International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 10 Issue 5 ǁ 2022 ǁ PP. 48-54

Seismic Analysis of Normal Brick and Interlocking Block in Residential Building

Shubhangi Patil[1], Rupali Mahamulkar[1], Shweta Sasane[1], Divya Bhagwat[1], D.W. Gawatre[2]
Department of Civil Engineering, Sinhgad Academy of Engineering, Pune – 411048 (M.S), INDIA
1- Under Graduate's Students ,2– Faculty of Civil Department, Sinhgad Academy of Engineering, Pune

Abstract: *In the most of the developing world with the increase in population the housing facility is inadequate & therefore due to high rate of urbanisation the cost of land &material of construction is increasing rapidly. Different types of interlocking blocks are being developed worldwide. Expansion of interlocking earth block is one of the best technologies for the production of low-cost building materials. [1] In this study, an attempt is made to analyze the structure of interlocking blocks. The structure is modelled using STAAD PRO software. RCC structure are built by normal bricks but due to rapid growth and expensive materials, now-a-days construction engineer are going for interlocking blocks. In this project a residential building of G+1 structure is considered.*

Keywords: *Interlocking block, STAAD PRO, seismic*

Date of Submission: 10-05-2022 Date of acceptance: 25-05-2022

I. Introduction:

Definition: A block is enhanced form of clay brick and basically made by precast concrete and blocks are designed to hold together itself with other blocks around it with mortar or without filling by key and lock mechanism.

Type: On base of uses there are different types of interlocking bricks likes interlocking pave bricks, interlocking wall bricks, interlocking landscape bricks, interlocking retaining wall bricks etc. Main composition of blocks is concrete, water and laterites. And other sub added substance which make blocks different are alkali activated solutions, fly ash quarry dust, geopolymer.

History: Mortarless technology is directly associated with interlocking bricks so the 2 terms will be used interchangeably. In this work we are going to deal with use of interlocking bricks stacked dry to build a wall while observing building constructions rules of proper bonding. Bonding is the arrangement of bricks in an interlocking pattern this results in a stable wall. the stretcher bond was the only (main) such pattern used in interlocking brickwork before this research. The history of interlocking bricks started in the early 1900s with the construction of toys for children's McKusick (1997), Love and Gamble (1985). Among the first inventors of toy systems that contributed to the mortarless technology.

From the beginning most toy mechanisms were designed to teaches the principles of creativity and were a tool for learning scientific, engineering and architectural principle. The original material used for toy construction were tin. metal. Wood and clay. though now mot toys are from plastic. of these various systems. Lego has the most similarly to walling. "An Interlocking Brick construction for toys (Automatic Binding Brick) was first developed in Demark in 1951 the "Automatic Binding Brick" was renamed as "Lego Musten" "Lego Brick" in English, "and first produced commercially in 1958".

Since 1970s the interlocking mortarless bricks/blocks for house construction, made from sand-cement, stabilised soil and burnt/baked soil, have been pioneered in Africa, Canada, the Middle East and India.

II. Literature Review: -

1. **Parimal Borbar, July 2020,** the concept, design and application of interlocking precast block design will prove effective example for sustainable approach towards construction. According to the analysis done in the ANSYS, it is clearly seen that the deformation of the retaining wall is produced less than 3mm which is quite safe enough. It is clearly observed that, when the RCC wall is compared with the precast wall stresses induced in the precast wall are very less as compared to RCC wall.
2. **S.S.Deshmukh**, June 2019, The seismic analysis of single storey , single bay frame with infill wall build using interlocking blocks and bricks are conducted and compered. In order to obtain more realistic value for stress and displacement results, we have conducted 3d analysis of structure. When compared the

displacement result of the frame with interlocking block wall, brick wall and frame without any infill wall (bare frame) it has been observed.

3. **Mubeena Salam, 2018**, Storey drifts are found within the limits as specified by code (IS 1893-2002 Part-1). The seismic base shear obtained by IS Code is not in a good agreement with the values obtained from Equivalent static and Response spectrum analysis using ETABS.
4. **Bhavani Shankar, October 2016**, it has been observed that overall displacement of interlocking block wall is reduced by about 69% when compared with frame without infill wall and about 15% when compared with brick infill wall.

In all the cases stress value is more in y direction. Thus, interlocking block will be effective in resisting the earthquake loads.

5. **Farzad Hejazi, 2015**, Finite element model of mortarless block masonry wall foundation soil system has been developed.

The model is at micro level which includes the modelling of masonry material, mortarless dry joint and block-grout interface behaviour.

6. **Jeba Jeslin, 2019**, The compressive strength of the interlocking block increases by 15% to 30% when compared with the nominal brick. Interlocking blocks have better tolerances and no efflorescence when compared with nominal brick. The bond strength of interlocking block is greater than that of nominal brick. The resistance due to impact for interlocking block is 80% to 85% greater when compared to the nominal brick. The energy absorbed by interlocking block is 60% to 70% greater than that of nominal brick.
7. **Rinju Mathew**, in this study, the effect of openings in the wall under the lateral loading are studied and discussed.
8. **Farzad Hejazl, 2014**, The interlocking keys provided for this system were able to integrate the blocks into a sturdy wall and can replace the mortar layers that are used for conventional masonry construction in low seismic area.

PROBLEM STATEMENT: The project deals with the seismic analysis of interlocking blocks to minimize the damages to the construction.

Objective:

1. To study the comparison between normal bricks and interlocking block.
2. To design the structure using conventional bricks wall and interlocking blocks.
3. To calculate analytically the boundary loading conditions on both developed structures.
4. To analyse the model using software analysis.

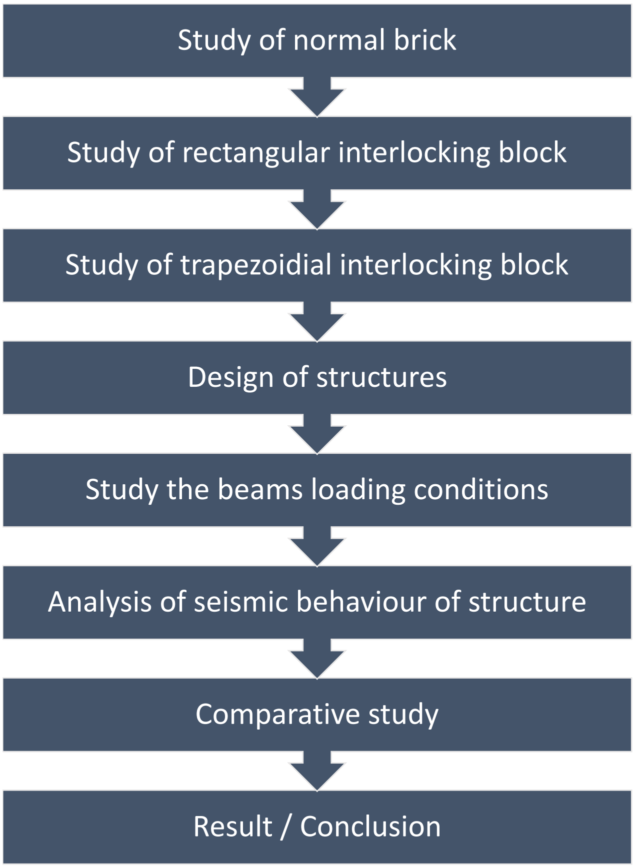
III. Methodology:

In the present project study, Civil Software is used for Seismic Analysis of structure Interlocking block. Dimension of building is will be selected by the literature study and analyzed in the software. The design parameters are building height, area, each floor height, thickness of slab, Soil layer depth is also considered in this study. Material used for analysis is Fe 415 steel and M30 grade of concrete The models are as follows: -

1. 1st Model: - In this model, structure with Normal bricks wall load is applied.
2. 2ndModel: - In this model, structure with Rectangular Interlocking block wall load is applied.

Flow of Project: -

Design Data Collection: -



We have collected data from various research papers, books and internets. The required data is as follows: -

1. Dimension of residential structure.
2. Dimension of normal brick.
3. Dimension of Interlocking blocks.
4. Load values applied on structure.

Modelling of the Project: -

1. Structure with normal bricks.
2. Structure with rectangular interlocking blocks.

Fig 1. Interlocking block wall

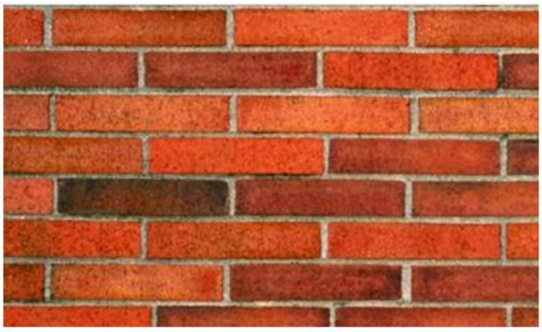


Fig 2. Sand Crete brick wall [2]

Design of residential building

A. Dimension of residential building

1) Material Properties
a. Young's modulus of (M30) concrete, E = $27.386 \times 10^6 kN/m^2$
b. Density of Reinforced Concrete = $25kN/m^3$
c. Modulus of elasticity of brick masonry = $3500 \times 10^3 kN/m^2$
d. Density of brick masonry = $20kN/m^3$
e. Density of interlocking block masonry =$18KN/m^3$
2) Assumed Dead Load Intensities
- Floor finishes = $1.5kN/m^2$
3) Live load intensities
- Imposed loads = $3.5KN/ m^2$
4) Member properties
a. Thickness of Slab = 0.150m
b. Column size = (0.4m x 0.3m)
c. Beam size = (0.35m x 0.3m)
d. Thickness of wall = 0.23m
e. Thickness of concrete wall = 0.20m
5) Load Calculations
a. Wall load on roof =1x0.23x20 = 4.6 KN/m (brick)
b. Wall load on each storey =2.8x0.23x20 = 12.88KN/m
c. Wall load on roof = 1x.0.20x18=3.6KN/m (interlocking block)
d. Wall load on each storey =2.8 x 0.20 x 25 = 10.08KN/m

HEIGHT	2.8 m
TOTAL HEIGHT	10 m
FLOOR AREA	4 X 12.5 = 50 m^2

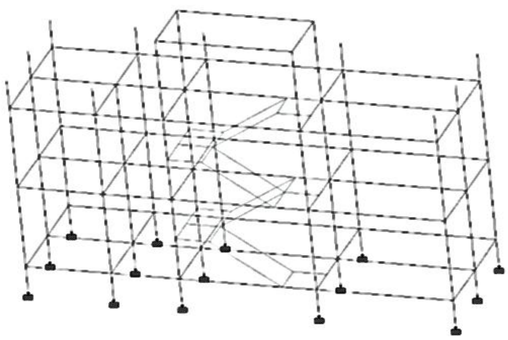


Fig 3: structure of building

B. Seismic Parameters

- Zone factor as per (table 2 of IS 1893-2002) = 0.16(Zone-III)
- Importance factor I from (Table 6 of IS 1893-2002) = 1(General building)
- Response reduction factor R from (Table 7 of IS 1893- 2002 =3.00(OMRF)
- Soil type (Figure 2 of IS 1893-2002) =Type III (Hard soil)

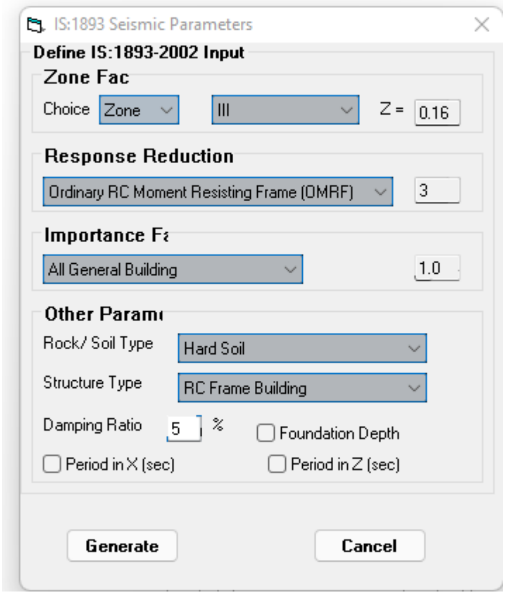


Fig 4: window of seismic valve.

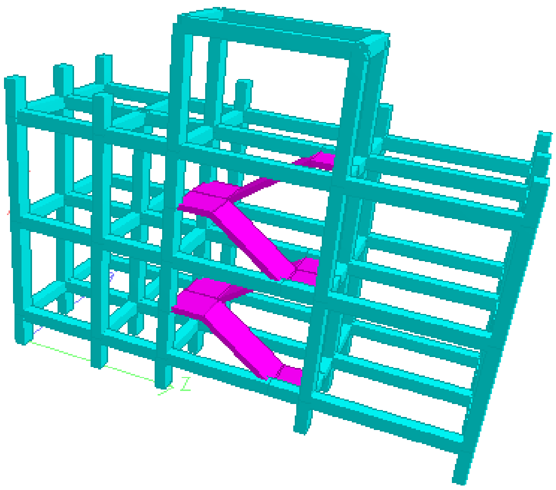


Fig.5: Frame Model

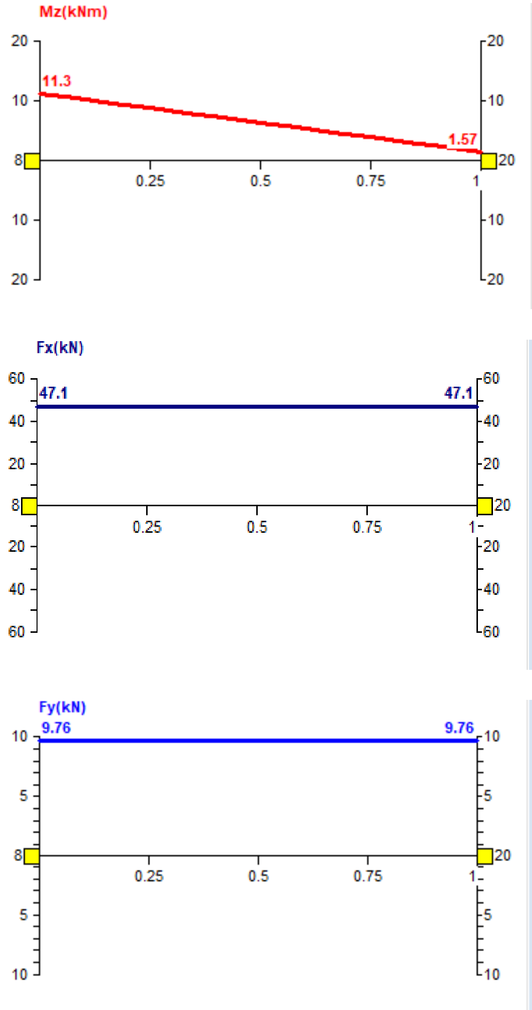
```
**********************************************************
*
* TIME PERIOD FOR X 1893 LOADING =     0.42176 SEC       *
* SA/G PER 1893=     2.371, LOAD FACTOR= 1.000           *
*      FACTOR V  PER 1893=     0.0632 X    2457.82       *
*
**********************************************************
```

Fig.6

STORY	LEVEL IN METE	PEAK STORY SHEAR IN KN X	PEAK STORY SHEAR IN KN Z
4	10.00	306.40	323.45
3	7.00	1299.10	1345.03
2	4.00	1980.49	2072.66
1	1.00	2057.15	2158.12
BASE	0.00	2057.15	2158.12

Fig. 7

GRAPH:



IV. Result:

For this study, the beam of plinth level is considered B37. The below table seismic load on X-axis is taken. For displacement column of staircase is taken in X direction.

	Without wall	With Wall
Maximum Support Reaction in Y direction	51KN	47KN
Maximum Displacement	3.870mm	3.866mm

Fig: - 8

For earthquake resistance the frequency are mention in table :-

V. Conclusion:

- Comparing the support reaction and displacement for above two models in a tabular form. Fig 6
- The seismic analysis of G+1 storey building, wall built by using normal brick and interlocking block are conducted and compared.
- As per result, there is difference of valve, reaction.

References:

[1]. Bhavani Shankar, seismic analysis of interlocking block as infill wall, international research journal of engineering and technology (IRJET), volume: 03 issue: 10 | oct -2016.

[2]. Zakari Mustapha, comparative cost analysis between interlocking bricks and sand Crete blocks for residential buildings in Ghana, MOJ Civil Engineering, vol. 4, issue 4-2018.

[3]. Parimal Borbar, analysis and design of structural precast interlocking blocks for retaining wall, JES, ISSN no:0377-9254, vol. 11, issue 7, July /2020, page:304

[4]. S.S. Deshmukh, seismic analysis of interlocking blocks of wall, JASC, ISSN no: 1076-5131, vol. Vi, issue vi, June/2019, page no:1594.

[5]. I. Jaswanth Reddy, lateral load behavior of interlocking block masonry wall, volume 8, issue 3, march 2017, pp. 831–841 article id: ijciet_08_03_084
[6]. Mubeena Salam, seismic analysis of interlocking blocks in walls, IJSRD, vol. 6, issue 05,2018/ ISSN (online): 2321-0613
[7]. Farzad Hejazi, seismic analysis of interlocking mortar less hollow block, challenge journal of structural mechanics 1 (1) (2015) 22–26
[8]. Dhaval h. Joravia, study on performance of infill wall masonry RCC frame using alternative types of bricks, IJETST vol.||02||issue||06||page.
[9]. Sampson Assiamah, comparative study of interlocking and sandcrete blocks for building walling systems. IJRET, EISSN 2319-1163| PISSN: 2321-7308, vol.05, issue 01 jan-2016.
[10]. Venkata V.H.Chunduri, Comparative study on load resistance of eco-friendly interlocking blocks for sustainable. DOI: https://doi.org/10.21203/rs.3.rs-492442/v1
[11]. V.Sai Himaja, Comparative seismic analysis of open ground storey framed building with infill wall and shear wall. IHEDR1602004, Vol. 4 issue 2|
[12]. Mochamad Teguh, Experimental investigation on interlocking concrete block for masonry wall, vol. 4, 2019.
[13]. G.H.Kumbhar, seismic analysis of interlocking blocks of wall, vol. 2, June 2019, JASC.
[14]. D.W.Gawatre, "Seismic Analysis of structures with Irregularities", International Journal of Mechanical and civil Engineering. (IOSR-JMCE) Volume 2 Issue 4 April 2014.Pp 63-66(e-ISSN: 2278-1684 p-ISSN: 2320-334X).
[15]. D.W.Gawatre, "Experimental Study on Properties of Lightweight Sandwich Concrete Blocks using EPS Sheet", International Research Journal of Engineering and Technology (IRJET), Volume-07, Issue 06, June-2020. Pp 6913-6920. P-ISSN 2395-0072, e-ISSN 2395-0056.
[16]. D.W.Gawatre, "Seismic Analysis of structures with Irregularities", International Journal of Mechanical and civil Engineering. (IOSR-JMCE) Volume 2 Issue 4 April 2014.Pp 63-66(e-ISSN: 2278-1684 p-ISSN: 2320-334X).
[17]. D.W.Gawatre, "Strength characteristics of Different Types of Bricks", International Journal of Science & Research.(IJSR)Volume 3 issue 10, October 2014 (ISSN: online-2319-7064).Pp2247-2252.Impact factor (2012-3.358).
[18]. D.W.Gawatre, "A performance of Fly ash Interlocking Brick", International Journal of Civil Engineering and Technology (IJCIET) Volume 4 Issue 6 December 2013(ISSN 0976-6308).Pp 82-88.
[19]. D.W.Gawatre, "A Review paper of Seismic analysis of interlocking block and normal brick in residential building", International Journal of Progressive Research in Science and Engineering (IJPRSE) Volume 3, issue 05, May 2022
[20]. Bureau of Indian Standards: IS 1893 (part 1): 2002, -Criteria for Earthquake resistant design of structures: Part 1 General provisions and buildings||, New Delhi, India.
[21]. Bureau of Indian Standards: IS 456: 2000, -Plain and Reinforced Concrete- code of practices||, New Delhi, India.
[22]. Bureau of Indian Standards: IS 875(part 1): 1987, - Dead loads on buildings and structure||, New Delhi, India.
[23]. Bureau of Indian Standards: IS 13920: 1993, - Ductile detailing of reinforced concrete structures subjected to seismic forces – Code of practice||, New Delhi, India.
[24]. Seismic analysis and earthquake resistant design of structure book by S.K.Bhattacharjee.