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OPTIMUM LOCATION OF SHEAR WALL IN A MULTI-STOREY BUILDING SUBJECTED TO SEISMIC BEHAVIOR USING GENETIC ALGORITHM

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Abstract - *GA is an iterative optimization process. Instead of working with a single solution in every iteration, it works with a number of solutions (populations) and there working follows the techniques of natural genetics and natural selection. It allows both continuous and discrete design variables. GAs is easy in calculation however strong in their investigation for development. This study proposes to present a procedure and application of software for optimum positioning of reinforced concrete walls called shear wall in a multi-storey structures subjected to seismic behavior using Genetic Algorithms. The study is related with optimization of the location of shear wall with Genetic Algorithm (GA,) which is coded in MATLAB and the objective is analyzed in ETAB2015 software. The main aim of the work is to minimize the lateral displacement of the multistory storey building with shear wall subjected to earthquake load. The work suggests the idea to optimize the input variables. Present work will be done to find the optimum position of shear wall in a multi-storey structure and the building will be analyzed for various positioning of reinforced concrete walls (shear walls) for finding the constraints such as lateral displacement using equivalent static method which are carried out as per IS: 1893 (part 1)-2002 using finite element analysis software ETABS2015 for earthquake zone V in India and MATLAB for Genetic Algorithm. The present work contains six different models; first model has the building without shear wall and remaining five models have the buildings with shear wall at different locations.*

Key Words: Multi-storey building, Shear wall location, Equivalent static method, Lateral displacement, Genetic Algorithm, ETAB2015 and MATLAB etc…

1. INTRODUCTION

It has always been a human desire to create taller and taller structures so in recent days there is a considerable increase in the high rise buildings and the modern development is headed for more tall and slender structures. Every structural engineer is met with the problem of giving sufficient strength and stability of these tall buildings against lateral load thus the effect of lateral loads like wind loads, earth quick loads and blast forces are attaining escalating importance. For the reason of the accessibility and availability of developed software in engineering design activities, optimization algorithms are becoming more popular. Wide applications of this kind of software are in the design engineering problems where a specific goal is to minimize or maximize a certain parameters. Design engineers need to design buildings, bridge, dams and other structures, in these design process it is necessary to reach a maximum protection or minimum rate or both, so in these cases optimization algorithms have wide applications. Optimization technique plays a main role in reaching economy, which is an important factor next only to safety. Optimization of Complex buildings is very difficult when variable interaction increase. GA is famous for handling global optimization problems when several local optimal are presenting a non-continuous fitness landscape. GAs is a type of optimization algorithms they are used to find the optimal solution to a given computational problem that maximizes or minimizes a particular function and these are function optimizers.

1.1 Objective of the Study

The most important objectives of present study include:

- To analyze the multi-storey building with shear wall using Equivalent static method.
- Make the objective function to minimize the lateral displacement of the multi-storey building during earthquake.
- Optimum location effects of shear wall in multi-storey building which are subjected to lateral loads.

2. MODELLING AND ANALYSIS

Current work includes study on lateral loads which is done as stated in the seismic code IS 1893 (Part-1):2002 for the shear walled building models. Optimum location of shear wall is found by using MATLAB programming software. To carry out a structural optimization with MATLAB Genetic Tool a structural analysis program is coded in MATLAB. Analysis program is done on the bases of the well known matrix displacement formulations. For coding, most convenient feature of MATLAB is used to divide the program in many parts. Therefore the program comprises of many distributed m files. These files are responsible of reading data, developing stiffness matrices, calculating element forces and deflection of nodes and visualizing the deformed and undeformed structure. To create 3D models and to carry out all analysis ETABS2015 nonlinear software is used.

For this work, (G+10) storey building with a 3 meter height for every storey, with plan 40mx40m is taken. Building has eight bays of 5m in both X and Y directions. Building material properties are given in table-1 below

In this problem the lateral displacement is taken as objective function. The objective function of our problem is to minimize the lateral displacement of the building. This is an unconstrained problem.

The input for genetic algorithm are programmed as,

1. Number of variables of objective function,
2. Number of generations,
3. Number of individuals per sub-population,
4. Name of selection function: In selection, we have considered roulette wheel selection (rws).
5. Name of cross over function: For crossover we have considered general multi-point crossover (Xovmp).
6. Name of mutation function: In this, we have considered discrete mutation function (mut).
7. The program is joined with analysis program and genetic algorithm program to calculate the objective fitness in MATLAB.
8. The operators of genetic algorithm are selection of fit individuals; crossover and mutations are formulated in the program.
9. The generations are continued until all the constraints and the objective function are satisfied.

Table -1: Building Description

PARTICULARS	RCC STRUCTURE
Young's modulus of M20 concrete, E	$22.36x10^6 kN/m^2$
Grade of concrete	M_{20}
Grade of steel	Fe415
Density of Reinforced Concrete	$25\ kN/m^3$
Modulus of Elasticity of Brick Masonry	$2100x10^3 kN/m^2$
Density of Brick Masonry	$20\ kN/m^3$
No of Storey	G+10
Beam size	0.25m x 0.45m
Column size	0.6m x 0.6m
Slab thickness	0.125m
Shear wall thickness	0.4m
Wall thickness	0.25m
Height of all storeys	3m
Seismic zone	V
Soil type	Medium soil
Importance Factor(I)	1
Response Reduction Factor(R)	5

2.1 Building Models

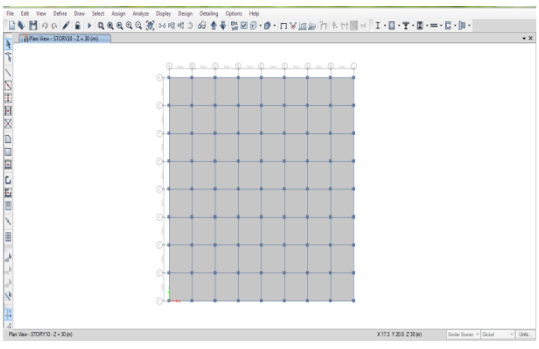

Fig -1: Model-1 Building without Shear wall

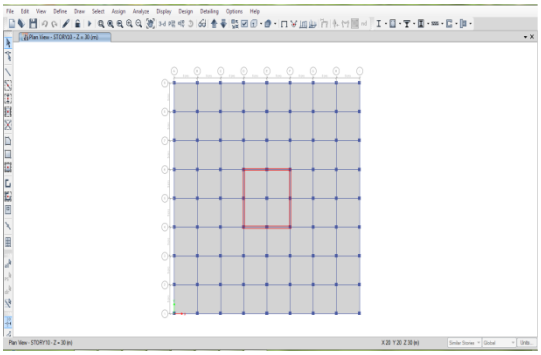

Fig 2: Model-2 Building with optimized location of Shear wall

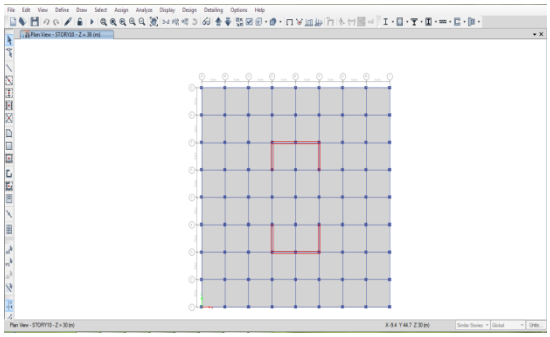

Fig 3: Model-3 Building with optimized location of Shear wall

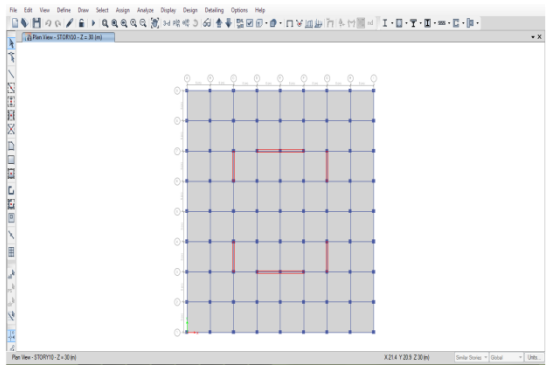

Fig 4: Model-4 Building with optimized location of Shear wall

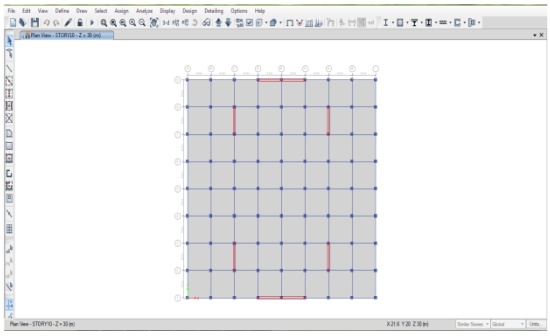

Fig 5: Model-5 Building with optimized location of Shear wall

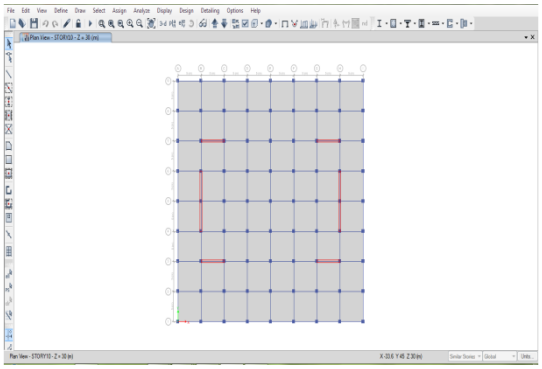

Fig 6: Model-6 Building with optimized location of Shear wall

3. RESULTS

Storey displacement for different shear wall building models obtained from equivalent static analysis method is shown below gives the value of storey displacement in mm.

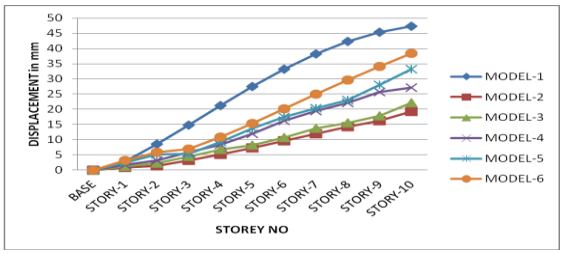

Chart -1: Storey Displacement using Equivalent Static Method along X-Direction

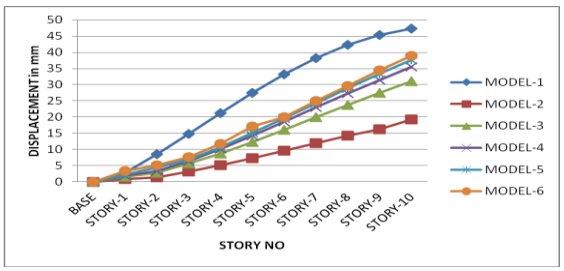

Chart -2: Storey Displacement using Equivalent Static Method along Y-Direction

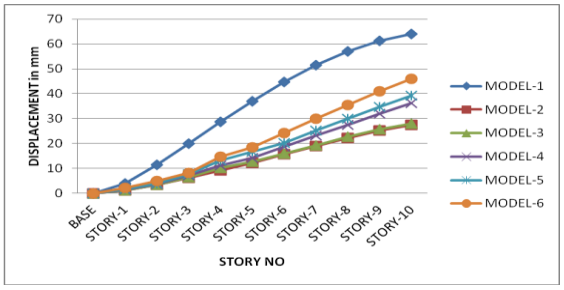

Chart -3 Storey Displacement using Equivalent Static Method for 1.2(DL+LL+EQX)

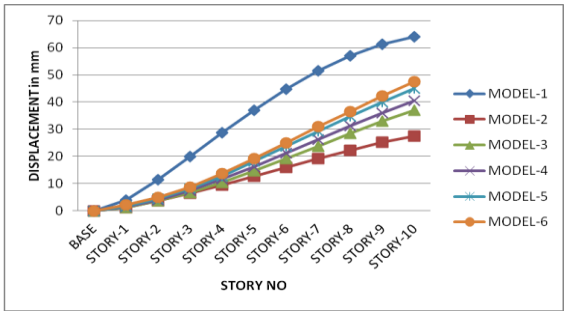

Chart -4 Storey Displacement using Equivalent Static Method for 1.2(DL+LL+EQY)

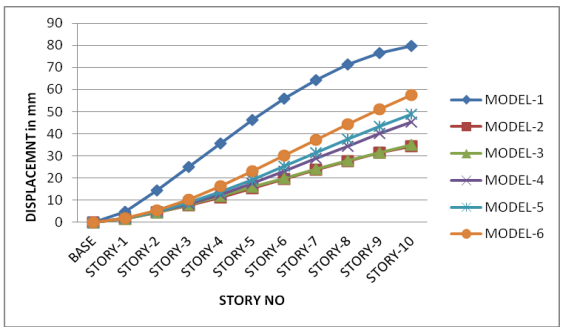

Chart -5 Storey Displacement using Equivalent Static Method for 1.5(DL+ EQX)

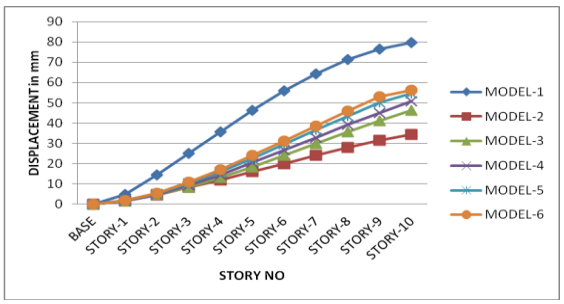

Chart -6 Storey Displacement using Equivalent Static Method for 1.5(DL+ EQY)

4. CONCLUSIONS

Based on the above results from analysis of the different building models, following conclusions may be made:

- It is observed from the above analysis that the displacement observed in first model, which is without shear wall building shows maximum displacement compared to the remaining models having shear wall at different locations.
- The best location of shear in multi-storey building obtained from the application of genetic algorithm is in model-2 i.e. near the core of the building.
- It is also seen from the study that the Genetic Algorithm linked to the design rule provides an automotive way of structural analysis procedures, which can be readily used by practicing designers.
- Finally it is concluded that, optimization using genetic algorithm is a best procedure for finding best solution among several solution, in present work model-2 shows best place of shear wall in (G+10) building. By providing shear wall to the high rise buildings, Structural seismic behavior will be affected to a great extent and also the stiffness and the strength of the buildings will be increased.

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