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A Study on Performance of Steel Buildings

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***Abstract*--Steel buildings are made up of structural steel sections. In codal method of design, the buildings are designed through prescriptive suggestions of the design code. In such design procedure, it is not possible to regulate the performance of the buildings. However, by choosing suitable sections, it is possible to achieve target performance in steel buildings. In the present study three sample buildings have been considered for IO, LS and CP performance levels. The performance of the designed building have been found out by carrying out pushover analysis and nonlinear time history analysis. It has been found that three buildings satisfied the target performance criteria.**

I. INTRODUCTION

Performance Level: It indicates the state of damage of the structure .in other words, the plastic rotation is an indicator of amount of damage level.

The performance level are three types:Immediate occupancy level (IO), Life Safety (LS)& Collapse prevention (CP)These levels are discrete points on a continuous scale describing the building‘s expected performance, or alternatively, how much damage, economic loss, and disruption may occur. Each Building Performance Level is made up of a Structural Performance Level that describes the limiting damage state of the structural systems .

Immediate occupancy level (IO):The post earthquake damage state in which only very limited structural damage has occurred.The basic and vertical and lateral force resisting systems of the buildingretain nearly all of their pre – earthquake strength and stiffness. The risk of threatening injury as a result of structural damage is very low.

Life Safety (LS)*Structural Performance Leve;, Life Safety, means the post-earthquake* damage state in which significant damage to the structure has occurred, but some margin against either partial or total structural collapse remains. Some structural elements and components are severely damaged, but this has not resulted in large falling debris hazards, either within or outside the building. Injuries may occur during the earthquake; however, it is expected that the overall risk of life-threatening injury as a result of structural damage is low. It should be possible to repair the structure; however, for economic reasons this may not be practical.

Collapse Prevention Performance Level(CP): Structural Performance Level S-5, Collapse Prevention, means the building is on the verge of experiencing partial or total collapse. Substantial damage to the structure has occurred, potentially including significant degradation in the stiffness and strength of the lateral force resisting system, large permanent lateral deformation of the structure and to more limited extent degradation in vertical-load-carrying capacity. However, all significant components of the gravity load resisting system must continue to carry their gravity load demands. Significant risk of injury due to falling hazards from structural debris may exist. The structure may not be technically practical to repair and is not safe for reoccupancy, as aftershock activity could induce collapse.

Performance point (PP): Indicates the damage state for which building is to be desigined. The displacementat (pp) is the target displacement (Δt) also called design displacement(Δd).

To know the performance of the building we need to know the performance point.

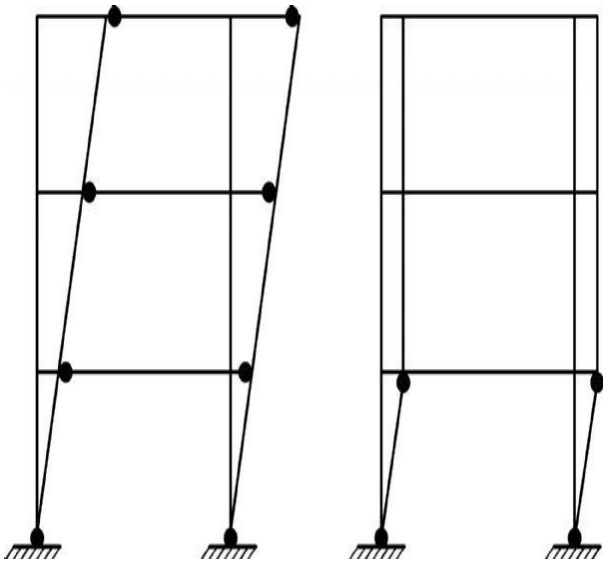
If$\Delta_{pp} < \Delta_{IO}$, it implies IO building.

$\Delta_{pp} > \Delta_{IO}$ &< Δ_{LS} , LS building.

$\Delta_{pp} > \Delta_{LS}$ &< Δ_{CP}, CP building.

For example , the performance point (pp) of **(IO)** building**AI5** is **178.261 (mm)**acc to **FEMA 440** displacement modification.

Drift:It is the displacement of one level relative to each other level above or below.



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$\boldsymbol{\Delta i}$ = amount of sway in the floor,$\boldsymbol{\Delta_{i+1} - \Delta_i}$=difference in sway (storey drift)

$\frac{\Delta_{i+1}-\Delta_i}{h}$= storey drift ratio

Plastic Hinge: Is a zone of yielding due to flexure in a structural member although hinges do not actually form .it can be seen that large changes of slope occur over all small length of members at position of maximum moments.A strain hardening action occurs at these hinges so that large deflection are accompined by slight increase in load.therefore the plastic hinge can be defined as ayeilded zone due to flexural in a structure in which infinite rotation can take place at aconstant restraining moments Mp of section.

Push over analysis: Is a static nonlinear analysis underpermanenet vertical loads and gradually increasing lateral loads.A plot of total base shear verses top displacement in structure is obtained by this analysis that would indicate any premature failure or weakness.The analysis is carried out upto failure ,thus it enabels determination of collapse load and ductility capacity.On abuilding frame ,load/displacement is applied incrementally,the formation of plastic hinges,stiffnessdegradation,and plastic rotation is monitored and lateral inelastic force verses displacement response for the complete structure .

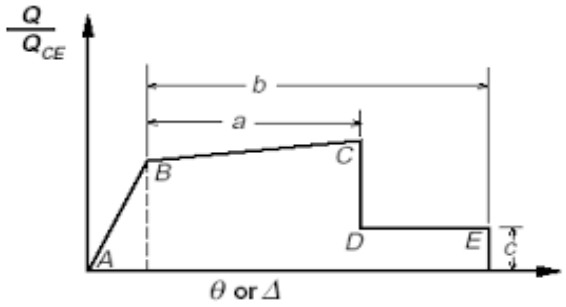
Non Linear Time History Analsis:Is the method describe the actual behaviour of the structure during an earthquake .this method is based on direct numerical integration of the motion differential eqs by considering the plastic deformation of structure element.this method capture the effect of amplification due to resonance, the vibration of displacements at diverse levels of a frame , an increase of motion duration and a tendancy of regularization of movements result as far s the level increase from bottom to top.this method when used,shall be based on an appropriate ground motion and shall be performed using accepted principels .the value of damping for a building may be taken and 2% .

Fema Model: Gives the generalised load deformation curve parameters a,b,& c are plastic rotations. As shown in below fig.

Where Q=generalised component load .

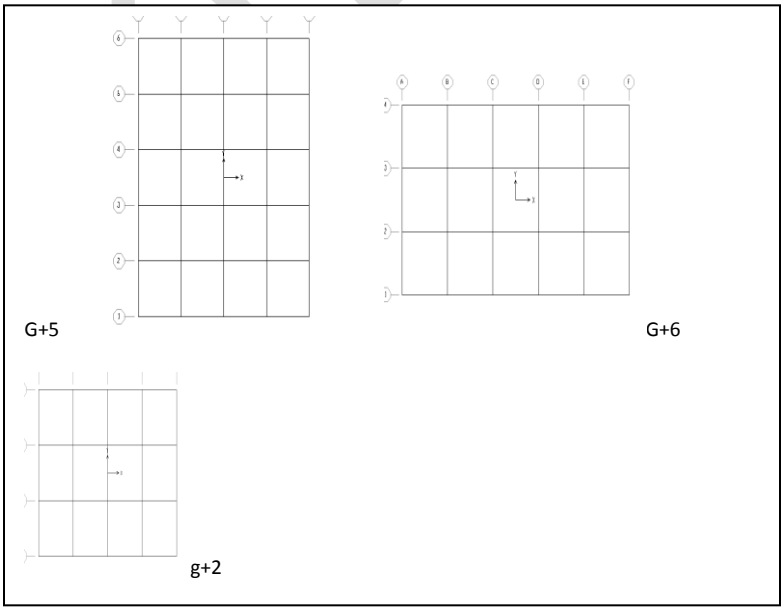
Θ=total elastic & plastic rotation of beam or coloum.

Δ=total elastic and plastic deformation.



II.PRESENT WORK

Building Plans considered:



Building Name	Target Performance objectives		Achieved performance	
	PL	Drift	PL	Drift
AI5	IO	1%	IO	0.95%
BII6	IO	1%	IO	0.85%
CIII2	LS	2%	LS	1.87%

TABEL 1- Member sizes considered:

BUILDINGTYPE	BEAM	COLOUM
AI5	ISMB 500	ISHB 400
BII6	ISMB 400	ISHB 450
CIII2	ISMB 300	ISWB 500

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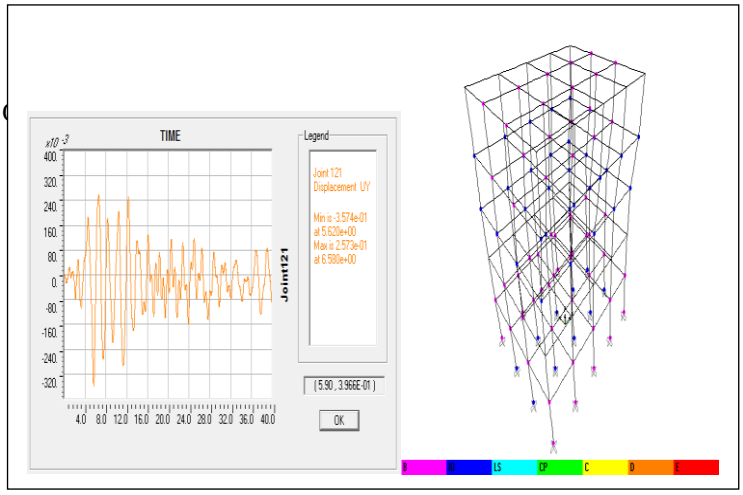
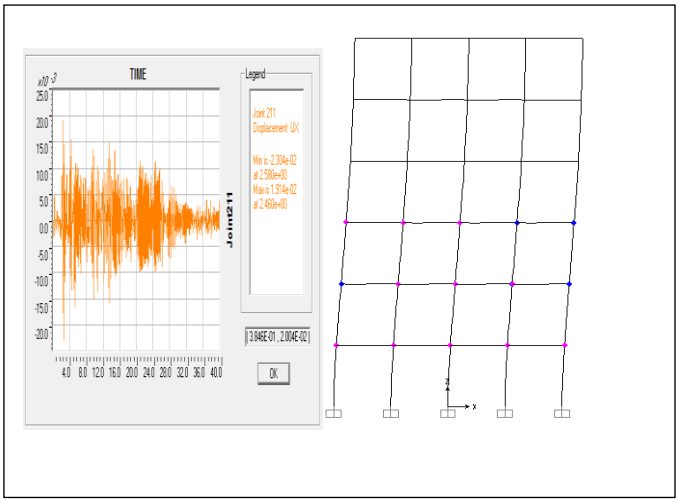
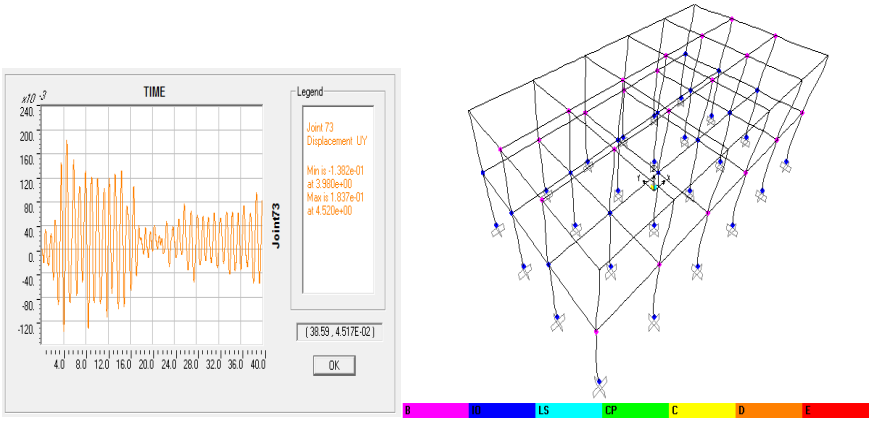
Roof displacement history:

AI5:drift in TY dir:257.3mm@6.580sec,joint 121BII6: drift in TX dir:19.41mm@2.46sec,joint 211.





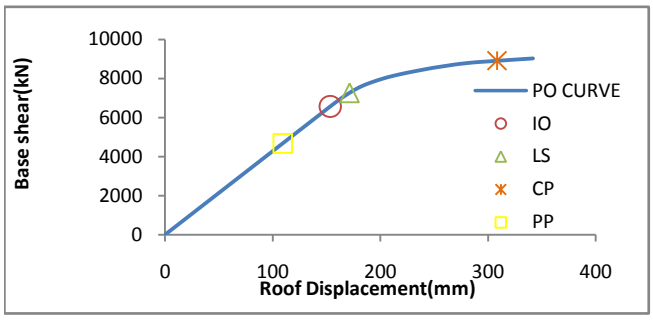
CIII2:drift in TY dir:183.7mm@4.52s@joint 73



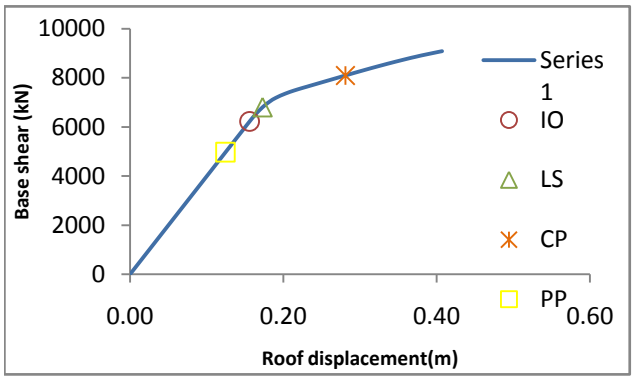
POC in short and long directions

Hinge diagram at PP

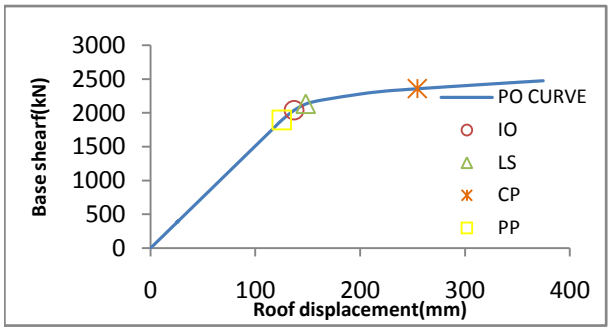
AI5



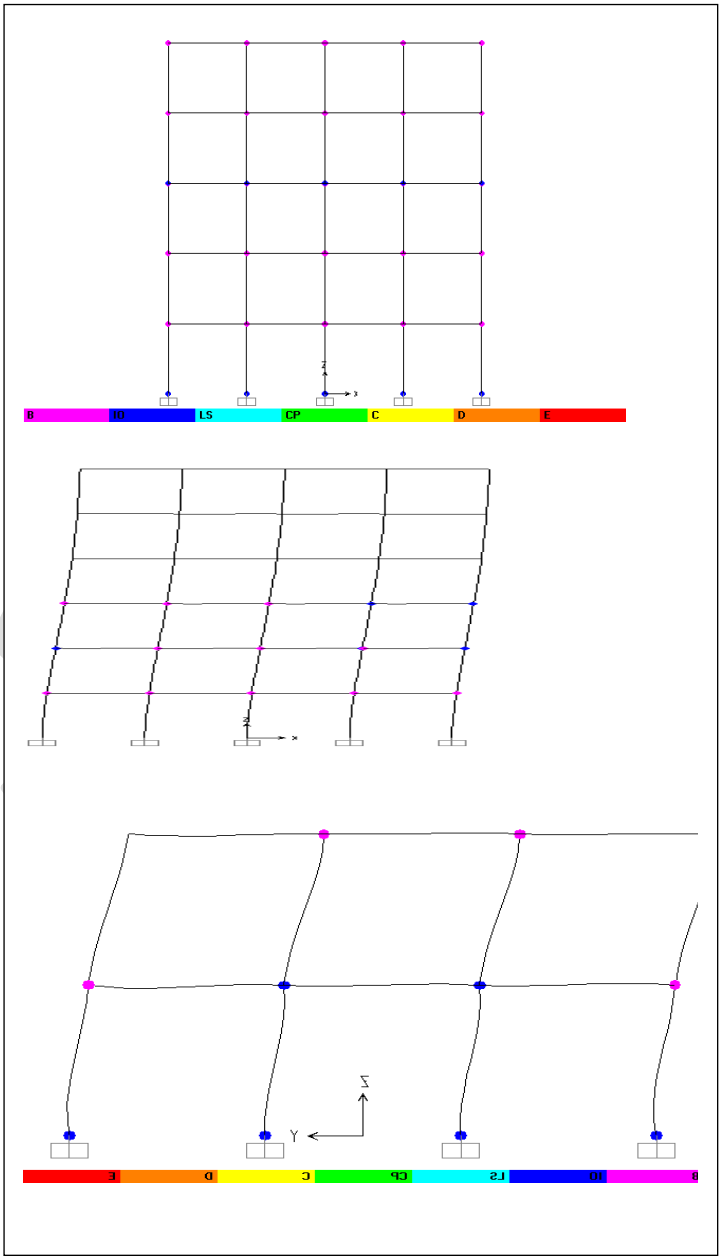
BII6



CIII2



Hinge diagram at PP



CONCLUSION

The steel buildings can be designedfor given target objectives by using suitable size of members.Such buildings are found to achieve the desired performance levels and target drift.

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