IJETST- Vol.||02||Issue||06||Pages 2747-2752||June||ISSN 2348-9480 2015

Open access Journal International Journal of Emerging Trends in Science and Technology

Study on Performance of Infill Wall Masonry RCC Frame Using Alternative Types of Bricks

Authors

Dhaval H. Joravia[1], Dr. Kaushal B. Parikh[2]

[1]M.E.CASAD (Computer Aided Structure Analysis and Design) Student, Government Engineering Collage Dahod, Gujarat Technological University, Rajpipla-393145, Plot 11-12, Petco Compound. Gujarat India

Email: *Dhavaljoravia@hotmail.com*

[2]Head of Department, Applied Mechanics, Government Engineering Collage Dahod, Collage Road Gujarat, India, Gujarat Technological University

Email: *kbp1977@yahoo.co.in*

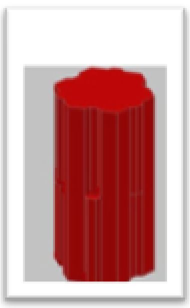
Abstract

Here the particular meaning of alternative type of bricks means the non-conventional type of bricks with new idea of using waste polymer materials. This bricks can be become translucent, insulating, light, strong and mechanically recyclable building material. The polymers materials are used for make alternative types of bricks are PET, HDPV, LDPE, PP, PVC, PC, PS, and ABS. these are widely available as waste material worldwide. The analysis of this bricks and brick modules analyzed by SAP2000 and ANSYS workbench software.

Keywords: *Interlocking bricks, Polymer bricks, SAP2000, ANSYS.*

1. INTRODUCTION

This alternative bricks are made of waste recycled polymers in shape of 3-D honeycomb self-interlocking structure makes it extremely strong without any chemical adhesives or binding material.



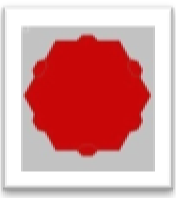


Fig.1 Isometric view **Fig. 2** Top view of bricks

Types of Recyclable polymer materials can be used for alternative type of bricks

1. Polyethylene Terephthalate (PET)
2. High Density Polyethylene (HDPE).
3. Polyvinyl Chloride (PVC).
4. Low Density Polyethylene (LDPE).
5. Polypropylene (PP).
6. Polystyrene (PS).
7. Acrylonitrile butadiene styrene (ABS)
8. Polycarbonate (PC)

This type of bricks has advantages like, Non-Brittle Super Strong Ultra-light Air-insulated, Simple Installation, and Environmental Gain.

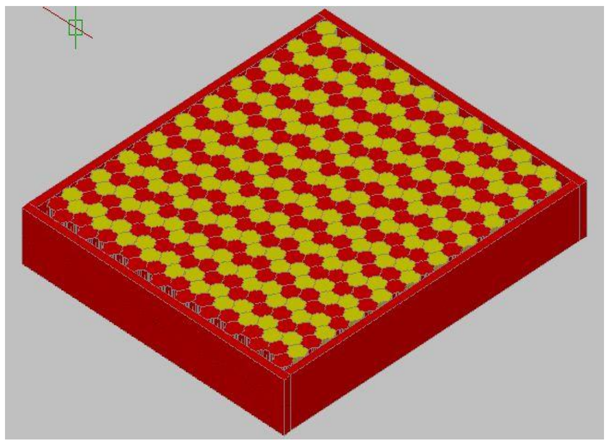


Fig.3 Realistic view of Wall module in AutoCAD

The wall module consist honeycomb formation of brick interlocked with each other and arranged inverted (red and yellow). This arrangement packed with 4 aluminum Subframes on outer side. The module also packed on both side surfaces with hard polycarbonate sheet.

Size of this designed bricks is 30 cm height and 10 cm side to side hexagonal width.

2. LITERATURE REVIEW

A research carried by Jadhao V. P. at el, Influence of Masonry Infill Walls on Seismic Performance of RC Framed Structures Comparison of AAC and Conventional Brick Infill, the Researcher described comparison of the base shear and reinforcement of AAC and conventional brick masonry modeling of RCC bare frame using SAP2000. The AAC bricks masonry RCC frame output lesser base shear than conventional brick RCC frame.

Jamnekar P. V. at el performed a research on Seismic evaluation of brick masonry infill, the Researcher described the study of the effect of infill walls in the seismic response of reinforced concrete (RC) buildings. For this study it has been used a typical 9 story RC building, considering three different lateral bearing systems using sap2000. They compared base shear, displacement, and fundamental natural period of building with bare frame and 40 % partially infilled.

A research carried by By. M V Renukadevi at el on Influence of reinforcement on the behavior of hollow concrete block masonry prism under compression- an experimental and analytical approach, the Researcher described Finite element analysis were performed using the ANSYS (14.5) software to investigate the behavior of masonry prisms under compression and to predict the ultimate failure compressive stress. Willam-Warnke's five parameter failure theory has been adopted to model the failure of masonry materials. The comparison of the numerical and experimental results indicates that the FE models can successfully capture the highly nonlinear behavior of the physical specimens and accurately predict their strength and failure mechanisms.

A research carried by P. Arjun et al. on the effect of stiffeners on the lateral stiffness of infill frames with openings. The researchers described macro and micro model analysis of infill wall masonry using program in ANSYS, Where micro analysis related with the FEM software mesh modeling of RCC frame. And macro model deals with the frame diagonal strut method.

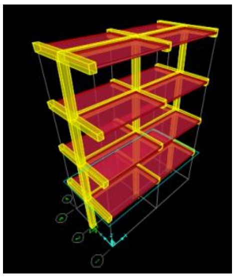
F. Moghadas Nejad et al. carried out a study on behavior of block pavement using 3D finite element method. The researchers described analysis of interlocking blocks for pavement. They adopted 3D finite element model mechanism of interlocking between pavers was discussed. Parametric study were conducted on 3D models

Jonathan Taaffe et al. published a paper on Experimental characterization of Polyethylene Terephthalate (PET) Bottle Eco-bricks. The researchers described issues of recycling waste plastic by considering the feasibility of use of Eco-bricks for constructional purposes. The Eco-bricks are formed by packing plastic within Polyethylene Terephthalate (PET) bottles. Guidelines were provided for the construction of Eco-bricks. Experiments were carried out to find some of the properties of these bricks. Compression test, sound insulation assessment and light transmission were considered in this regard and compared with traditional construction materials and conditions.

Tzu-Wei Liu et al. published a paper on Building material and built-up building material structure "the pollibricks. The researchers described the all new type of curtain wall system made from PET plastic bottles named as "Pollibricks" and the PC (poly carbonate) sheets are attached with it for more stability.

3. MODELING OF STRUCTURE USING SAP2000

The software used for seismic analysis is SAP2000 V.17



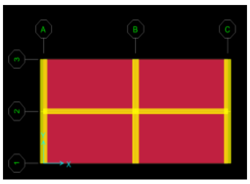


Fig 4 3D view in SAP2000 **Fig 5** Plan in SAP2000

Total 96 models are needed to be analysis for compare them with conventional brick masonry. (12 types of bricks modules X 8 types of polymer materials.) The parameter for comparison is Base shear of RCC frame using IS 1893-2002 in SAP2000 modal analysis.

The preliminary data for analysis is listed below.

1. Type of structure – special RC moment resisting frame
2. Seismic zone – IV
3. Number of stories – four (G+3)
4. Floor Height- 3.5 m
5. Infill wall – 250 mm thick in longitudinal and 150 mm thick in transverse direction .
6. Imposed load- 3.5 kN/m2
7. Materials- M20 , Fe415
8. Size of columns- 250 mm X 450 mm
9. Size of beams- 250 mm X 400 mm in longitudinal and 250 mm X 350 mm in transverse direction
10. Dept of slab- 100 cm
11. Specific weight of RCC- 25 kN/m3
12. Specific weight of infill- 20 kN/m3
13. Types of soil- Rock

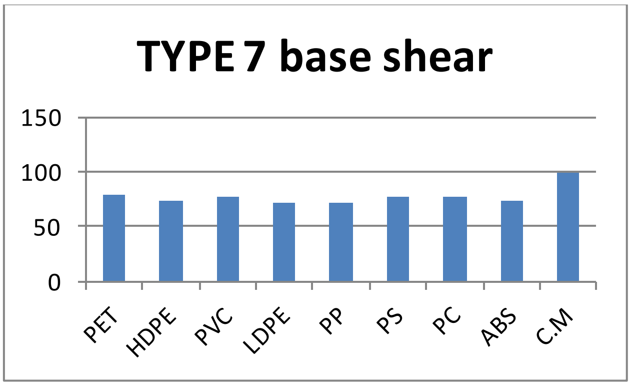


Fig. 6 Base shear for type 7 Design brick

4. MODELING OF BRICK AND BRICK MODULE

4.1 MODELING OF BRICK

The software used for analysis is ANSYS workbench version 14.0.

As per IS 1905-1987 (clause D-3.2) the strength of brick use in walls must be more than 3.5 MPa. Hence, in analysis process the pressure applied 4.5 MPa on single bricks. It is Slighter more than minimum to check the validity and acceptability of brick.

Model (B4) > Static Structural (B5) > Loads		
Object Name	*Pressure*	*Pressure 2*
State	Fully Defined	
Scope		
Scoping Method	Geometry Selection	
Geometry	5 Faces	
Definition		
Type	Pressure	
Define By	Normal To	
Magnitude	4.5 MPa (ramped)	
Suppressed	No	

Fig 7.Load input data for ANSYS workbench

For trial analysis of bricks in ANSYS, the type Type-3, Type-4 Type-7 and Type-9 concerned. And the rare and less available materials are eliminated. The following materials are taken in account for analysis. HDPE (High density polyethylene) LDPE (low density polyethylene), PVC (polyvinyl chloride) and the PP (polypropylene).

First for HDPE the Type-3, Type-5, Type-7, Type-9 all four bricks geometry checked by applying 4.5 MPa load on hexagonal side. The reason behind first concern HDPE is it's has lowest yield compressive strength among all 8 materials.

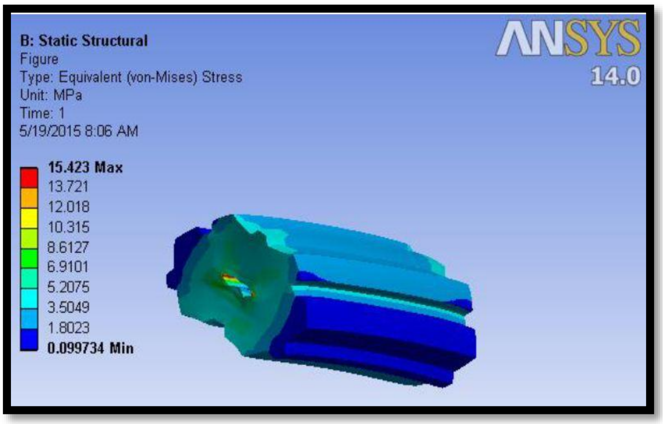


Fig.8. Compressive stress pattern of HDPE type 3

After different brick design's analysis Results shows that type 7 can be possible acceptable if stronger material used. (HDPE is weakest material from all 8 recyclable materials.)

So, with type-7 design the Lightest (i.e. PP) and the heaviest (i.e.PVC) material need to check for compressive strength analysis.

Table 1 Unit weight of recyclable polymer materials

polymer	HDPE	LDPE	PP	PVC	PET	ABS	PC
Density	0.95	0.92	0.91	1.44	1.35	1.06	1.2

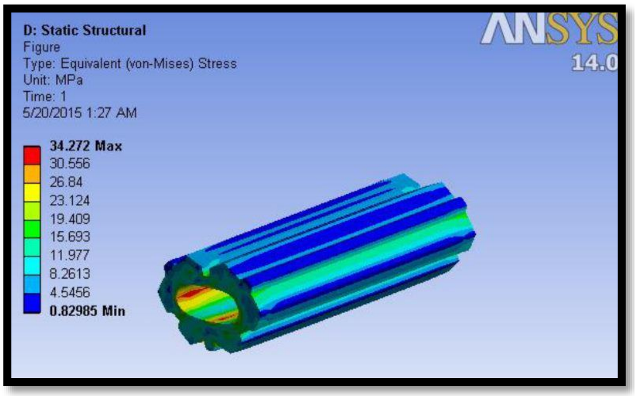


Fig.9 compressive stress pattern of PVC type 7

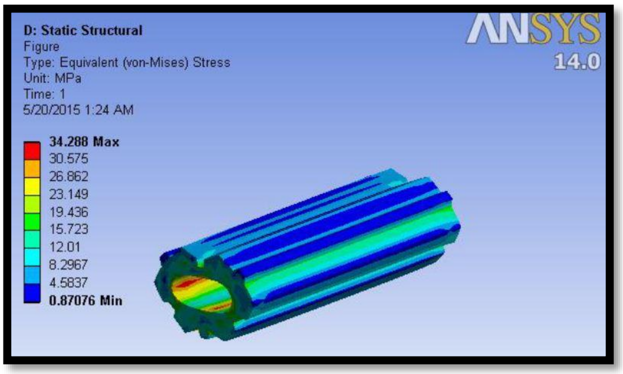


Fig 10.compressive stress pattern of PP type 7

Table 2 Results and comments from ANSYS analysis

Material And design	Induced compressive strength	Allowable compressive strength	comment
HDPE Type 3	15.42	20	acceptable
HDPE type 5	20.96	20	Unacceptable
HDPE Type 7	34.03	20	Unacceptable
HDPE Type 9	263.73	20	Unacceptable
PVC Type 7	34.272	40	acceptable
PP Type 7	34.29	53	acceptable

4.2 MODELING OF BRICK MODULE

By using ANSYS 14.0 workbench software the modeling of a single wall module is done.

The overall size of Wall module is 2.16 m in length and 2.40 m in height. The thickness is 31 cm including the covers both side. The all module is bounded by concrete beams and columns of size 230 mm X 300 mm. and the module width is 31 cm. the aluminum sub frame is also connected on all four sides in between polypropylene brick module and concrete.

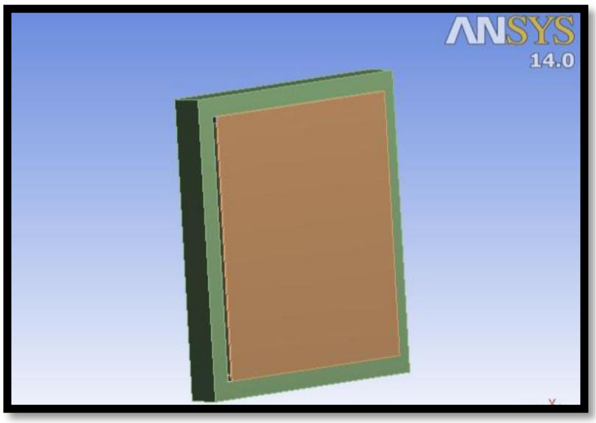


Fig 11. The wall module

The load consideration is taken as for check the stress behavior of this frame concentrated lateral load of 16.43 KN taken as per literature review's pervious analysis data.

And the wind pressure for exterior wall taken 720 N/m2, As per given In IBC 2012 chepter-16 section 1607.13.

The both load are applied simultaneously for ultimate worst condition. So the stress behavior data are obtained as per below figure. The stress behavior data shows that maximum load induced in frame's corner due to joints. Now red zones are visible in considerable amount.. So, these joints are connected with wild or bolted connection of aluminum sub frame. And aluminum can withstand this load easily.

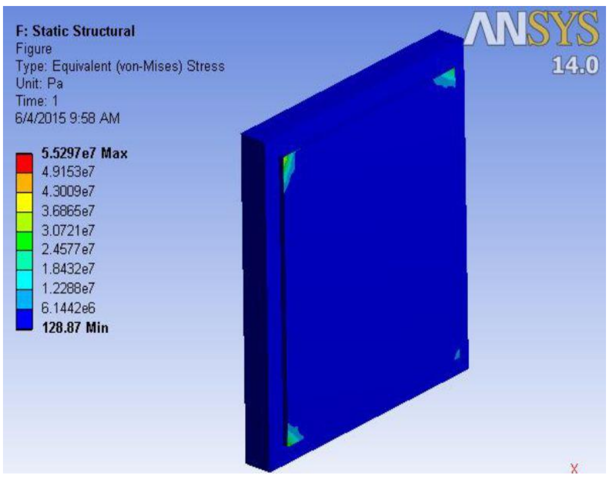


Fig.12 Stress behavior data in ANSYS

The below figure visualize deformation in various regions. The top displacement is 2.89 mm. it is negligible and clear that frame is withstand for this wind pressure and concentrated load.

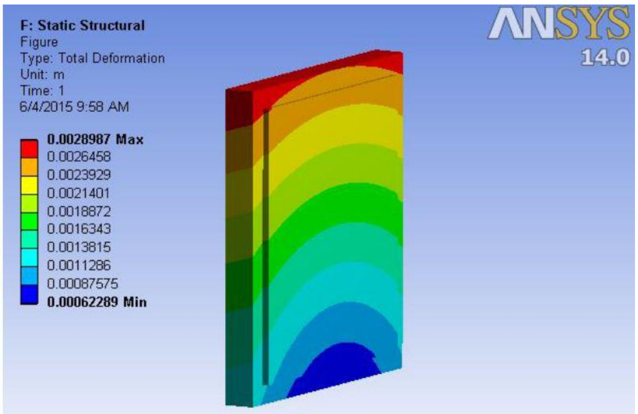


Fig 13. Deformation of Wall module in ANSYS.

5. RESULT AND DISCUSSION

Table 3 Saving in material in respective designed bricks

Type of brick	Saving in material (%)	actual volume (cm3)
Type 1	0%	3394.82
Type 2	0.79	3368.15
Type 3	3.14	3288.12
Type 4	7.07	3154.76
Type 5	12.57	2968.04
Type 6	19.64	2727.98
Type 7	28.29	2434.57

- For type 3 HDPE brick is safe for 4.5 MPa compressive load. The maximum compressive yield stress is 20 MPa for HDPE. So here in maximum induced stress is 15.42 MPa so it's acceptable.
- For type 5 HDPE brick is not safe for 4.5 MPa compressive load. The maximum compressive yield stress is 20 MPa for polypropylene.. So here in maximum induced stress is 20.96 MPa so it's not acceptable.
- For type 7 HDPE brick is not also safe for 4.5 MPa compressive load. The maximum compressive yield stress is 20 MPa for polypropylene. So here in maximum induced stress is 34.026 MPa so it's not acceptable.
- For type 9 HDPE brick is not safe for 4.5 MPa compressive load. The maximum compressive yield stress is 20 MPa for polypropylene. So here the maximum induced stress is 263.73 MPa, so it's not acceptable.
- For type 7 PP brick is safe for 4.5 MPa compressive load. The maximum compressive yield stress is 40 MPa for polypropylene.. So here in maximum induced stress is 34.288 MPa so it's acceptable.
- For type 7 PVC brick is safe for 4.5 MPa compressive load. The maximum compressive yield stress is 53 to 87 MPa for polypropylene. So here in maximum induced stress is 34.288 MPa so it's acceptable.

6. CONCLUSION

For all the modules of brick, from SAP2000 seismic analysis results shows that The base shear of Polypropylene material is less, possibly due to its less unit weight

From PVC and PP from type 1 to type 7 , the Type 7 have 28.29 % maximum material saving than solid type 1 brick design so as a economic point of view type 7 is best among all 7 design.

From the analysis of type 7 brick module using PP (Polypropylene) material withstand the standard wind pressure and the lateral concentrated load it is safe for deflection and stress criteria. Hence this brick module is acceptable.

The base shear of brick type 7 made up PP (polypropylene) is less than type 7 brick made up from PVC ((Polyvinyl chloride) hence type 7 brick made up of PP is advisable for brick module.

In short, This Designed bricks performed very well in seismic condition. And the design is acceptable. The best results obtained for PP type-7 bricks in with the compressive strength and economic Point of view.

7. AKNOWLEDGMENT

Heartily thanks to GTU patent clinic for helping me to provide better knowledge of fill up patent application for this innovation. From their valuable help patent application filed at Indian patent office Mumbai by Authors.

REFERENCES

1. IPTS (institute for prospective technological studies) technical proposal, Spain.
2. Waste plastics recycling a good practices guide by and for local & regional authorities Europe.
3. ISO 15270 Plastics — Guidelines for the recovery and recycling of plastics waste
4. Earthquake resistance design of structure by Pankaj agarwal and Manish shrikhande: reference book
5. Plastics Europe Market Research Group (PEMRG)
6. seismic evaluation of brick masonry infill By Mr. V. P. Jamnekar1, Dr. P. V. Durge published in IJETET in 2013
7. Influence of Masonry Infill Walls on Seismic Performance of RC Framed Structures a Comparison of AAC and Conventional Brick Infill," By Vikas P. Jadhao, Prakash S. Pajgade (published in International Journal of Engineering and Advanced Technology 2013)
8. Effect of infill walls in structural response of RC buildings by .I. Idrizi & N. Idrizi ,Z. Idrizi , S. Idrizi ,I. Idrizi (published in Challenges, Opportunities and Solutions in Structural Engineering and Construction – Ghafoori (ed.) 2010)
9. Effect of Infill Walls on Structural Frames By M Harunur Rashid and Sobura Khatun published in ICMPAE'2011
10. seismic assessment of symmetrical RC structure with brick masonry infills By V. V. Diware, A. C. Saoji published in International Journal of Engineering Research and Applications 2012
11. Earthquake Assessment of R/C Structures with Masonry Infill Walls By Marius Mosoarca (published in International Journal of Science Technology 2007)
12. Response Spectrum Modal Analysis of Buildings using SpreadsheetsBy Ravi Kant Mittal, P. Prashanth Published in International Journal of Modern Engineering Research (IJMER) (2012)
13. Experimental characterisation of Polyethylene Terephthalate (PET)Bottle Eco-bricks by Jonathan Taaffe , Sean O'Sullivan , Muhammad Ekhlasur Rahman , Vikram Pakrashi ⇑ Published in 2014 in sciencedirect
14. building material and built-up building material structure "the pollibricks" By Tzu-Wei Liu, Chian-Chi Huang, and Min-Feng Huang, Published in Patent Application Publication United states, on April 2011
15. Lateral Stiffness of Brick Masonry Infilled Plane Frames By P. G. Asteris published in journal of structural engineering in 2003

Authors Profile

Dhaval H Joravia received B.E.CIVIL degree from GEC Surat. He is now final year student in M.E.CASAD at GEC Dahod

Dr. Kaushal B Parikh received the PhD from SVNIT Surat. He is now stayed at Head of department of applied mechanics department at GEC Dahod.