DRISHTI
A Revolutionary Concept

DRISHTI - A Revolutionary Concept, S.V.N.I.T.

EARTHQUAKE RESISTANT STRUCTURE

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Abstract:

Earthquake resistance of a structure is mainly achieved by providing trusses in the frames which can handle both horizontal and vertical forces. The other and most used method is base isolation method in which superstructure remains steady independent of the movement in base.

Motivation:

Earthquake, one of the disastrous acts of god is taking millions of lives every year. The worst part about this calamity is that it is unpredictable. Many people lose their lives due to this calamity every year. Many of the victims of earthquake died not because of their fault, but because of infrastructural fault in design of buildings. Many of the prominent Indian cities lie in the high damage seismic risk zones. New Delhi and Chandigarh being in Zone 4. With the pace at which new residential apartments and shopping malls are being constructed in these cities, the hazard and risk involved is also increasing. We need to design all the structures in these regions such that the economic and life loss at the time of any unfortunate event of an earthquake is minimized.

1. Basic Concept

The basic idea behind to make any structure earthquake resistant is use of specially designed trusses and base isolation method. By these, the structure can withstand more impact as compared to any other structure in which the given measures are not implemented.

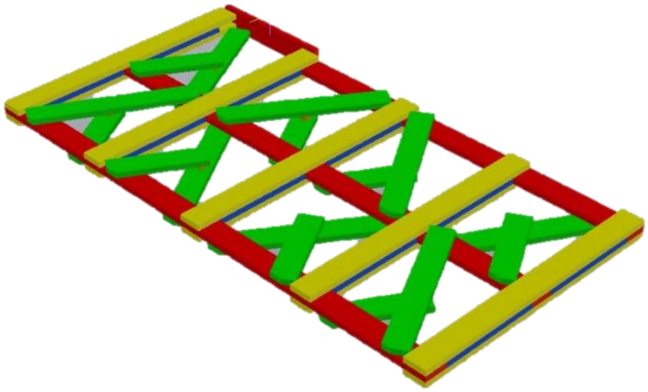
1.1 Truss Design

The basic thing that was kept in mind for designing the truss is that it should not failed when both horizontal (earthquake waves) and vertical (dead and live load) forces are applied to it. There are several designs of truss designs which can sustain both loads like:

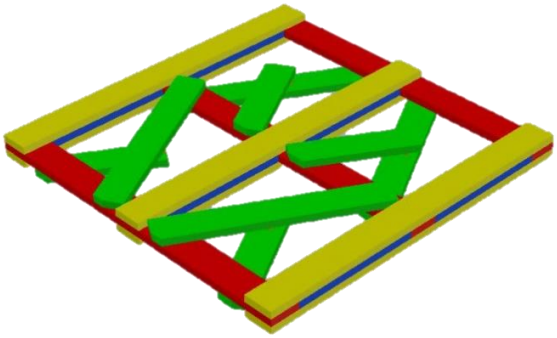
- X Truss
- K Truss and many others

To make inner duct two frames are made:

- Outer frame:



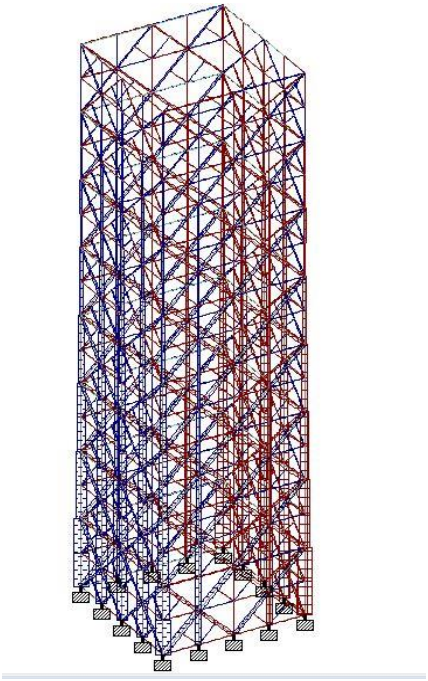
- Inner Frame:



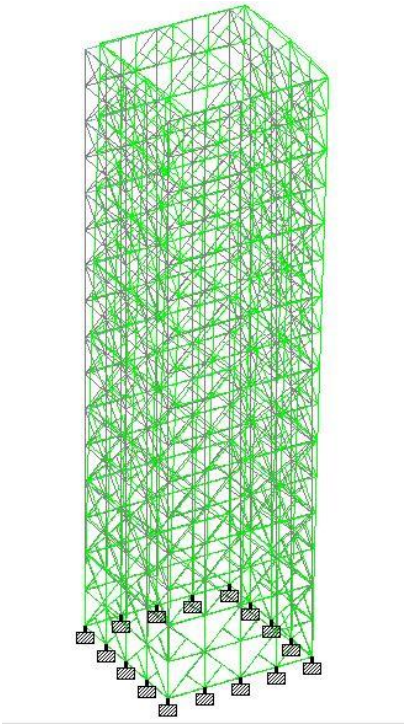
Analysis is done on the structure in STAAD Pro. Link to the files are added in the end of documentation.

Here are some pictures of the result:

- Axial Force Diagram under Earthquake Load:



- Displacement under Earthquake Load:



1.2 Base Isolation Method

In base isolation method, the superstructure is not directly connected to the ground through footings but some elastic materials or springs are attached between the ground footing and superstructure. In our structure, it is achieved by using rubber bands which connect the base and superstructure through hooks attached to both. Rubber bands dampen the motion created due to earthquake and hence it doesn't move due to earthquake.

2. Material Used

Following materials are used for making the entire structure:

- Popsicle Sticks (For making truss)
- Plywood (Used as floors and base)
- Fevicol SH (As an adhesive)
- Rubber Bands (For connecting base and super structure)
- Hooks (To attach rubber bands)

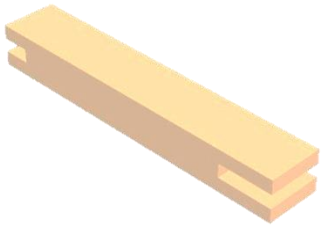
3. Construction Process

3.1 Column

Columns of the superstructure are made using 3 popsicle sticks. The middle stick is shorter than the outer ones so beams can be attached to columns by inserting in the gaps created in between. Dimensions of the columns are as follows:

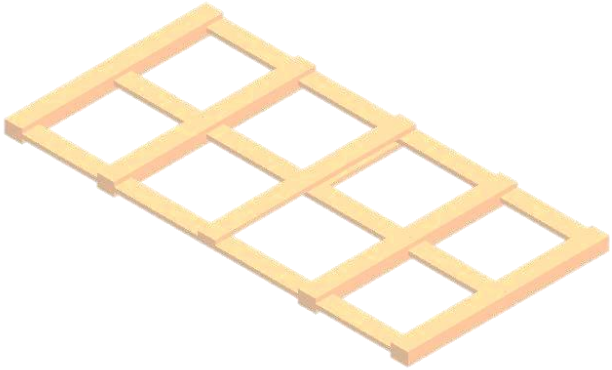
- Outer sticks = 70mm
- Inner stick = 52mm
- 12mm spacing from one side and 6mm spacing from other

Here is the picture of a single column:

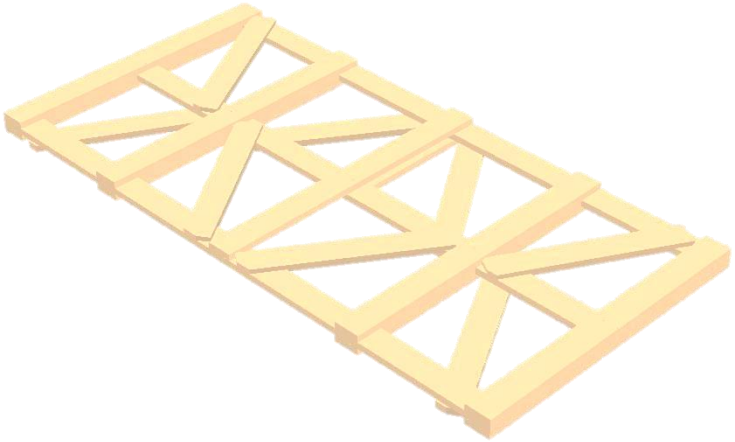


3.2 Frames

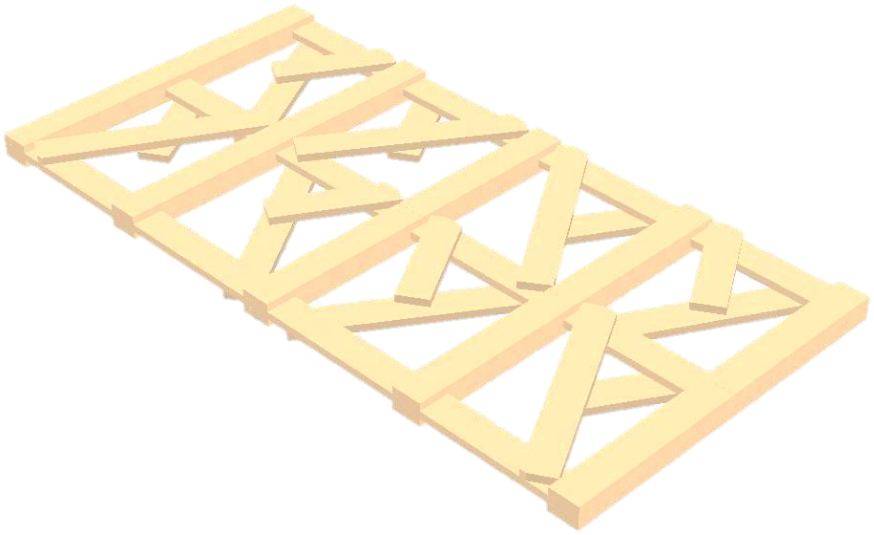
After making columns beams are attached to make initial frame.



After making the initial frames main body diagonals are added to the frame structure.



And finally, small diagonals are attached to the frame and one wall is completed.



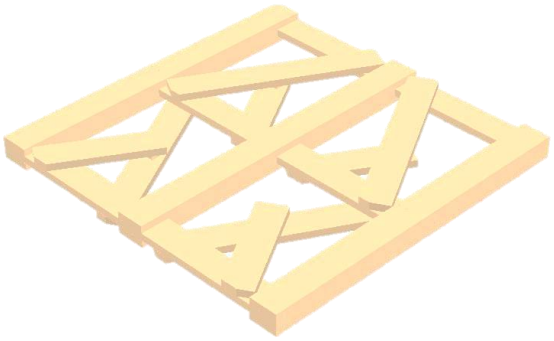
Final frame comprises of:

- 10 Columns
- 12 Beams
- 8 Main Diagonals
- 8 Small Diagonals

Same process is repeated for making the smaller inner frames which comprises of:

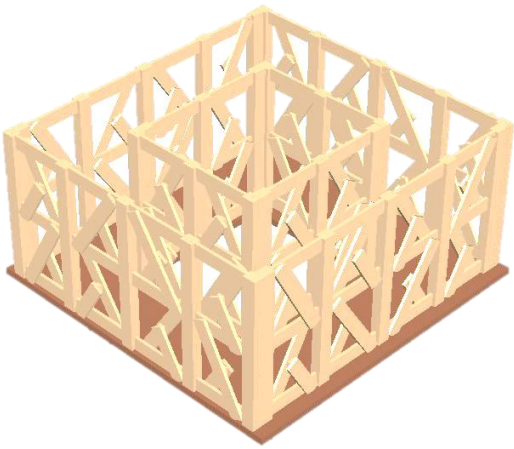
- 6 Columns
- 6 Beams
- 4 Main Diagonals
- 4 Small Diagonals

The final smaller frame look likes:

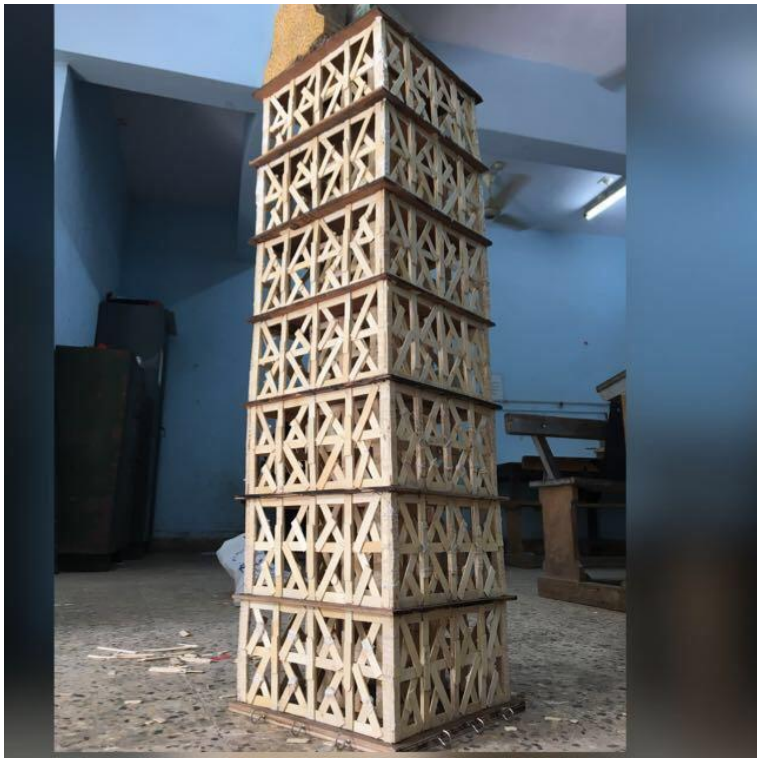


3.3 Floor

After every four outer and inner floors are made they are assembled together with the help of glue. To stable corners threads are also used to attach two frames. Frames are glued to the plywood with a square opening in it.



After adding such seven floors final super structure is made.

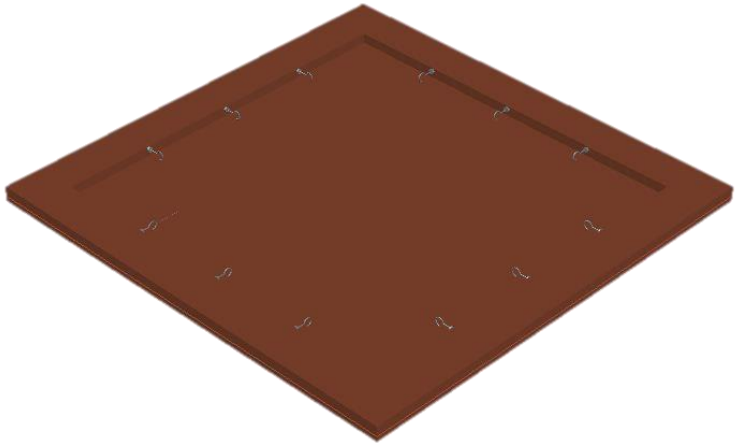


3.4 Base

To incorporate base isolation method two base ply are used:

- Lower one of 55cm X 55cm with 6mm ply
- Upper one with 45cm X 45cm hole in center with 12mm ply

Hooks are added to sides for attaching rubber bands



4. Results:

- The structure displacement is negligible even at high amplitude of 10mm when tested on Earthquake Simulator Machine.
- The axial load bearing capacity of the structure is more than 100kg.

5. Software Files:

All software files in which the structure is made is provided below:

- Auto CAD :
  - With Materials: https://drive.google.com/open?id=0B1oaSBOhxYpOaGpGZjFkNVRzQWs
  - Without Materials: https://drive.google.com/open?id=0B1oaSBOhxYpOeTNMZTRyVVFiNG8
- STAAD Pro (With analysis summary): https://drive.google.com/open?id=0B1oaSBOhxYpOckQtNVNlS1NUUEU