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DESIGN AND ANALYSIS OF AN H-TYPE EARTHQUAKE RESISTING BUILDING USING ISOLATION TECHNIQUE BY STAAD PRO

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ABSTRACT

In order to complete in the ever growing competent market it is very important for a structural engineer to save time. As a sequel to this an attempt is made to analyze and design an earthquake resisting building by using a software package STAAD pro. For analyzing a multi storied building one has to consider all the possible loadings and see that the structure is safe against all possible loading conditions and possible loading conditions due to earthquake. There are several methods for analysis of different frames like kani's method, cantilever method, portal method, and Matrix method. The present project deals with the analysis of an earthquake resisting building using isolation technique. The isolation is providing in between foundation to column base. The dead load &live loads are applied and the design for beams, columns, footing is obtained. In isolation dampers is hydraulic, fluid, viscos, and rubber are used. So in this project rubber dampers are used in isolation technique. STAAD Pro with its new features surpassed its predecessors, and compotators with its data sharing capabilities with other major software like AutoCAD, and MS Excel. We conclude that staad pro is a very powerful tool which can save much time and is very accurate in Designs. Thus it is concluded that staad pro package is suitable for the design of an earthquake resisting building.

Keywords: Earthquake resisting building, Isolation technique, STAAD Pro,Design and Analysis.

1. INTRODUCTION

In every aspect of human civilization we needed structures to live in or to get what we need. But it is not only building structures but to build efficient structures so that it can fulfill the main purpose for what it was made for. Here comes the role of civil engineering and more precisely the role of analysis of structure. are many classical methods to solve design problem, and with time new software's also coming into play. Here in this project work based on software named staad pro has been used. Few standard problems also have been solved to show how staad pro can be used in different cases. These typical problems have been solved using basic concept of loading, analysis, condition as per IS code. These basic techniques may be found useful for further analysis of problems.

1.2. SPECIFICATIONS

The specifications are provided for the construction "H TYPEEARTHQUAKE RESISTING BUILDING". The provision is made in thespecifications are as follows.

1.2.1. SUB SOIL DATA

The sub soil is of course grade and compacted sand. The plate load test was conducted by the P.W.D authorizes to determine the SBC value.

1.2.2. ORIENTATION

The H type earthquake resisting building is proposed to be constructed atdeanery. This proposed land is owned by the private it faces south.

1.2.3. BRICK MASONARY

The most and widely used material for construction of building is brick. Ithas the following advantages.

i) Raw materials required are ordinary earth which is available isabundance.

ii) Kill burning bricks are used

iii) Locally available brick size 19 x 9 x 9 cm all the works will be in brick masonry in cement mortar 1:6 using abovemaintained bricks. The height of wall from floor level to roof level is 3m this brick are obtained from Arni town the sand is obtained from Cheyyar River.

1.2.4. CONCRETE

Concrete is a material obtained by combining together interest material like sand gravel and broken stone. This R.C.C is weak in tension and strong incompression so steel reinforcement is used to take up the tensile stress in thisproject the R.C.C for the ratio of 1:2:4 using 20mm nominal metals are obtained from Arni. All the R.C.C works are going to be done by volume batching.

1.2.5. ROOFING

The roofing will be of R.C.C M20 grade with 150 mm thick and it isdesigned as two way slab & one way slab.

1.2.6. COLUMN AND FOOTING

The column is of the size 0.35X 0.25 .1m center. The footings are the size of2.5 x 1.5 with 0.3m wide.

1.2.7. FLOORING

This will be of R.C.C 1:2:4 150 mm thick using 40mm nominal size HBGmetal over the wall compacted river sand cushion which is 150 mm thick the top ofthe floor is finished with mosaic slabs polished.

1.2.8. DAMP PROOF COURSE

The damp proofing of a building is achieved by using a suitable material this should satisfy the following requirement.

i) It should be imperious to moisture

ii)It should be stable in loaded and unloaded condition.

iii) It should not be distributed by the effect of dead load coming over the surface

iv)Damp proofing properly should remain constant with lapse of time inthis project the CM of 3 cm is used as DPC.

1.2.9. DOORS AND WINDOWS:-

The primary purpose of doors is serving as a means of communication from one room to another room. Secondly in combination with windows providescircular ventilators.

1.2.10. PLASTERING:-

Plastering for the ceiling is in CM 1:3, plastering for walls if 1:5 with 5 cm curing is done locally available portable water.

1.2.11. WHITE WASHING:-

White washing is done by using white cement over the plastered surface ofinternal walls to improve its appearance.

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1.2.12. WEATHERING COURSE:-

This will be in brick jelly works with lime of 40% and over which that tiles are laid in oiled mortar required slope may be maintained.

1.2.13. COLOUR WASHING:-

The color wash is applied in one or the more coats over the first coat ofwhite wash 5% of gum is added to the solution. The application is similar.

1.2.14. STEEL:-

This steel used in the design of the R.C.C member is Fe 415.

1.3. BASE ISOLATION

Base isolation, or the method of decoupling a structure from its base, and in effect from the horizontal motion produced by an earthquake. In a base isolation system, the horizontal stiffness is low enough to prevent the ground motion from being transmitted to the structure. Elastomeric base isolation systems are proven to be effective in reducing seismic forces transmitted to buildings.

Fig 1 Base isolation

Fig 2 Without base isolation

2. MATERIAL PROPERTIY

2.1. Physical Properties of Cement

Ordinary Portland cement, 53Grade conforming to IS: 269 – 1976.Ordinary Portland cement, 53Grade was used for casting all the Specimens. Different types of cement have different water requirements to produce pastes of standard consistence. Different types of cement also will produce concrete have a different rates of strength development. The choice of brand and type of cement is the most important to produce a good quality of concrete. The type of cement affects the rate of hydration, so that the strengths at early ages can be considerably influenced by the particular cement used. It is also important to ensure compatibility of the chemical and mineral admixtures with cement.

2.1.1 Specific Gravity

The density bottle was used to determine the specific gravity of cement. The bottle was cleaned and dried. The weight of empty bottle with brass cap and washerW_1 was taken. Then bottle was filled by 200 to 400g of dry cement and weighed as W_2.The bottle was filled with kerosene and stirred thoroughly for removing the entrapped air which was weighed as W_3.It was emptied, cleaned well, filled with kerosene and weighed as W_4.

2.1.2 Fineness (By Sieve Analysis)

The fineness of cement has an important bearing on the rate of hydration and hence on the rate of gain of strength and also on the rate of evolution of heat. Finer cement offers a greater surface area for hydration and hence faster development of strength. 100 grams of cement was taken on a standard IS Sieve No.9 (90 microns). The air-set lumps in the sample were broken with fingers. The sample was continuously sieved giving circular and vertical motion for 15 minutes. The residue left on the sieve was weighed.

2.1.3 Consistency

The objective of conducting this test is to find out the amount of water to be added to the cement to get a paste of normal consistency. 500 grams of cement was taken and made into a paste with a weighed quantity of water (% by weight of cement) for the first trial. The paste was prepared in a standard manner and filled into the vicatmould plunger, 10mm diameter, 50mm long and was attached and brought down to touch the surface of the paste in the test block and quickly released allowing it to sink into the paste by its own weight. The depth of penetration of the plunger was noted. Similarly trials were conducted with higher water cement ratios till such time the plunger penetrates for a depth of 33-35mm from the top. That particular percentage of water which allows the plunger to penetrate only to a depth of 33-35mm from the top is known as the percentage of water required to produce a cement paste of standard consistency.

2.1.4 Initial Setting Time

The needle of the Vicat apparatus was lowed gently and brought in contact with the surface of the test block and quickly released. It was allowed to penetrate into the test block. In the beginning, the needle completely pierced through the test block. But after sometime when the paste starts losing its plasticity, the needle penetrated only to a depth of 33-35mm from the top. The period elapsing between the time when water is added to the cement and the time at which the needle penetrates the test block to a depth equal to 33-35mm from the top was taken as the initial setting time.

2.2 Property of Fine Aggregate

Clean and dry river sand available locally will be used. Sand passing through IS 4.75mm Sieve will be used for casting all the specimens.

2.2.1 Absorption, Porosity, and Permeability

The internal pore characteristics are very important properties of aggregates. The size, the number, and the continuity of the pores through an aggregate particle may affect the strength of the aggregate, abrasion resistance, surface texture, specific gravity, bonding capabilities, and resistance to freezing and thawing action. Absorption relates to the particle's ability to take in a liquid. Porosity is a ratio of the volume of the pores to the total volume of the particle. Permeability refers to the particle's ability to allow liquids to pass through. If the rock pores are not connected, a rock may have high porosity and low permeability.

2.2.2 Surface Texture

Surface texture is the pattern and the relative roughness or smoothness of the aggregate particle. Surface texture plays a big role in developing the bond between an aggregate particle and a cementing material. A rough surface texture gives the cementing material something to grip, producing a stronger bond, and thus creating a stronger hot mix asphalt or portland cement concrete. Surface texture also affects the workability of hot mix asphalt, the asphalt requirements of hot mix asphalt, and the water requirements of portland cement concrete. Some aggregates may initially have good surface texture, but may polish smooth later under traffic. These aggregates are unacceptable for final wearing surfaces. Limestone usually falls into this category.

2.2.3 Strength and Elasticity

Strength is a measure of the ability of an aggregate particle to stand up to pulling or crushing forces. Elasticity measures the "stretch" in a particle. High strength and elasticity are desirable in aggregate base and surface courses. These qualities minimize the rate of disintegration and maximize the stability of the compacted material. The best results for Portland cement concrete may be obtained by compromising between high and low strength, and elasticity. This permits volumetric changes to take place more uniformly throughout the concrete.

2.2.4 Hardness

The hardness of the minerals that make up the aggregate particles and the firmness with which the individual grains are cemented or interlocked control the resistance of the aggregate to abrasion and degradation. Soft aggregate particles are composed of minerals with a low degree of hardness. Weak particles have poor cementation. Neither type is acceptable. The Mohs Hardness Scale is frequently used for determination of mineral hardness.

2.3 Property of Coarse Aggregate

Crushed granite aggregate with specific gravity of 2.77 and passing through 4.75 mm sieve and will be used for casting all specimens. Several investigations concluded that maximum size of coarse aggregate should be restricted in strength of the composite. In addition to cement paste – aggregate ratio, aggregate type has a great influence on concrete dimensional stability. 20mm down size aggregate was used.

2.3.1 Specific Gravity

A pycnometer was used to find out the specific gravity of coarse aggregate. The empty dry pycnometer was weighed and taken as W_1. Then the pycnometer is filled with 2/3 of coarse aggregate and it was weighed as W_2. Then the pycnometer was filled with part of coarse aggregate and water and it weighed as W_3. The pycnometer was filled up to the top of the bottle with water and weighed it as W_4.

2.3.2 Bulk Density

Bulk density is the weight of a material in a given volume. It is expressed in Kg/m^3.A cylindrical measure of nominal diameter 250mm and height 300mm was used. The cylinder has the capacity of 1.5 liters with the thickness of 4mm. The cylindrical measure was filled about 1/3 each time with thoroughly mixed aggregate and tampered with 25 strokes. The measure was carefully struck off level using tamping rod as straight edge. The net weight of aggregate in the measure was determined. Bulk density was calculated as follows.

Bulk density = (Net weight of coarse aggregate in Kg)/ (Volume)

2.3.3 Surface Moisture

100g of coarse aggregate was taken and their weight was determined, say W_1. The sample was then kept in the oven for 24 hours. It was then taken out and the dry weight is determined, says W_2. The difference between W_1 and W_2 gives the surface moisture of the sample.

2.3.4 Water Absorption

100g of nominal coarse aggregate was taken and their weight was determined, say W_1. The sample was then immersed in water for 24 hours. It was then taken out, drained and its weight was determined, says W_2. The difference between W_1 and W_2 gives the water absorption of the sample.

2.3.5 Fineness Modulus

The sample was brought to an air-dry condition by drying at room temperature. The required quantity of the sample was taken (3Kg). Sieving was done for 10 minutes. The material retained on each sieve after shaking, represents the fraction of the aggregate coarser then the sieve considered and finer than the sieve above. The weight of aggregate retained in each sieve was measured and converted to a total sample.

3. PREPARATION OF SPECIMENS

The concrete is casted in to cube moulds of size 100mm×100mm,beam moulds of size 100×100×500mm and cylindrical moulds of 200 mm height×150 mm dia. The moulds used for the purpose are fabricated with steel seat. It is easy for assembling and removal of the mould specimen without damage. Moulds are provided with base plates, having smooth to support. The mould is filled without leakage .In assembling the moulds for use joints between the section of the mould are applied with a thin coat mould oil and similar coating of mould oil is applied between the contact faces of mould and the base plate to ensure that no water escape during filling .The interior surfaces of the assembled mould shall be thinly coated with mould oil to prevent adhesion of concrete.

Fig 2 Moulds

4.1 PLACING OF MIX IN MOULDS

After mixing the proportions in the mixing machine, it is taken out into the bucket. The concrete is placed in to the moulds (cubes, beams & cylinders), which are already oiled simply by means of hands only.

Fig 3 -Mixing of concrete

Fig 4 -Placing of mix in moulds

5. HAREDENED CONCRETE TESTS

5.1COMPRESSIVE STRENGTH

The cubes were tested in the compression testing after proper curing. The failure load obtained from C.T.M. machine and the results are tabulated below. The values for 3 types of mixes were calculated as follows.

Formula used = (p x 1000)/(150 x150) N/mm2
Where p = failure load (from dial gauge of C.T.M.) in Kn

Compressive strength reading for conventional concrete (3days)

S.NO	Description	Specimen1	Specimen2	Specimen3
1	Concrete mix designation	M_{20}	M_{20}	M_{20}
2	Curing time (days)	3	3	3
3	C/S area of specimens(mm)	150 × 150	150 × 150	150 × 150
4	Breaking load	180KN	200KN	160KN
5	Compressive strength, (N/mm^2)	8.00	8.88	7.11

Table no. 5.1.1.1 Average compressive strength = 7.9N/mm^2

Compressive strength reading for conventional concrete(7days)

S.NO	Description	Specimen1	Specimen2	Specimen3
1	Concrete mix designation	M_{20}	M_{20}	M_{20}
2	Curing time (days)	7	7	7
3	C/S area of specimens(mm)	150 × 150	150 × 150	150 × 150
4	Breaking load	320KN	340KN	360KN
5	Compressive strength, (N/mm^2)	14.2	15.11	16

Table no. 5.1.1.2 Average compressive strength = 15.11N/mm^2

Compressive strength reading for conventional concrete(28days)

S.NO	Description	Specimen1	Specimen2	Specimen3
1	Concrete mix designation	M_{20}	M_{20}	M_{20}
2	Curingtime (days)	28	28	28
3	C/Sareaofspecimens (mm)	150 × 150	150 × 150	150 × 150
4	Breaking load	650KN	630KN	610KN
5	Compressive strength, (N/mm^2)	28.88	28.0	27.11

Table no. 5.1.1.3 Average compressive strength = 27.97N/mm^2

Fig. 5- C.T.M. Test Fig.

Fig 6 - C.T.M. cube failure

5.2 TENSILE STRENGTH

The Cylinders were tested in the compression testing machine after curing and the results are tabulated below. Four cylinders with M20 MIX proportion were casted and after curing the specimens were tested.

The size of cylinder is 150 mm dia and 300 mm height.

Formula used:

Tensile strength = (2 x p) / (3.14 x l x d)

Where,

P = Failure load (Kn)

L = ht. of cylinder

D = Dia of cylinder

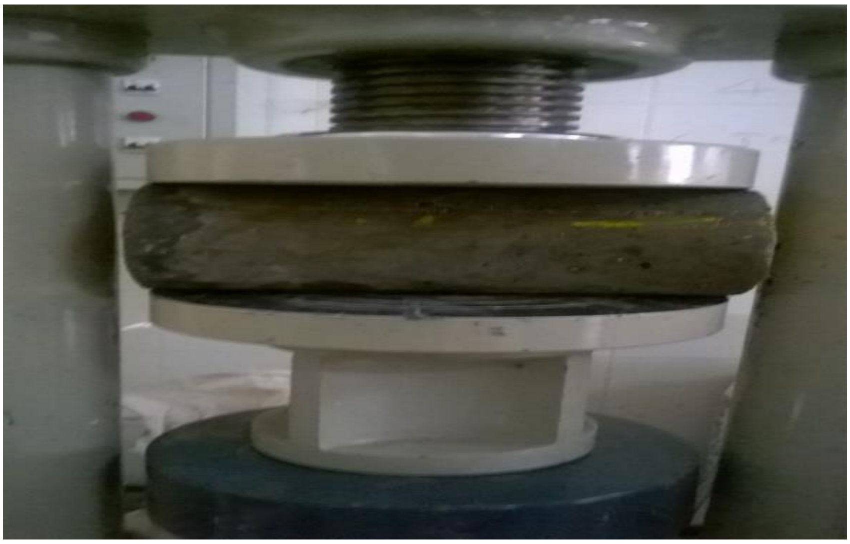

Fig. 7 Tensile Test at 7 Day

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Fig. 8 Failure pattern

SL. NO	SPECIMEN	HEIGHT (L) mm	DIA (D) mm	LOAD AT FAILURE (P in kN)		TENSILE STRENGTH (N/mm^2) STRENGTH		
				CYL 1	CYL 2	CYL 1	CYL 2	AVG
1	conventional concrete (7 days)	300	150	120	132	1.70	1.87	1.78
2	conventional concrete(28 days)	300	150	316	328	4.47	4.64	4.56

Table 5.2.1 -Tensile strength using spilt tensile test

Fig 9- Standard Beam

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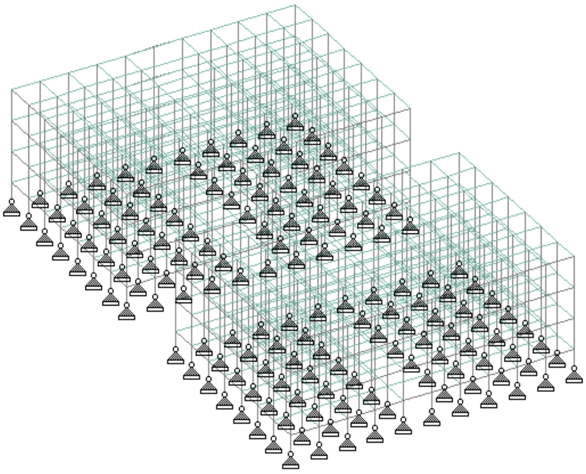
FLEXURAL STRENGTH VALUES

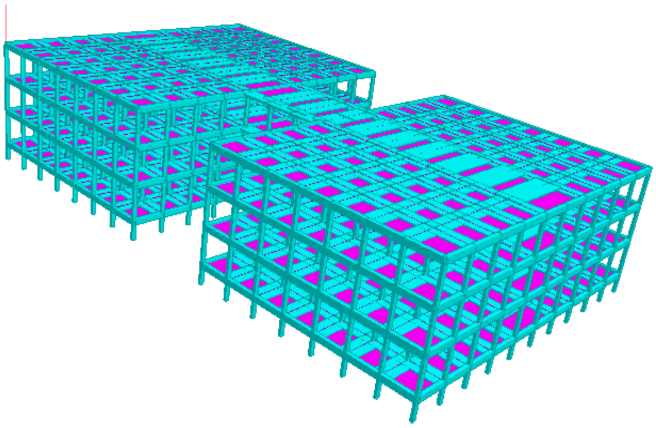
SL.NO	SPECIMEN	BEAM SIZES(cm)			LOAD		a	f_b
		L	B	D	in Kg	in Kn	cm	Kg/cm^2
1	conventional concrete (7 days)	60	20	15	3658	36.58	18	43.90
1	conventional concrete (28 days)	60	20	15	4300	43	20	57.33

Table.5.3.1Flexural strength

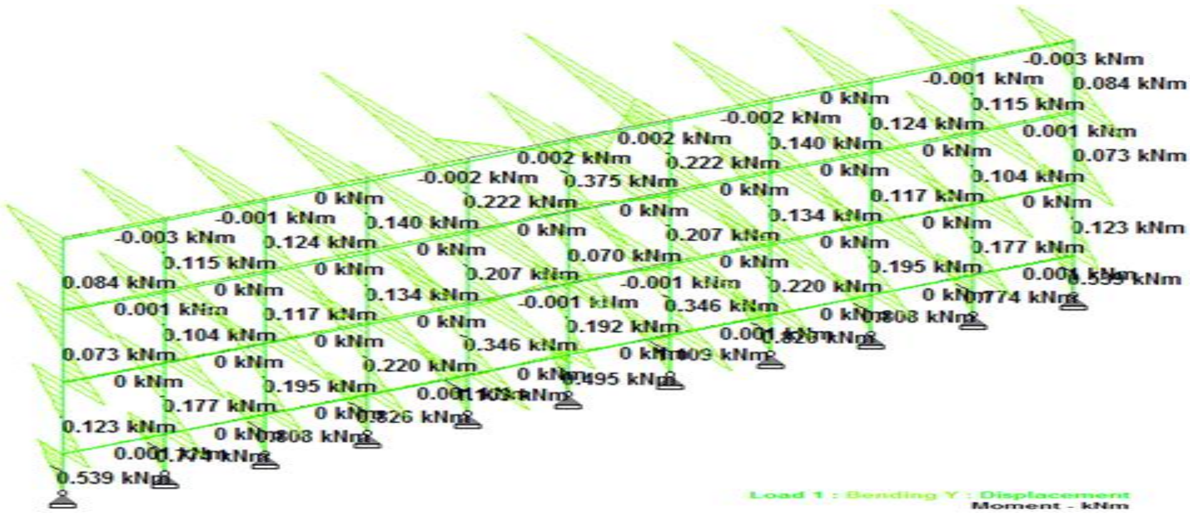
STAAD.PRO ANALYSIS



2D view



3D view



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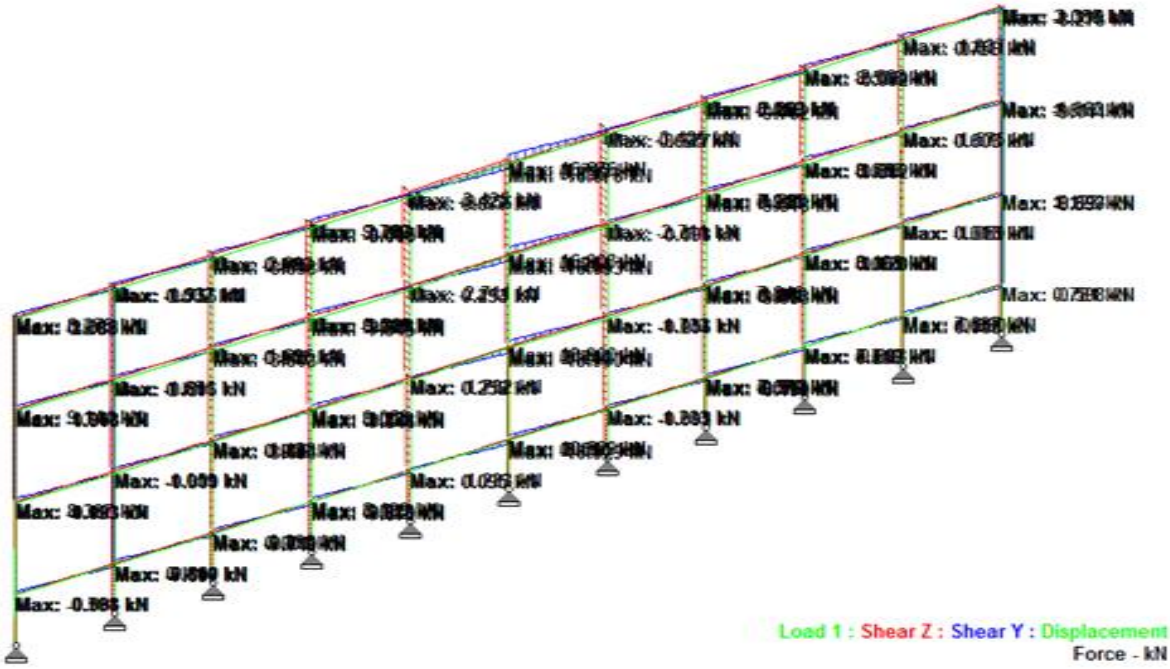
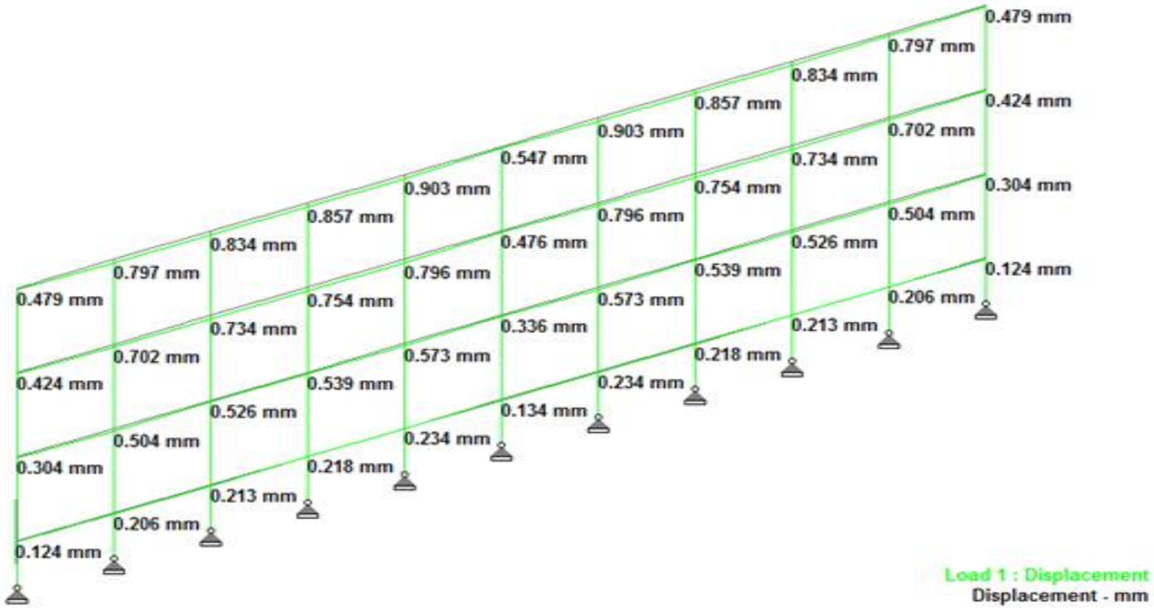
BENDING MOMENT DIAGRAM



SHEAR FORCEDIAGRAM



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CONCLUSION

The necessary drawing for reinforcement details was prepared using AutoCAD software. Designing using Software's like Staad reduces lot of time in design work. Details of each and every member can be obtained using staad pro.All the List of failed beams can be obtained and also Better Section is given by the software.Accuracy is improved by using software.By doing this project to draw and prepare for a "DESIGN AND ANALYSIS OF H-TYPE EARTHQUAKE RESISTANCE BUILDING USING ISOLATION TECHNIQUE BY STAAD PRO SOFTWARE" we also now have a rough idea about the various books available in design of R.C.C members.The design was done by the following the provisions of IS 456:2000, IS 875: PART-III; SP-16.

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