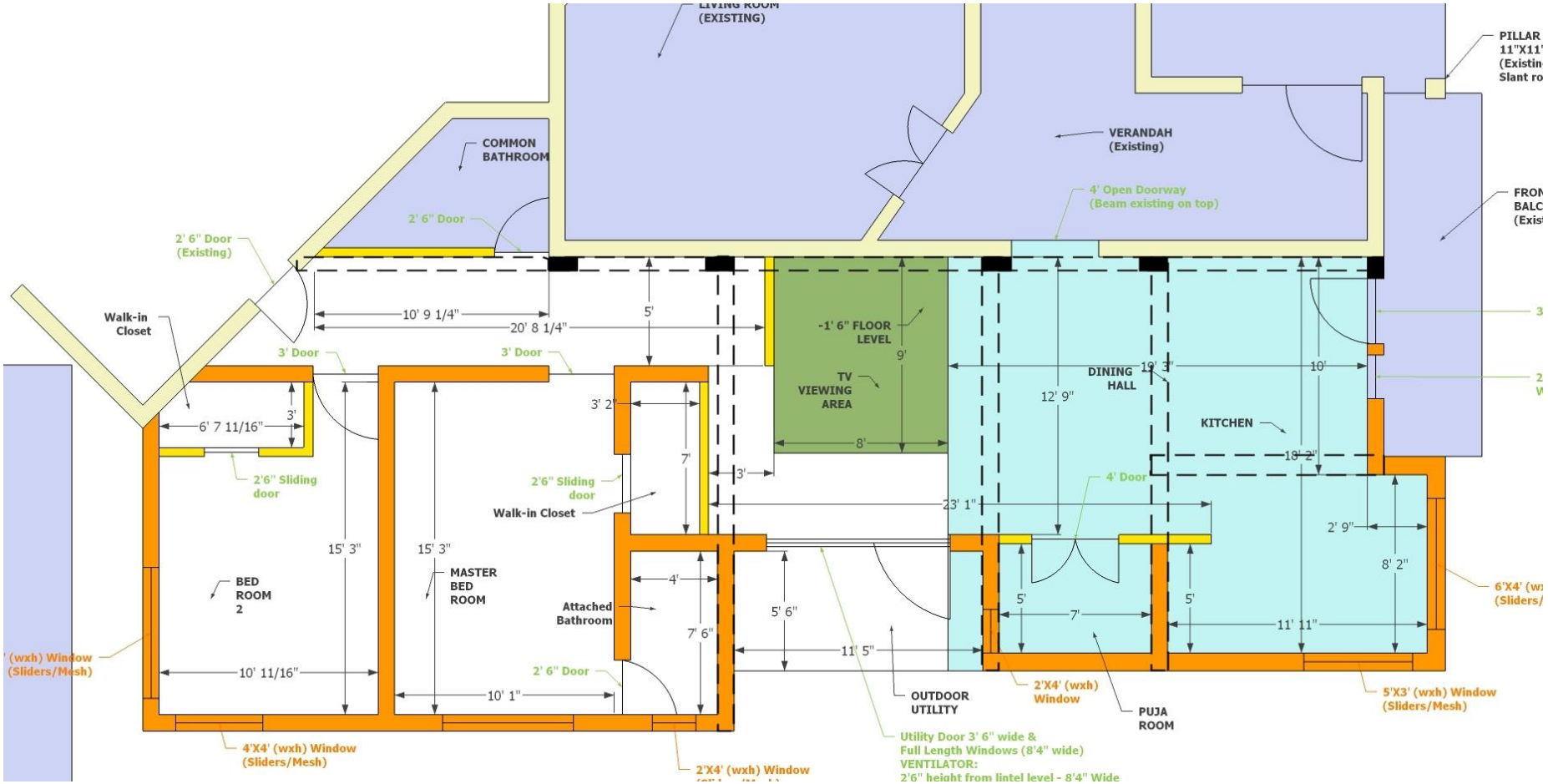
SVYM, Mysore

Sadhana @ Vivekananda Institute of Leadership Development, Mysore

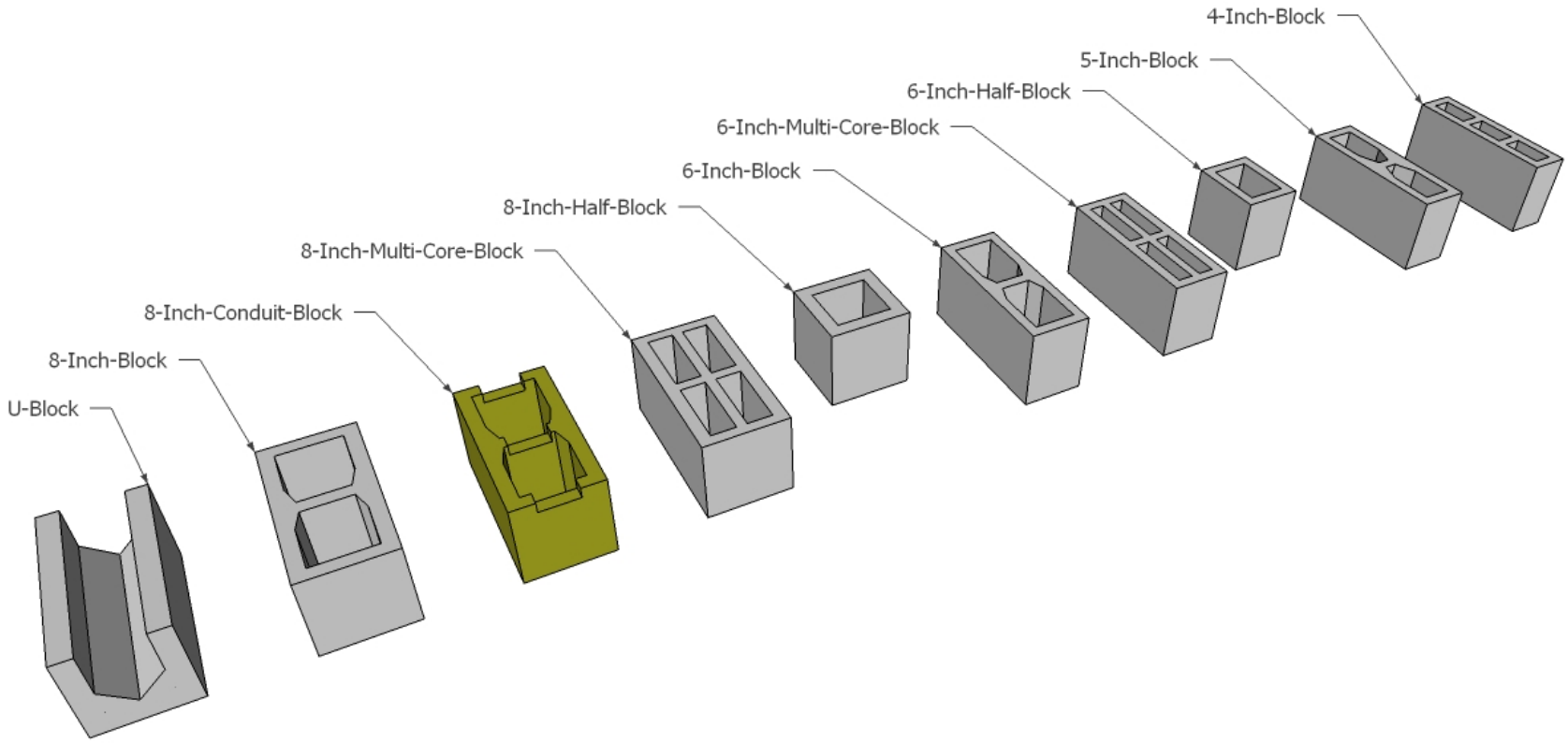
BMS-SMRC

BMS-SMRC

Exposed EHCB masonry, partly reinforced; EE: ~ 2.4 GJ/sq.m

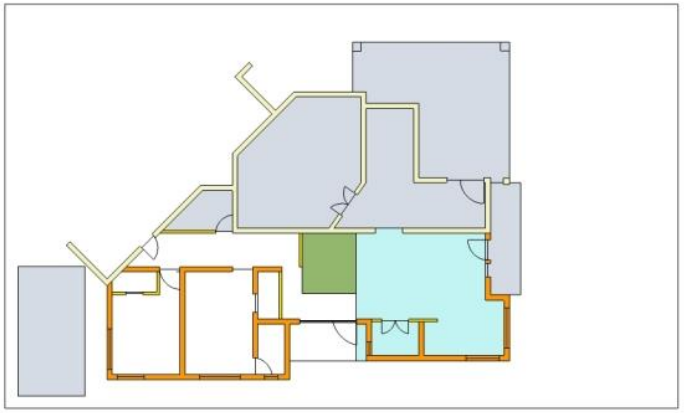

LIVING ROOM
(EXISTING)
PILLAR
11"X11'
(Existin
Slant ro
COMMON
BATHROOM
VERANDAH
(Existing)
FRON
BALC
(Exis
2' 6" Door
(Existing)
2' 6" Door
4' Open Doorway
(Beam existing on top)
Walk-in
Closet
10' 9 1/4"
20' 8 1/4"
5'
-1' 6" FLOOR
LEVEL
9'
3' Door
3' Door
TV
VIEWING
AREA
DINING
HALL
19' 3"
10'
12' 9"
KITCHEN
3'
3' 2"
6' 7 11/16"
8'
18' 2"
2'6" Sliding
door
7'
2'6" Sliding
door
3'
4' Door
Walk-in Closet
23' 1"
2' 9"
15' 3"
15' 3"
8' 2"
BED
ROOM
2
MASTER
BED
ROOM
4'
Attached
Bathroom
5' 6"
5'
7'
5'
11' 11"
7' 6"
11' 5"
10' 11/16"
10' 1"
2' 6" Door
OUTDOOR
UTILITY
2'X4' (wxh)
Window
PUJA
ROOM
5'X3' (wxh) Window
(Sliders/Mesh)
4'X4' (wxh) Window
(Sliders/Mesh)
Utility Door 3' 6" wide &
Full Length Windows (8'4" wide)
VENTILATOR:
2'6" height from lintel level - 8'4" Wide

Types of blocks:
Engineered Hollow Block Masonry

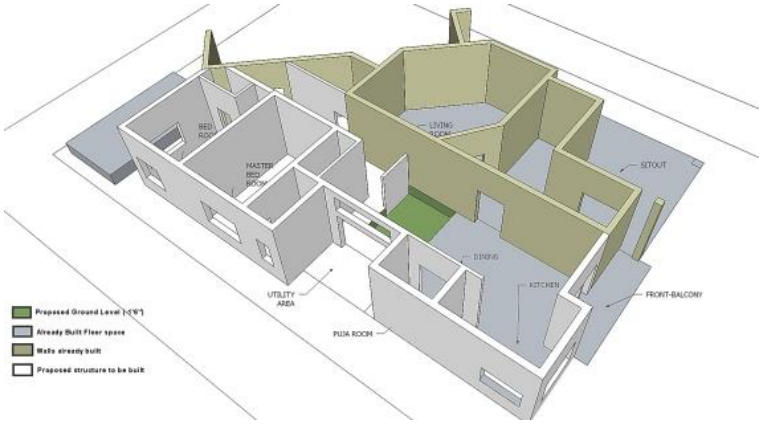


ZERO WASTE

Planning – Design to Site Concept: Residence of Sri. Nagendra, Mysore



Conventional Plan of house

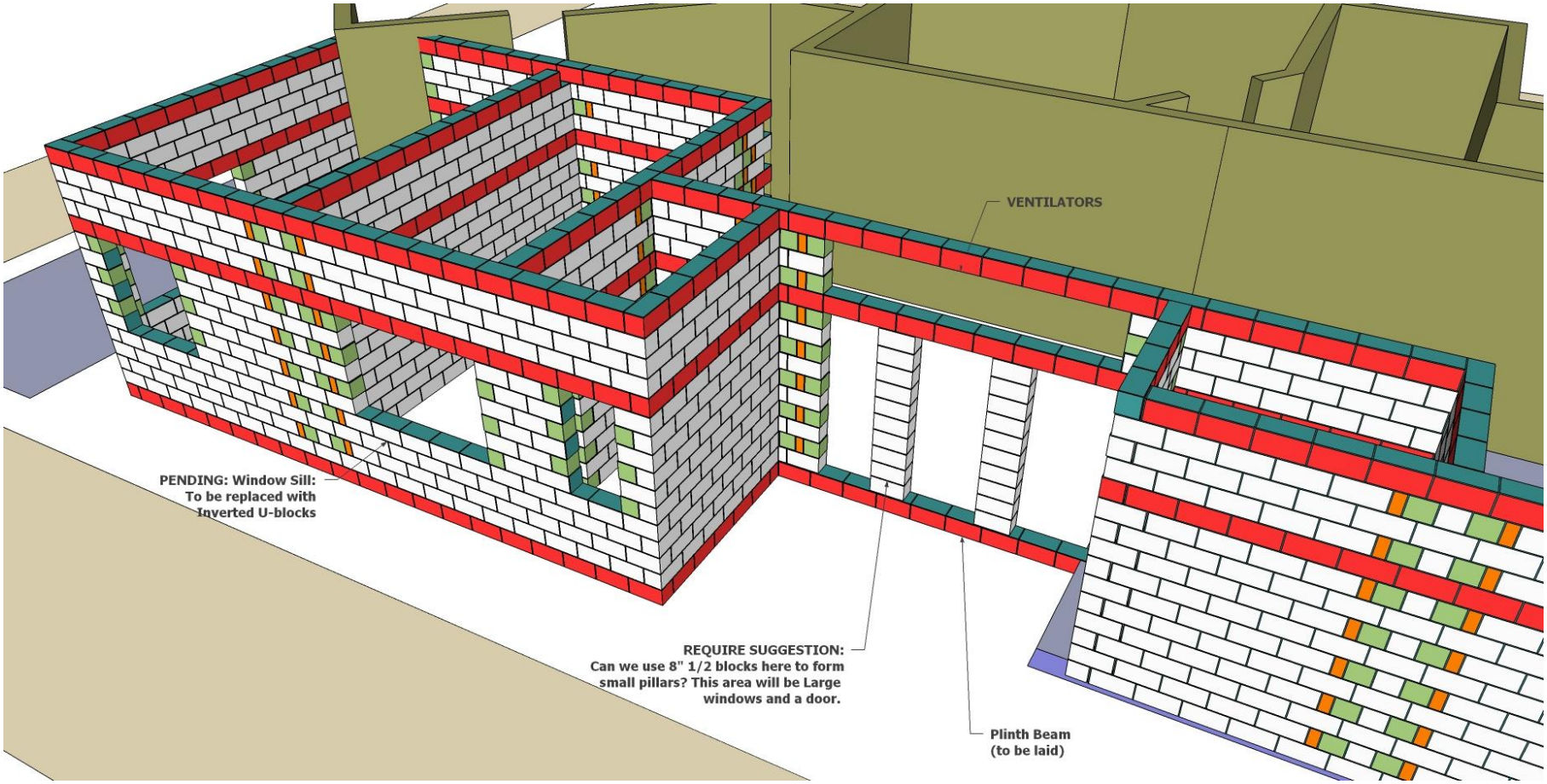


3D modeled Plan of the same house

Sl	Block Type	Picture	Required Quantity for Gnd Floor	ORDER QUANTITY
1	8" Standard Block		1418 Nos.	1800 Nos.
2	8" U-Block		421 Nos.	600 Nos.
3	8" Conduit Block		-	100 Nos.
4	8" Half-Block		228 Nos.	400 Nos.

1418

Bill of Material generated from Software!


VENTILATORS
PENDING: Window Sill:
To be replaced with
Inverted U-blocks
REQUIRE SUGGESTION:
Can we use 8" 1/2 blocks here to form
small pillars? This area will be Large
windows and a door.
Plinth Beam
(to be laid)

Plinth Beam Laying

U-Blocks used for Plinth (and Lintel and Tie beams)

U-blocks laid to form beam structure

← Metal rods for Plinth Beam inserted into U-block

Pillar rods (if required) tied to the Plinth beam rods before casting plinth →

Wall Construction

Wall construction on top of Plinth beam starts

Lighter blocks help speed up construction!

Retaining old Parapet wall and continuing construction with new technology.

A Day's worth construction with 3 masons and 5 helpers!

Tools for applying mortar!

Mortar applied with a special tool! Reduces wastage due to dropping inside hollow blocks, Better Packing of mortar, and uniform 10mm thick layer!

Reduces effort on the Mason and speeds up a mason's work!

Uniformly laid 10mm thick mortar, packs mortar better between 2 courses and avoids wastage to a significant extent!

Reinforced Masonry Columns

← Pillar rods fastened to Plinth beam rods

← Pillar made out of blocks too! No need for box, casting, curing!

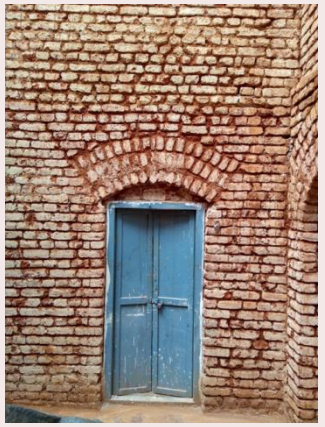
← Rings at each course of blocks for pillars.

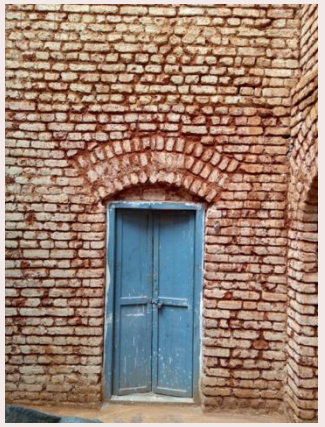
Pillar gets erected along with your walls! Daily by 4-5 course heights! No need for separation of wall and pillar construction!

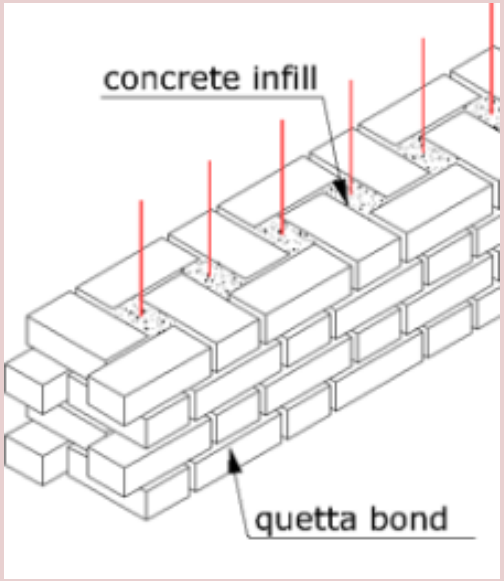
Pillar height achieved in 2 days! →

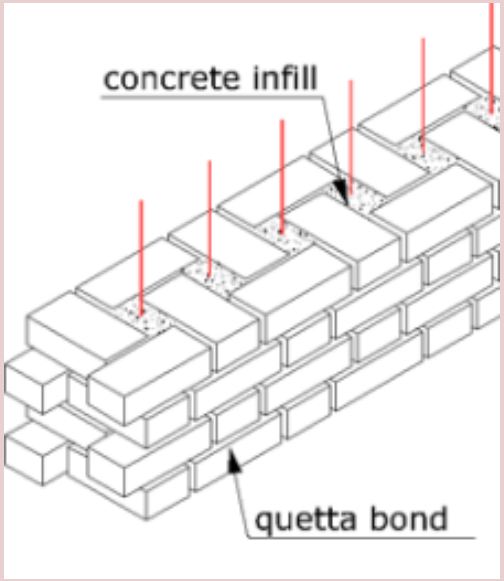
Nearly Finished!

	Concrete	Masonry
Composition	Fine aggregate, coarse aggregate and binding material	Masonry units and mortar (fine aggregate and binding material)
Distribution of constituents		
Behaviour		

	Concrete	Masonry
Composition	Fine aggregate, coarse aggregate and binding material	Masonry units and mortar (fine aggregate and binding material)
Distribution of constituents		
Behaviour		

	Concrete	Masonry
Composition	Fine aggregate, coarse aggregate and binding material	Masonry units and mortar (fine aggregate and binding material)
Distribution of constituents		
Behaviour	Good in compression, weak in tension, Brittle, Crack pattern is irregular Can be considered isotropic	Good in compression, weak in tension, Brittle, Cracks occur generally at unit-mortar interface, Orthotropic

	Concrete	Masonry
Reinforcement		
For a civil engineer		

	Concrete	Masonry
Reinforcement		
For a civil engineer		

Advantages of Masonry

- No formwork
- Plays a dual role – functional and structural
- Economy
- Durable
- Aesthetic
- Can be made ductile
- Can be made light-weight

Disadvantages of Masonry

- Structurally very complex
- Too many variables!

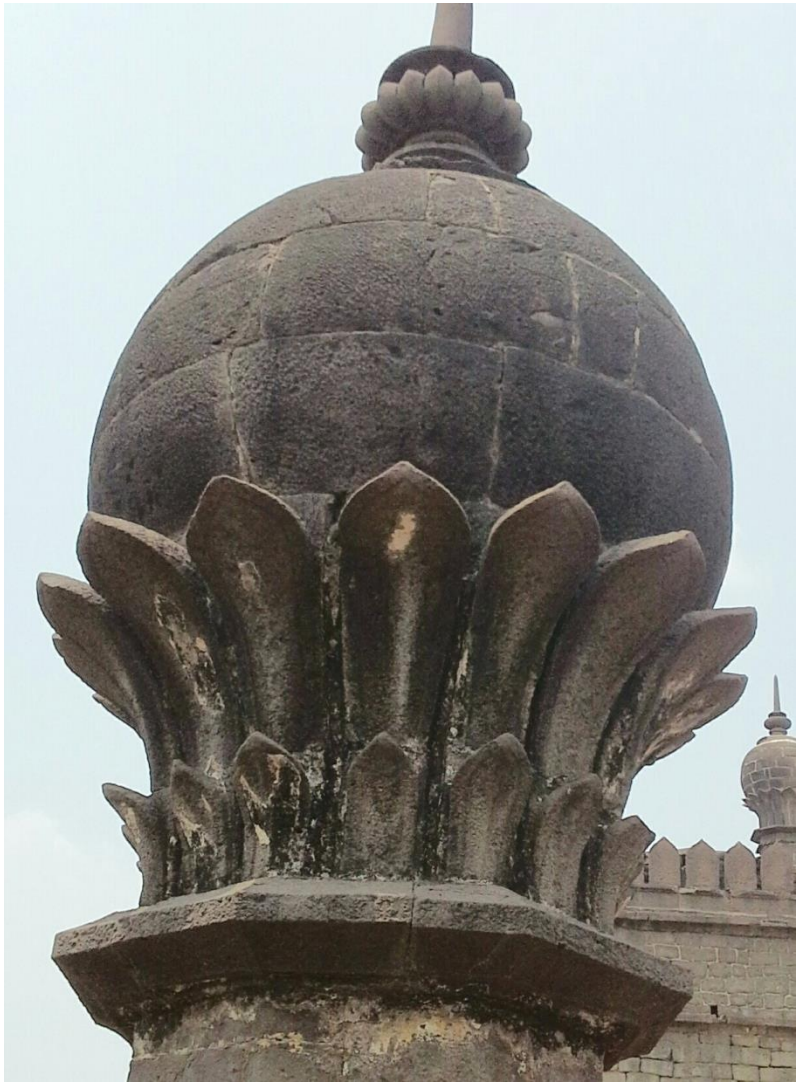
Structural Walls have 3 functions:

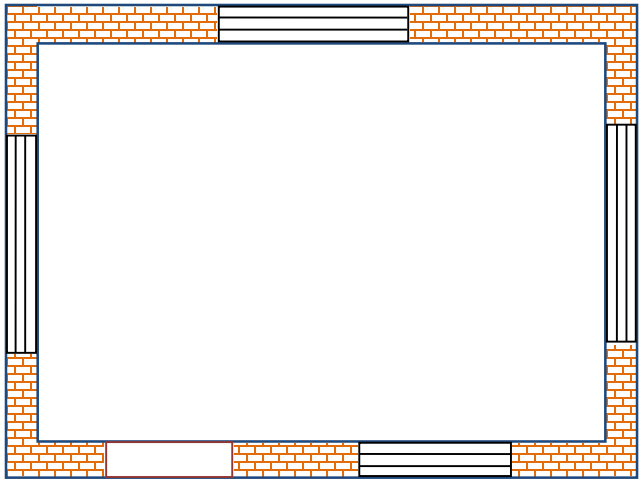
1. Resist vertical compression

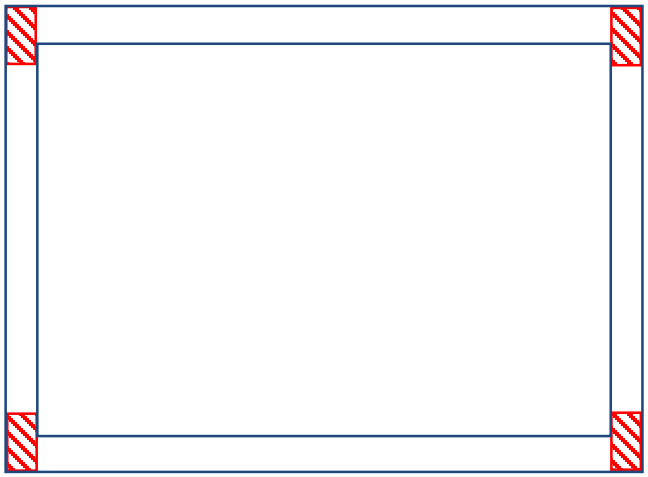
2. Resist out-of-plane bending from eccentric vertical loads (gravity loads), and/or transverse loads such as wind loads and earthquake loads

3. Resist in-plane forces (in-plane shear and in-plane bending) attracted by the masonry building as a whole

Multi-storeyed Un-reinforced masonry tower, Tanjavur, India







Case studies

Rural context

Affordable Housing..

…the basic aim of any affordable housing scheme is to provide stimulus to economic activities, with an immediate objective of employment generation to the urban poor, especially construction workers, where adverse impact of current economic down turn is being experienced.

The schemes shall strive to ensure equitable supply of land, shelter and services at affordable prices to all sections of society and thereby prevent the growth of slums in urban areas…

In India the various/varying types of homelessness can be classified as;

- Landless homelessness
- ✓ Homelessness due to extreme poverty (rural)
- ✓ Homelessness due to natural disaster
- Homelessness due to refugee status - political migrants
- ✓ Street homelessness (urban)
- ✓ Homelessness of migrant workers - man-made disaster
- Homelessness due to change in land-use patterns
- Homelessness due to extended use of house (beyond its lifespan)

These can be further subdivided into primary, secondary and tertiary homelessness.

the two approaches…

- **Need based approach**

Generally adopted by government, large-scale construction of houses, focus is on achieving economy in large-scale

- **Asset based approach**

Considered more sustainable, small-scale interventions, adopted by NGOs, focus is on empowerment of communities

a house in Kottamedu village in Kanchipuram dist., TN

Stabilised Adobe Blocks

NIVASA
Redefining Rural and Urbanscapes

1

2

3

4

8

7

6

5

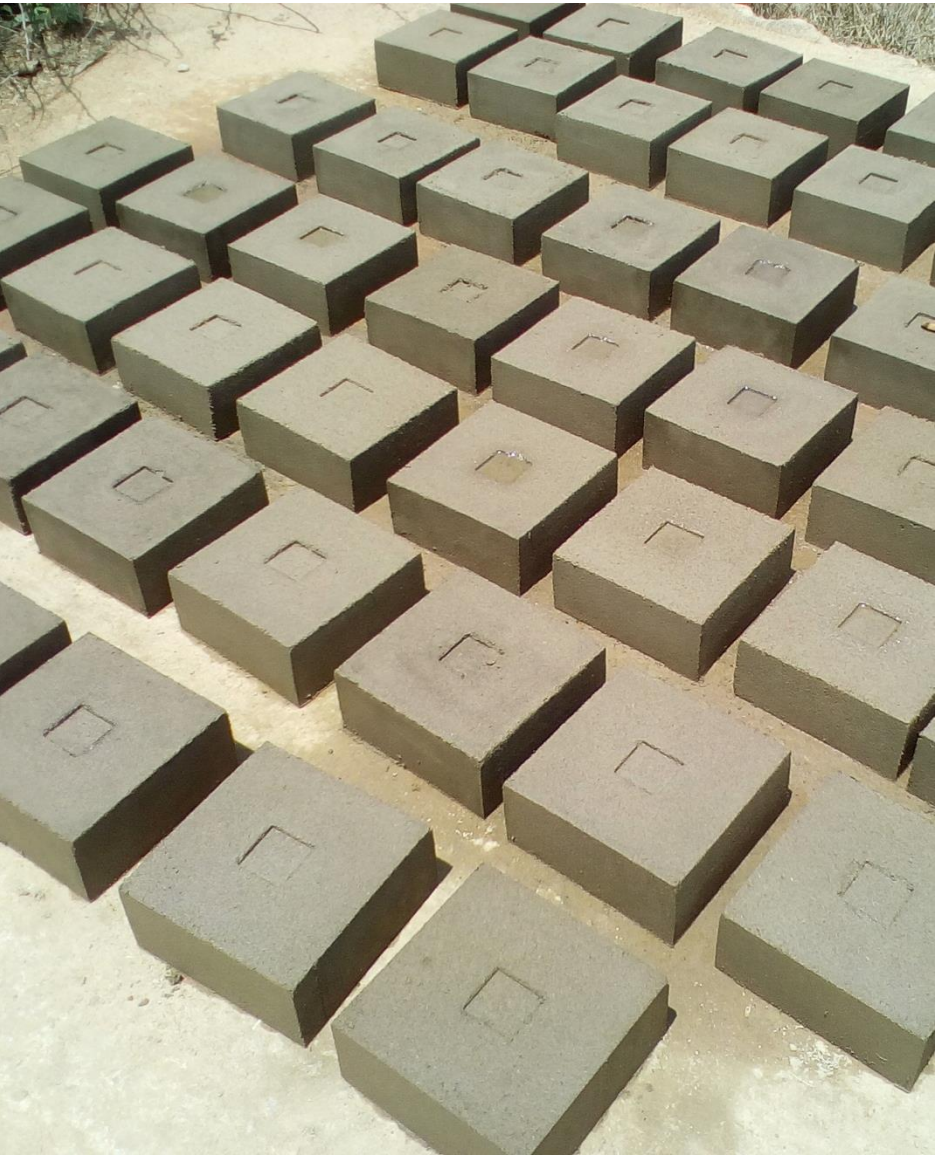
9

10

11

12

NIVASA
Redefining Rural and Urbanscapes



NIVASA
Redefining Rural and Urbanscapes

NIVASA
Redefining Rural and Urbanscapes

a typical house in Udagirinallappana Halli, Chikkaballapur district, Karnataka

NIVASA
Redefining Rural and Urbanscapes

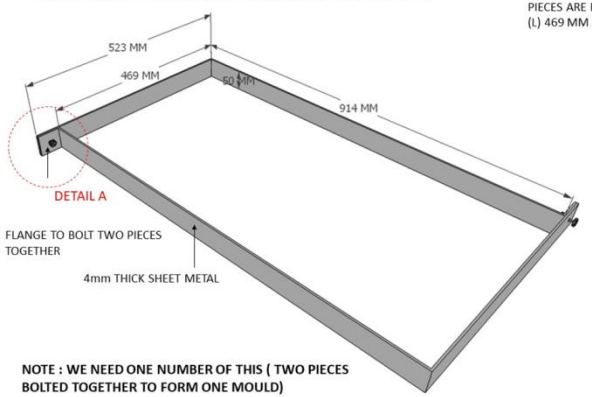
Steel beam and stone chappadi roof being used in and around Udagiri

NIVASA
Redefining Rural and Urbanscapes

Steel beam and stone chappadi roof being used in and around Udagiri

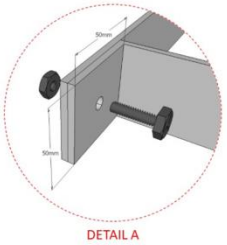
NIVASA
Redefining Rural and Urbanscapes

PANEL SIZE – 469 MMX 914 MM X 50MM CLEAR

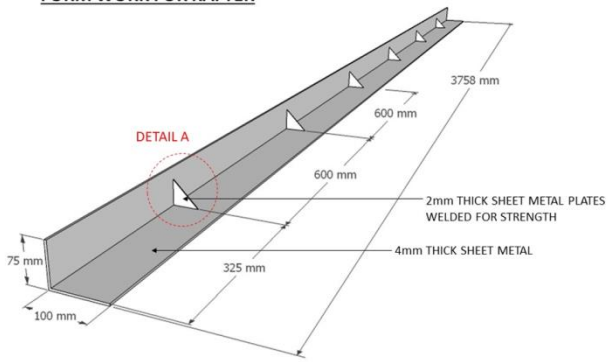


NOTE : WE NEED ONE NUMBER OF THIS (TWO PIECES BOLTED TOGETHER TO FORM ONE MOULD)

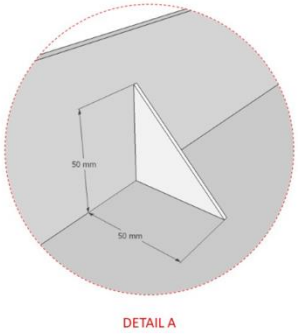
INNER CLEAR DIMENSION OF THE MOULD AFTER TWO PIECES ARE BOLTED TOGETHER SHOULD BE
(L) 469 MM X (B) 914 MM X (H) 50 MM



FORM WORK FOR RAFTER



NOTE : WE NEED TWO NUMBERS OF THIS



In-situ testing – **building confidence and competence** in stake-holders

Ease of assembling, acceptance of technology, upgradation of skills, employment generation, **100% REUSE….**

NIVASA
Redefining Rural and Urbanscapes

Δx approach…

Stabilized Adobe Blocks (Udagirinallappana Halli, Chikkaballapur dist.)

NIVASA
Redefining Rural and Urbanscapes

NIVASA
Redefining Rural and Urbanscapes

SAB technology at Thimmayannadoddi, Anekal taluk, Karnataka

Technical inputs: Dr. Yogananda MR

Interlocking blocks with thin-bed joint mortar, Cherkady, Udipi district

Laterite blocks, Udipi, Kundapura districts

Some case studies in semi-urban and urban segment

DRRT school, near Chickkaballapur

BMS-SMRC

BMS-SMRC

DRRT School,
Chikkaballapur district

DRRT School,
Chikkaballapur district

BMS-SMRC

BMS-SMRC

Platinum rated villa

Project: ZED Earth, BCIL

Sadhana @ Vivekananda Institute of Leadership Development, Mysore

BMS-SMRC

BMS-SMRC

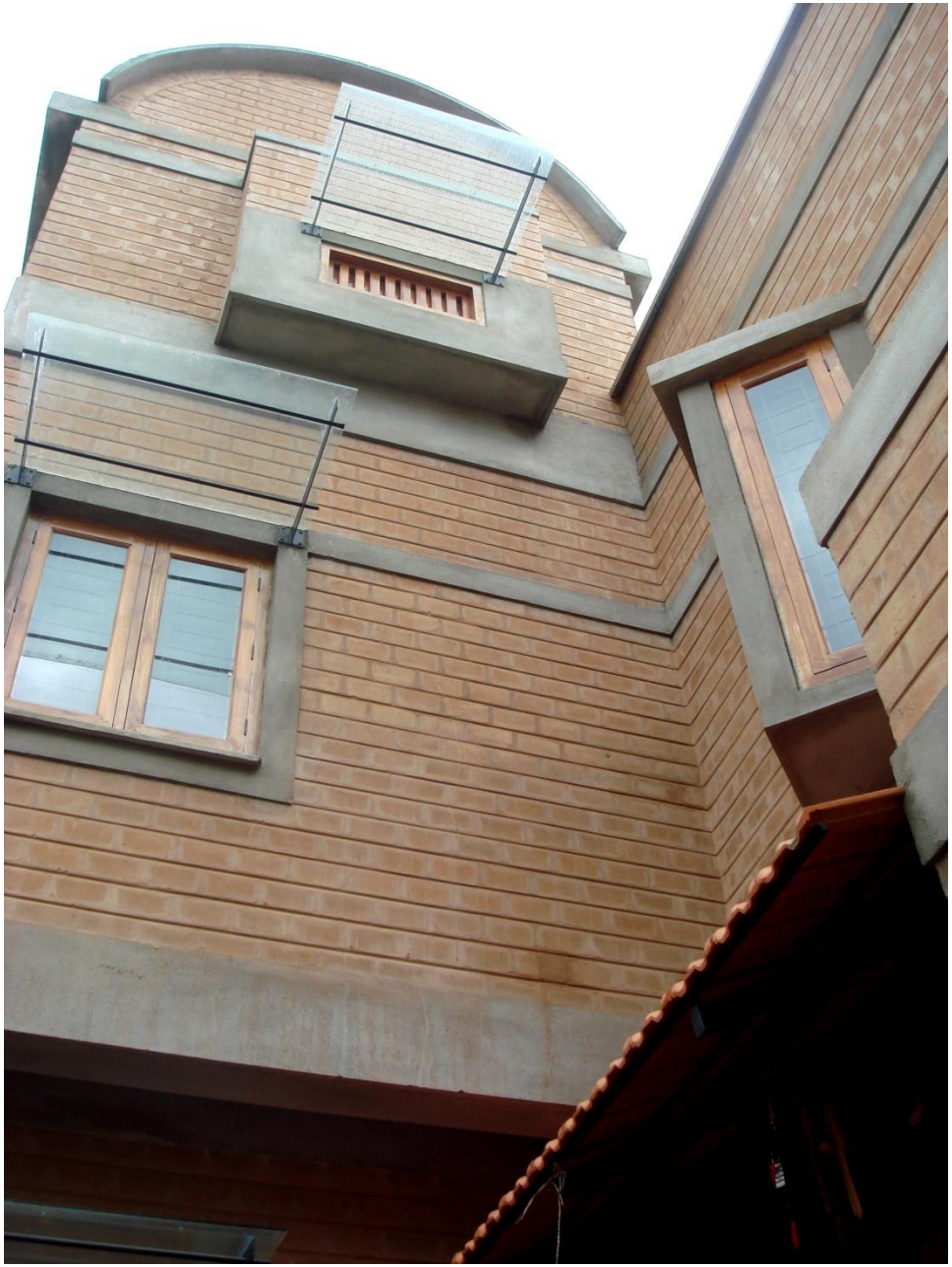
Exposed EHCB masonry, partly reinforced; EE: ~ 2.4 GJ/sq.m

Recent developments in mortar-less masonry – Dry stack, interlocking

Ar. Rajesh Jain, Mysore

BMS-SMRC

Engineered dry-interlocking blocks with provision for vertical reinforcement (photo courtesy: Sri. **NR Ashok**, Mysuru)



BMS-SMRC

Comply robust design

Satisfy anthropo-dynamic requirements

BMS-SMRC

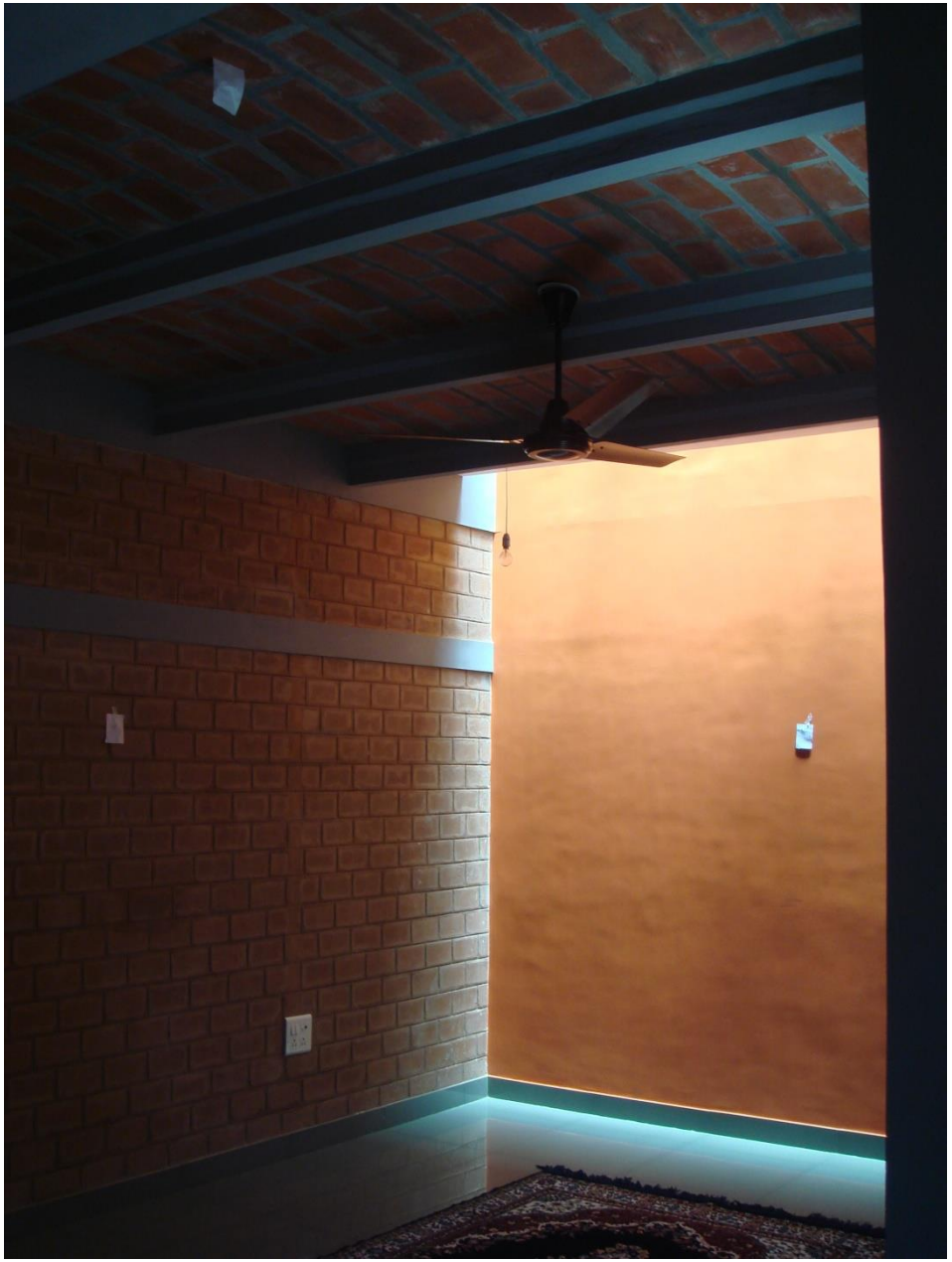
Flexibility in floor plans

BMS-SMRC

Photo courtesy: **Jagadish KS**

BMS-SMRC

SMB vaulted roof



BMS-SMRC

- Jack arch roofing and
- Opening on western wall
- Solar passive architecture

- ✓ Engineered masonry systems have been gaining acceptance, possibly for multiple benefits it offers – cost, aesthetics, variety, and structural benefits. Perhaps, low-embodied energy is a by-product of this choice.

Research work by Varsha BN

Concluding remarks

Some personal thoughts….

- Develop technologies that satisfy ‘Reduce – Re-use & Re-cycle….’ tenets
- Exploit local resources – local human resource (with skill-set), local material, local machinery etc.
- Avoid capital intensive technologies since they are very cost sensitive to time over runs – work out the overall economics

DISPROPORTIONAL technology!!

Unoccupied for > 3 years!!

Unacceptable!

Some personal thoughts….

- develop and promote technologies that
  - Generate employment
  - Sustain employment
  - Upgrade skills
  - Encourage participation from wide skill sets
  - Open up new skill-sets

Very low capital cost; Pic: Jagadish KS

Innovation within innovation!

Some personal thoughts….

- Avoid ‘thrusting’ of new technologies for masses – technology transfer should be top-down and not other way.

- Do not use ‘new technology’ projects for field trials in housing projects. Carry out field trials for individual houses.

- Do not use laboratory results alone to promote new technologies

Every technology has ‘temporal’ & ‘spatial’ acceptability

- Invariably, building technologies are not maintenance free, factor for maintenance cost and time
- Ensure that newer technologies gets acceptance through ‘codes of practice’
- Do not use natural disasters to ‘kill’ traditional technologies, instead, poor performance during disasters may be taken as an opportunity to improve them
- Never show case ‘green points’ of opulent buildings to promote technology – it is an insult to economically weaker sections

Some personal thoughts….

- Integrate building technologies with other services in a housing project

- Avoid '**cartel**' technologies and technologies which rely heavily on outside resources

Some personal thoughts….

- Do not ‘sell’ new technologies; educate stake holders about new technologies
- Do not compare technologies through laboratory results alone
- Educate stake holders through ‘recipe’ concept

Some personal thoughts….

- Do not give ‘as-built’ house; promote ‘build-as-you-like’ **but** sustainable house

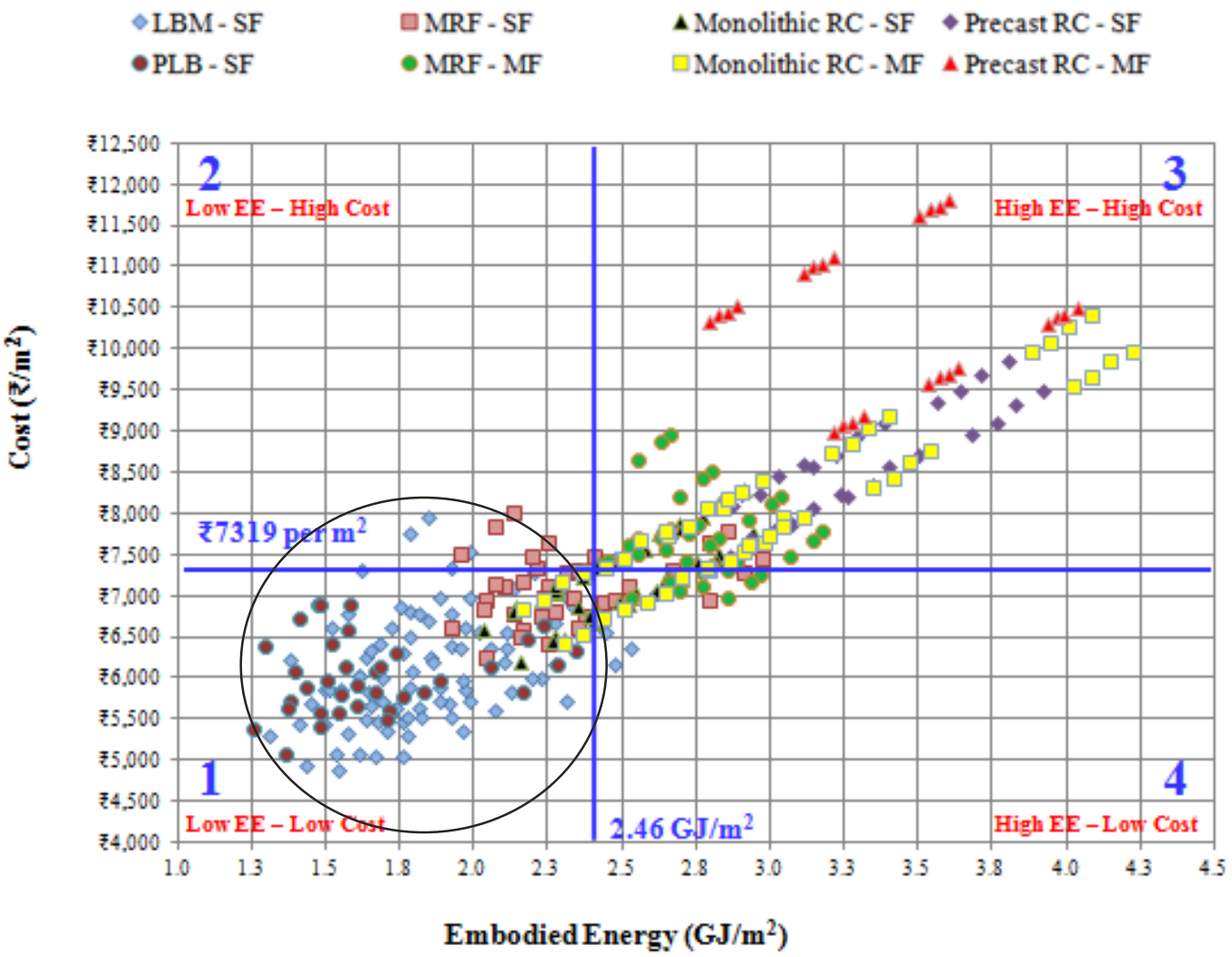
- Prepare ‘trouble shooting’ manuals for every technology
- Show case technologies through ‘tech parks’

- Do not give ‘as-built’ housing; promote ‘build-as-you-can’ housing projects. Encourage co-operative movement

- Do not attribute ‘non-acceptance’ of building technologies to ‘mind-set’ of beneficiaries, very often technologies are not accepted due to non-technical reasons

BMS-SMRC

Residence of Sri. Ramesh Kikkeri, Mysore; exposed EHCB masonry, EE: 1.05 GJ/sq.m



Research work by Dr. Varsha BN


R-SW
U-WW

Contact

S Raghunath

Professor, Department of Civil Engineering

BMS College of Engineering

Phone: +91 80 98457 94060

email: raghunath.smrc@gmail.com

raghu.civ@bmsce.ac.in

www.bmsce.ac.in

www.nivasa-ngo.org

NIVASA

Redefining Rural and Urbanscapes

Thank you!