Seismic Analysis on Shear Wall with Non-Prismatic Coupling Beam

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***Abstract*— In high and medium rise structures to resist lateral forces, coupled shear walls are one of the systems commonly used. In multistory building should not collapse or is induced severe damage during earthquake actions so, for this reason coupled shear walls are used. It should be having high strength, high ductility, high energy absorption capacity and high shear stiffness to limit lateral deformations. The aim of this work is to find out the effect of lateral loads on building having shear wall with prismatic and non-prismatic coupled beam. Non prismatic beam used are stepped haunch cubical, haunch and parabolic haunch, then compare the behavior these beams on the buildings are studied Analysis is done by using ETABS'15 software for static and dynamic case.**

Keywords*— Coupled shear walls, coupling beam, non prismatic beam, coupling ratio.

I. INTRODUCTION

In last few years the widespread damage to reinforced concrete building during earthquake generated demand for seismic evaluation and retrofitting of existing buildings in Indian subcontinents. In addition, most of our buildings built in past decades are seismically deficient because of lack of awareness regarding structural behavior during earthquake and reluctance to follow the code guidelines. Due to scarcity of land, there is growing responsiveness of multistoried reinforced concrete structures to accommodate growing population. In developing countries, multi-storied buildings are generally provided with shear wall. Structural engineers should design the structures in such a way that the structural systems perform their functions satisfactorily and at the same time the design should prove to be economical.

A coupled shear wall is a structure composed of two secluded or isolated shear walls that are connected by beams or slabs in height wise manner. Normally, shear walls are incorporated with openings, just to allocate elevator doors, windows, shafts, stairwells, service ducts in the buildings which are unavoidable. Thus the walls on each side of opening must be coupled either by beams or by floor slabs or by combination of both the elements. The beams used for coupling the isolated walls are called coupling beams. The overriding purpose of the coupling beams is to assemble the walls and make them act as a single composite cantilever unit. Consequently, the horizontal stiffness is also improved when compared to the uncoupled shear walls. An extensive research from past shows that the coupled shear walls are the prolific systems and could outlast in any kind of circumstances just by the introduction of a coupling beam. This introduction of coupling beam effectively increases the axial forces, thereby reducing bending moments in the walls and also the lateral deflection in the structures. And the performance of the coupled shear wall is decided by the combined action of shear and flexure.

Members that do not have the same cross sectional properties from one end to the other are called Non-prismatic members. Members having reinforcement over parts of their lengths and members that do not have a straight axis are also known as Non-prismatic members. The most common forms of structural members that are non-prismatic have haunches that are either stepped or tapered or parabolic in shape. Non-prismatic members can be used to shape the members in accordance with the distribution of the internal stresses. By using these types of members, one can achieve the required strength with the minimum weight and material and also may satisfy architectural or functional requirements. In industrial buildings, bridges, and high rise buildings, non-prismatic members with constant, linear, and parabolic height or width variations are commonly used. Different approaches have been developed for the analysis of prismatic member.

II. OBJECTIVES

- To optimize of haunch length of non-prismatic coupled beam (stepped beam, parabolic haunched and linear haunched).
- To determine the performance of non-prismatic coupled beam with stepped, parabolicnand linear haunched.

III. METHODOLOGY

Methodology employed is response spectrum method of analysis.

A. Modelling of Building

Here the study is carried out for the behaviour of G+19 storied building with coupled shear wall at four corners.and also the coupling beam replaced with non-prismatic section with stepped beam, parabolic haunched and linear haunched. Floor height provided as 3m. The modeling of buildings was created in ETABS software.

B. Building Plan

A building of plan 20m x 20 m(i.e. 400m^2) is considered with G+15 storey in zone V. A medium soil stratum is considered at the location.

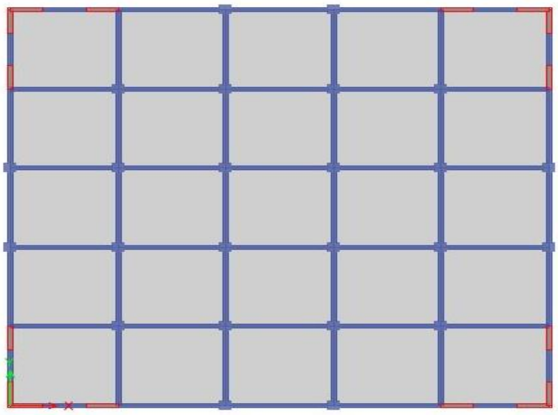

Fig.1 plan of building

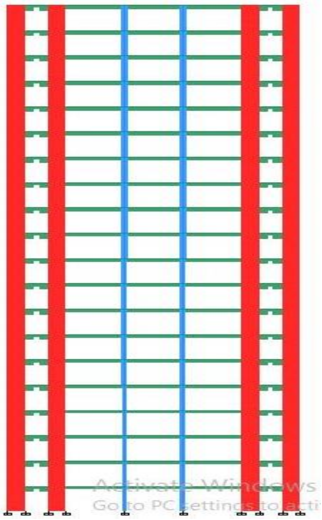

Fig.2 Elevation of stepped haunched coupling beam

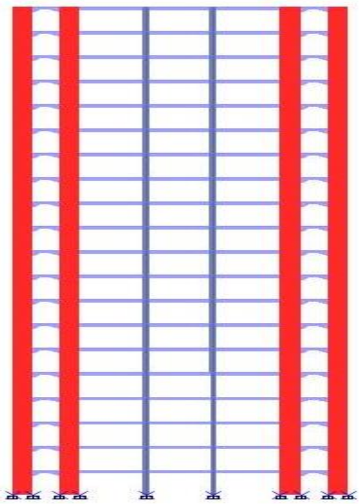

Fig.3 Elevation of parabiolic haunched coupling beam

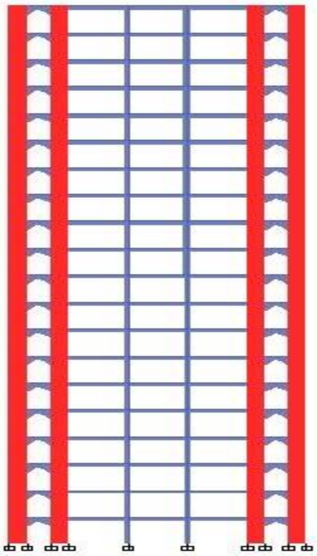

Fig.4 Elevation of limear haunched coupling beam

C. Loads considered

The loads considered for the present study is given in Tables

Table 1

Dead load and live load data

Live Load	4 kN/m^2
Roof Live Load	1.5 kN/m^2
Floor Finish	1 kN/m^2

Table 2

Earthquake load data

Seismic zone	III
Soil Type	Medium (Type - 2)
Zone Factor ,Z	0.16
Importance factor ,I	1
Response reduction factor, R	5
Damping Ratio	5%

D. Optimization of Haunch Length

For optimizing the L_h/L ratio, different ratios were considered and modeled in RC Frames and the response spectrum analysis was conducted. The value of h_{max}/h_o kept constant as 2. The displacement, drift, storey stiffness values were used to determine the most optimized section. For optimization the regular R C frame with the stepped haunch coupling beam was considered and length of coupling beam (L) as 2m.

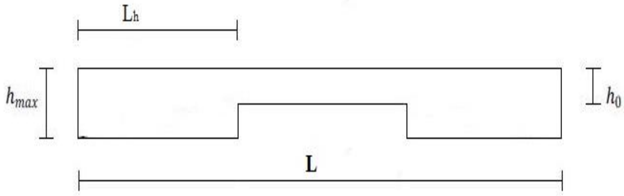

Fig.2 Optimization of Haunch Length

Table 3
Optimization Result

HAUNCH LENGTH (L_H)	L_H/L	MAX. STOREY DISPLACEMENT (MM)	STOREY STIFFNESS (KN/M)	TIME PERIOD (S)	STOREY DRIFT
0.5	0.25	16.49	1742176	2.536	0.000329
0.6	0.30	16.34	1847541	2.52	0.000321
0.8	0.35	16.2	1933359	2.509	0.000315
0.9	0.40	16.08	1993125	2.501	0.0003

The most effective L_H/L was found out by conducting response spectrum analysis and it was minimum displacement, storey drift and time period. Ans also maximum storey stiffness. For given condition most optimized section where haunch length as 0.8m(ie L_H/L=0.4). similarly for the other two non prismatic beam also.

IV. COMPARISON OF RESULTS

After analysing the results obtained then it will be compared and find the seismic performance of the building with different non-prismatic beams for the haunch length of 0.8m.

Table 4
Comparision Result

Haunch Type	Time period(s)	Maximum storey displacement (mm)	Storey drift	Stiffness (KN/M)
Stepped	0.4	15.56	0.0003	2489901
Linear	0.395	15.73	0.0003	2304946
Parabolic	0.394	15.78	0.0003	2261666

A. Displacement

Fig.5 Comparison of Maximum Lateral Displacements.

Displacement is minimum for non-prismatic coupling beam with stepped haunch.

B. Storey Drift

For R.C.C, the minimum storey drift for there type haunched beam is within the limit and very less in stepped haunched section.

Fig.6 Comparison of Maximum Storey Drift

C. Stiffness

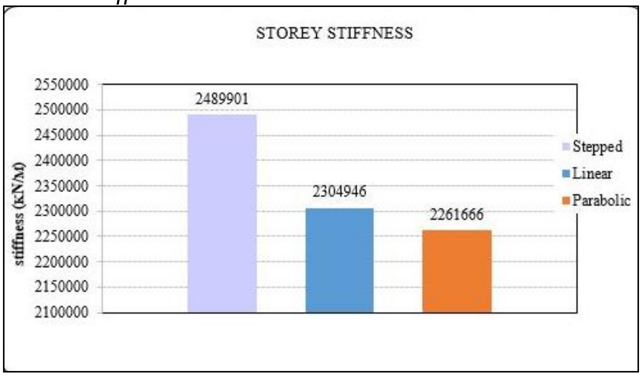

Fig.7 Comparison of Stiffness

From Fig. 7it is clear that storey stiffness is higher in building with stepped haunch. Lower value for parabolic haunch.

D. Fundamental Time Period

E.

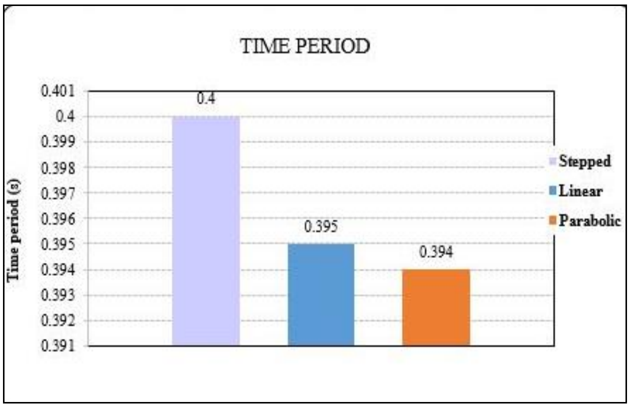

Fig.8 Comparison of Time period

First fundamental timeperiod for the modal analysis result maximum for stepped beam.

VI. CONCLUSIONS

Analytical study has been conducted to understand the behavior of non-prismatic member as coupling beam. ETABS software is used to carry out the analysis. In this stepped beam has most effective as comparing the values of time period, stiffness, storey drift and lateral displacement. Then comparing the linear and parabolic haunched beam linear haunched beam more efficient in response spectrum analysis

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