Analysis And Design of RCC Hospital Building Subjected To Seismic Forces By Using The NDMA of India Guidelines

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Abstract- *The NDMA guidelines on Hospital Safety have been developed with the vision that all hospitals in India will be structurally and functionally safe from disasters, such that the risks to human life and infrastructure are minimized. The main goal during earthquakes is to assure that building collapse doesn't occur and the risk of death or injury to people is minimized and beyond that to satisfy post-earthquake performance level for defined range of seismic hazards. Also seismic evaluation will determine which are the most vulnerable and weak components and deficiencies of a building during an expected earthquake. In the present work, existing G+6 Multistoried Hospital Building has been analyzed. To compare the parameters like Base shear, story drift and storey displacements. The seismic rehabilitation process aims to improve seismic performance, story displacement, story drift correct the deficiencies by increasing strength, stiffness and improving connections. Thus, a proposed retrofit implementation can be said to be successful if it results an increase in strength and ductility capacity of the structure which is greater than the demands imposed by earthquakes. It was then decided to implement RCC column jacketing technique due to its feasibility and ease for execution.*

Keywords- Base shear, Story Drift, Story Displacement, Joint displacement.

I. INTRODUCTION

The guidelines on Hospital Safety have been developed with the vision that all hospitals in India will be structurally and functionally safe from disasters, such that the risks to human life and infrastructure are minimized. The overall aim of the guidelines is to mainstream disaster prevention, mitigation, preparedness and response activities into the health sector in our country, with specific focus on hospitals; such that hospitals are not just better prepared but fully functional immediately after disasters and are able to respond without any delay to the medical requirements of the affected community. The RCC hospital building is analysed by using NDMA guidelines. In this analysis the comparison of story drift, story displacement, base shear, column and beam forces are calculated by using NDMA guidelines of RCC hospital building. The seismic rehabilitation process aims to improve seismic performance and correct the deficiencies by increasing strength, stiffness or deformation capacity and improving connections. Thus, a proposed retrofit implementation can be said to be successful if it results an increase in strength and ductility capacity of the structure which is greater than the demands imposed by earthquakes.

Seismic Analysis is a subset of structural analysis and is the calculation of the response of a building structure to earthquakes. It is a part of the process of structural design, earthquake engineering or structural assessment and retrofit in regions where earthquakes are prevalent. Seismic structural analysis methods can be divided into two main categories, static analysis and dynamic analysis. These two main categories can be divided into two main types of analysis, the linear and non-linear analysis. The studied building in this paper is a typical six-story model of a hospital building. The building is comprised of a reinforced concrete structural frame. The overall plan dimension is 69m × 26.99 m with 24.5 m in height. designed RC structure increasing column size with RC jacketing intervention is a strength-ductility based rehabilitation system: it provided a ductility increase equal to about 76% and a strength increase equal to about 43% with an elastic period decrease of about 25%;it allowed reducing the torsional behaviour of the structure by a factor of about 56%. This scheme was strongly effective in mitigating the torsional effects and increasing the seismic performance of the "as-built" structure.

II. IDENTIFY, RESEARCH & COLLECT IDEA

The overall aim of the guidelines is to mainstream disaster prevention, mitigation, preparedness and response activities into the health sector in our country, with specific focus on hospitals; such that hospitals are not just better prepared but fully functional immediately after disasters and

are able to respond without any delay to the medical requirements of the affected community.

Objective of the Guidelines

The key objectives of the guidelines are:

- To address hospital safety through a multi-hazard and inter-disciplinary Approach.
- To ensure structural safety of hospitals (especially of critical facilities).
- To ensure that all professionals involved in the day to day operation of hospitals are prepared to respond to disasters.
- To ensure that every hospital in the country has a fully functional and regularly
- Tested Hospital Disaster Management Plan.

An earthquake is the vibration of the earth's surface that follows a sudden release of energy in the crust. During an earthquake, the ground surface moves in all directions. The most damaging effects on buildings are caused by lateral movements which disturb the stability of the structure, causing it to top or to collapse sideways. The guidelines on Hospital Safety have been developed with the vision that all hospitals in India will be structurally and functionally safe from disasters, such that the risks to human life and infrastructure are minimized. In the case of seismic design of the lateral force-resisting system, the design problem can be reduced simply to the problem of providing adequate force and deformation capacity to resist the seismic demands. Also seismic evaluation will determine which are the most vulnerable and weak components and deficiencies of a building during an expected earthquake. The seismic rehabilitation process aims to improve seismic performance and correct the deficiencies by increasing strength, stiffness or deformation capacity and improving connections. Thus, a proposed retrofit implementation can be said to be successful if it results an increase in strength and ductility capacity of the structure which is greater than the demands imposed by earthquakes.

III. STUDIES & FINDING

RCC hospital building as per IS 1893:2016

No of stories G+6
Storey height 3.5m
Height 26.5m
Plan 69Mx26.99m
Type Regular
Grade of concrete M30
Grade of steel Fe415
Slab thickness 150mm
Beam dimension
B1=B300X600
B2=B400X600
B3=B400X800
B4=B500X800

Column dimension C1= C400X600

C2= C400X800
C3=C500X800
C4= C450X600
Live load 4 kN/m2
Floor finish 1 kN/m2

The analysis of following three models has been done. The following flow chart shows the steps involved in the analysis by ETABS.

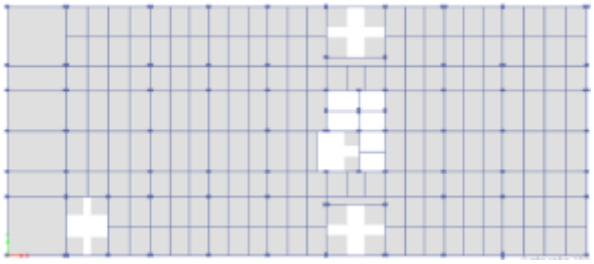

Fig 1.Plan of model 1

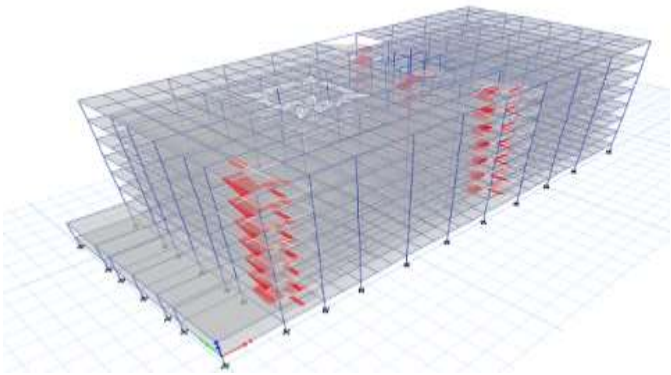

Fig 2 .Plan of model 1

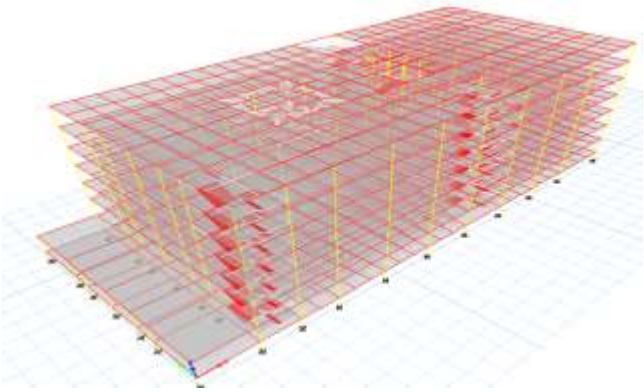

Fig 3.NDMA GUIDELINES

IV. PEER REVIEW

J. Sankar et.al.[1], analysed RC plane frames of G+3 story building for four earthquake zones. Story drift, story displacement, bending moment and shear force variation for different zones was carried out. Story drift is increased from zone II to zone V in force is required in order to design with supporting elements, from which the forces get transferred to the framework. The construction period of a structure is much than its expected life. Therefore, return period of 50 years may be considered for arriving at the both the directions X and Z. They concluded the Amount of story drift depends up on the amount of earthquake effect and also on the displacement of the story. For buildings, Earthquake zone factor for construction stages/period of a structure depending on its importance. The stability of a structure shall be checked both with and without the earthquake loads.

M.I.Adiyanto et.al.[2], designed the three story hospital building by considering seismic forces. The values of seismic load in this study are higher where the coefficient for importance factor was taken as 1.25 for hospital building. So, the value of shear base, *V* is higher than residential buildings by 20 percent. High seismic load requires the highest cross sectional area of steel reinforcement compared to other loads. They concluded that higher load will produce higher bending moment and shear force.

A.E.Hassaballa et.al.[3], designed the reinforced concrete columns of a hospital building considering two load case, one is the design load including combinations of dead, live and wind loads and case two includes dead, live and seismic loads. This paper suggested two solutions for this problem based on strengthening the weak columns by inserting reinforced concrete shear walls in the direction of y axis affected by seismic load and shear walls of length 4.5 m and 15 cm width. They conclude the seismic load effect is found to be more significant than the wind load when the seismic load is applied, most of the building columns are found to be inadequate and unsafe particularly in y-direction.

Md. Abul Hasan et.al. [4], proposed the existing hospital building has capacity to sustain for earthquake load having peak ground acceleration (PGA) of 0.15g which is suggested in Bangladesh National Building Code (BNBC)-1993. So to avoid devastating situation the existing Hospital Building is needed to retrofit immediately using base isolation devices for keeping functioning all time even after major earthquake. They concluded Hospital Building is needed to retrofit immediately using base isolation devices for keeping functioning all time even after major earthquake.

C. Sahin et.al. [5], analysed performance-based design aims to utilize performance objectives to determine acceptable levels of damage for a given earthquake hazard for new buildings or upgrade of existing buildings. It also describes how the linear analysis may be followed by the pushover analysis in order to estimate the seismic resistance of structure. They concluded the structural retrofit improved the seismic resistance of the building and it can be considered in the retrofit of moment frame structures to prevent the risk of structural collapse under the design load with much more confidence.

V.P. Selvam et.al. [6], studied a seven story RC building to investigate the structural seismic response. Then the designed structure is evaluated for the seismic performance under the old and the revised code of practice using Pushover Analysis. The Displacement controlled Pushover Analysis was carried out and the Pushover Curve was obtained for the building in both X and Y directions. From the analysis it is understood that, the frame is capable of withstanding the presumed seismic force with some significant yielding at several beams. The results obtained in terms of demand, capacity and plastic hinges gave an insight into the real behavior of structure. Pushover analysis is performed on the existing building for both zones (II & III) and Target displacement of the building was 80 mm but the building is analyzed for the displacement up to 200 mm. Pushover parameters were evaluated and compared for both zones. From the analysis it is understood that, the frame is capable of withstanding the presumed seismic force with some significant yielding at several beams. The results obtained in terms of demand, capacity and plastic hinges gave an insight into the real behavior of structure.

V. IMPROVEMENT AS PER REVIEVER COMMENTS

In which G+6 was modelled and analysed using ETABS software. And in the results they have noticed that base shear of RCC hospital building after applying seismic forces as per IS: 1893-2016 was decreased than RCC hospital

building after applying seismic forces by using NDMA guidelines.,The base shear value of hospital building by using NDMA guidelines is double than as per IS 1893:2016 which indicates that less seismic weight which gives better seismic response during earthquake.

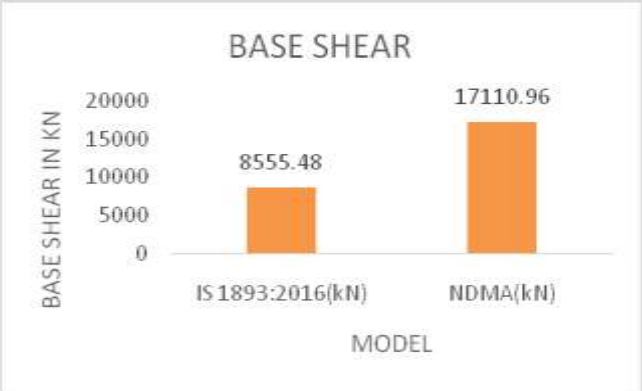

Figure 1 Base Shear

In model 2 the figure 2 and 3Story displacement in X direction of hospital building as per IS1893:2016 is same as by using NDMA guidelines after increasing size of column . Story displacement in Y-direction of hospital building as per IS1893:2016 is 9% more as by using NDMA guidelines . So hospital building as per NDMA guidelines is much less value after applying increasing column size technique due to its self-weight.The story displacements of hospital building as per IS1893:2016 and by using NDMA guidelines are within permissible limit as per IS: 456:2000.

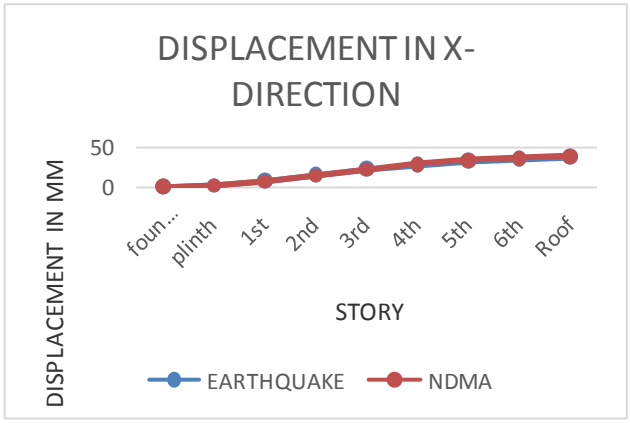

Figure 2 Storey displacement in X-direction

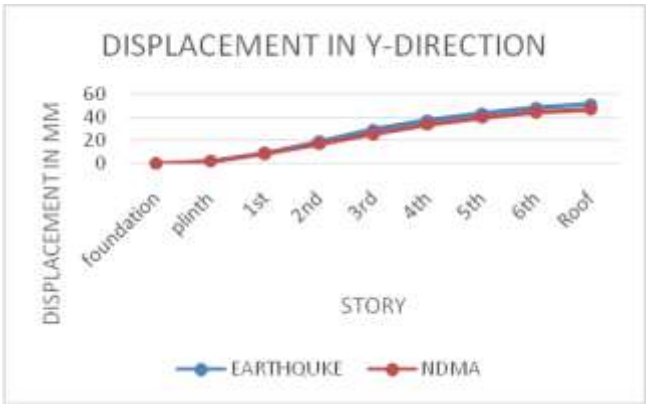

Figure 3 Storey displacement in Y-direction

In figure 4 and 5 In this graph we concluded that joint displacement in hospital building after as per IS: 1893-2016 is having 50% more value as compare to that hospital building by using NDMA guidelines in X- direction.In this graph we concluded that joint displacement in hospital building after as per IS: 1893-2016 is having 61% more value as compare to that hospital building by using NDMA guidelines in Y-direction

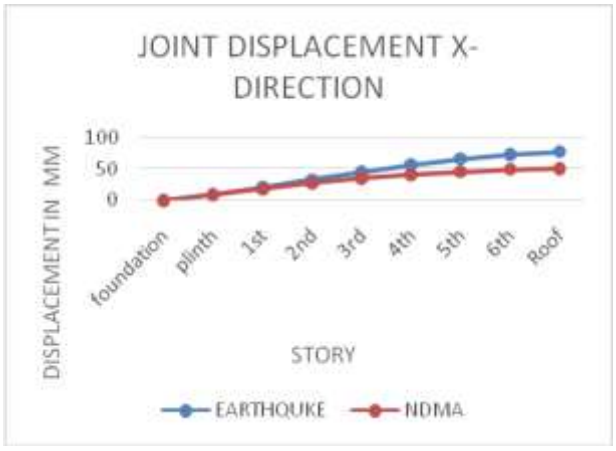

Figure 4 Joint displacement in X-direction

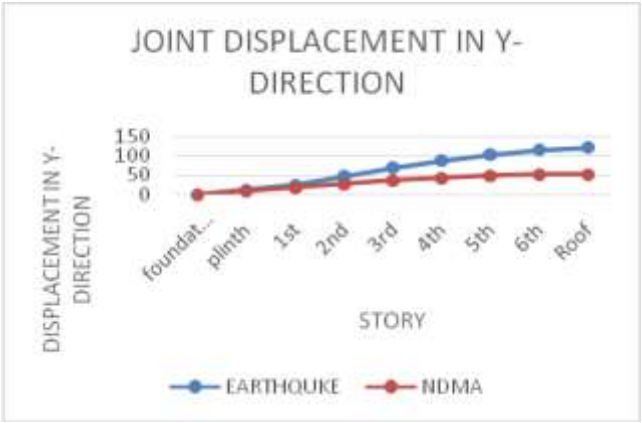

Figure 5 Joint displacement in Y-direction

The figure 6 and 7The graph show us that RCC exiting hospital building by using earthquake forces is having the less value of story drift as compare to RCC existing hospital building by using NDMA guidelines in X-direction. The story drift in x-direction is 51.35% is higher in RCC hospital building by using NDMA guidelines than RCC hospital building by using earthquake forces. So, In x-direction RCC exiting hospital building by using NDMA guidelines is better than RCC exiting hospital building by using earthquake forces in case of storydrift due to its greater weight.

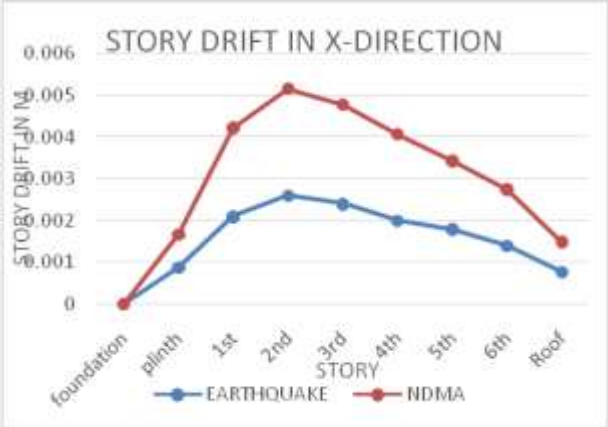

Figure 6 Storey Drift in X-direction

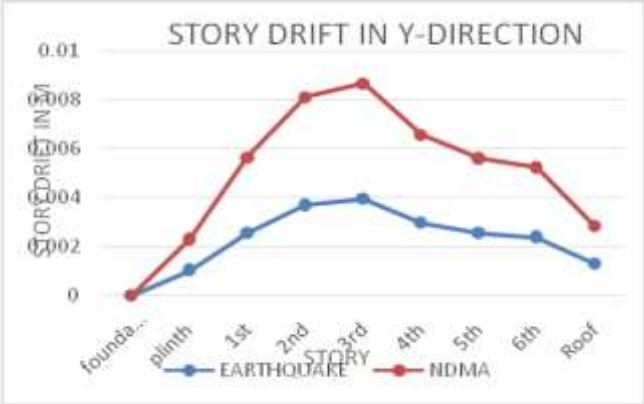

Figure 7 Storey Drift in Y-direction

VI. CONCLUSIONS

From the study Analysis and Design of RCC Hospital Building Subjected to Seismic Forces by Using NDMA Guidelines are concluded below.

1. Base shear value of hospital building by using NDMA guidelines is double than as per IS1893:2016. Base shear value of hospital building as per IS1893:2016 is 50% less than by using NDMA guidelines, which indicates that less seismic weight which gives better seismic response during earthquake.
2. Seismic weight value of hospital building as per IS1893:2016 is less than by using NDMA guidelines. Seismic weight value of hospital building as per IS1893:2016 is 40% less than by using NDMA guidelines, due to seismic forces is maximum.
3. Self weight value of hospital building as per IS1893:2016 is less than by using NDMA guidelines. Self-weight value of hospital building is 50% less than by using NDMA guidelines, which indicates that less seismic weight which gives better seismic response during earthquake.
4. Story displacement in X and Y- direction of hospital building as per IS1893:2016 is same as by using NDMA guidelines after increasing column size due to its greater weight.
5. The story displacements of hospital building as per IS1893:2016 and by using NDMA guidelines are within permissible limit as per IS: 456:2000.
6. Story drift in X and Y-direction of hospital building as per IS1893:2016 is less than by using NDMA guidelines before and after changing column size. Story drift in hospital building by using NDMA guidelines is 53% greater than as per IS1893:2016 due to its greater weight.

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