

## PRODUCTION BASE DESIGN AND ANALYSIS OF A NEW HOSPITAL BUILDING SUBJECTED TO IMPACT LOAD USING STAAD PRO

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### ABSTRACT

*The fundamental point of paper is to examine the arrangement of doctor's facility working by utilizing programming procedures. The outline of doctor's facility building ought to be created with following disciplinary exercises. The outline was followed up by utilizing IS (Indian standard) codes for better yield of plan contemplations. Here the healing facility building was outlined and investigated for G+3 story structure. These days, the product strategies were profoundly associated with a development field for snappy and better exactness of an investigation answer to execute the given venture effectively. The most noticeable utilizing programming for plan and investigation of the particular structures by STAAD.PRO programming for exactness and security respects. In this paper, STAAD.PRO has been utilized for outlining and examination purposes fundamentally for the aftereffect of shear power and greatest bowing minute. RCC itemizing is vital for clear in executing the fortification work on the site with no multifaceted nature. Execution based seismic plan (PBSD) is an other option to code based ways to deal with outline or assessment of structures that neglect to yield a more straightforward connection between a seismic occasion and the relating basic execution of a building; this for the most part prompts over-conservatism. This paper shows a contextual analysis on the option strategies utilized as a part of the execution based plan of another ten story minute casing healing center working in California, U.S. A definite three-dimensional model of the structure made utilizing Perform 3-D expressly speaks to the horizontal power opposing framework's (LFRS) geometry and solidness, both direct and non-straight, and the spatial appropriation of mass. The building was investigated and composed*

*utilizing a 3-D nonlinear reaction history examination (NLRHA) methodology in light of ASCE 41 with a suite of seven code based ground movement records. A correlation with the aftereffects of a nonlinear static weakling methodology (NSP) is displayed.*

### INTRUDUCTION

In the last decade, performance based seismic design of structures in high seismic regions has become more commonplace, though not yet ubiquitous, in the building industry. A conceptual framework for performance based design of structures was developed in the NEHRP Prestandard for the Seismic Rehabilitation of Buildings (FEMA 356), and has been adopted, with some modifications, as a design standard for Seismic Rehabilitation of Existing Buildings (ASCE 41). This paper presents a case study in the PBSD of a new hospital building in California, U.S. The structure's geometry and dynamic characteristics were such that an NSP per ASCE 41 was prohibited. A detailed model of the structure was created using Perform 3-D and analyzed using a three dimensional NLHRA based on ASCE 41 and the California Building Code (CBC 2007) utilizing a suite of seven ground motion records. In this paper, results of the NSP are compared with those from the NLRHA.

The Hospital building consists of various divisions like Ortho ward, Orthopedic ward, Opthamology ward, ENT ward, major and minor operation theaters, outpatient ward, seminar halls for medical students, scanning and X-ray Centre and

medicine store room, etc. The building is located in seismic prone zone (zone factor III). Since hospitals are very important buildings and need to remain standing after the earthquake, the design of such buildings needs to be done as per earthquake design

Structural analysis is the backbone of civil engineering. During recent years, there has been a growing emphasis on using computer aided software and tools to analyze the structures. There has also been advancement in finite element analysis of structures using Finite Element Analysis methods or matrix analysis. These developments are most welcome, as they relieve the engineer of the often lengthy calculations and procedures required to be followed while large or complicated structures are analyzed using classical methods. But not all the time such detailed analysis are necessary to be performed i.e. sometimes, just approximate analysis could suffice our requirements as in case of preparing the rough estimates and participating in the bidding process for a tender. Now-a-days, high rise buildings and multi-bay-multi-story buildings are very common in metropolitan cities. The analysis of frames of multistoried buildings proves to be rather cumbersome as the frames have a large number of joints which are free to move. Even if the commonly used Moment distribution method is applied to all the joints, the work involved shall be tremendous. However, with certain assumptions, applying the substitute analysis methods like substitute frame method, portal method, cantilever method or factor method, the structures can be analyzed approximately.

## 1.2 Geometry of the Hospital

The plan of the Hospital building is regular. It has a story height of  $H = 4.0\text{m}$

where all stories are of the same height. The Hospital building consist of five stories, it is six stories including ground floor. The Hospital building length is 31.75m and width is 19.25m so the area is  $611.1875\text{m}^2$ . The building consist of square columns with cross-section (0.5 x 0.5)m, rectangular beams with cross-section

## 4 Objective and Scope

Since hospital is the most important place during a disaster to give humanitarian aid and medical treatment, it is important to make sure that the hospital building can withstand the earthquake. The objective of this study is to make comparisons of analysis and design of a (G+5) story hospital building. Several cases of seismic loads will be applied to the building.

In Afghanistan there is no particular seismic analysis code for buildings, therefore Indian Standard Code (IS 1893-2002) will be used for this study. The building will be designed according to the Earthquake resistant considerations. The present study deals with an Equivalent Static Analysis of 6 story RCC hospital building using Structural Analysis and Design (STAAD Pro.) software

## Methodology

Review the existing literature and Indian design code provision for analysis and design of the earthquake resistant building.

The different types of structures are selected.

The selected structures are modelled.

Performing linear analysis for selected building for both gravity load, and earthquake loads and then a comparative study of both is obtained from the analysis.

Also design the building manually for design and analysis results obtained and compare with the area of steel of the

models obtained.

Using structural analysis and design Software ETABS and STAAD Pro and comparing both results.

Observation of results and discussions.

## LITERATURE REVIEW

### General

**Valmundsson and Nau(1997)** studied the earthquake response of 5-, 10-, and 20-story framed structures with non-uniform mass, stiffness, and strength distributions. The object of the study was to investigate the conditions for which a structure can be considered regular.

**Das (2000)** found that the structures designed by ELF method performed reasonably well. He concluded that capacity based criteria must be suitably applied in the vicinity of the irregularity.

**Sadjadi et al. (2007)** presented an analytical approach for seismic assessment of RC frames using nonlinear time history analysis and push-over analysis. The results from analytical models were validated against available experimental results. He observed that ductile and less ductile frames behaved very well under the earthquake considered.

**Adiyanto (2008)** analyzed a 3-storey hospital building using STAAD Pro. Seismic loads were applied to the building. The dead loads and live loads were taken from BS6399:1997 and seismic loads intensity is based on equivalent static force procedure in UBC1994. Result showed that the building can withstand any intensity of earthquake. It means that the buildings were suitable to be built in any area located near the epicenter of the earthquake.

**Kim and Elnashai (2009)** observed that buildings for which seismic design was done using contemporary codes survived the earthquake loads. However the vertical

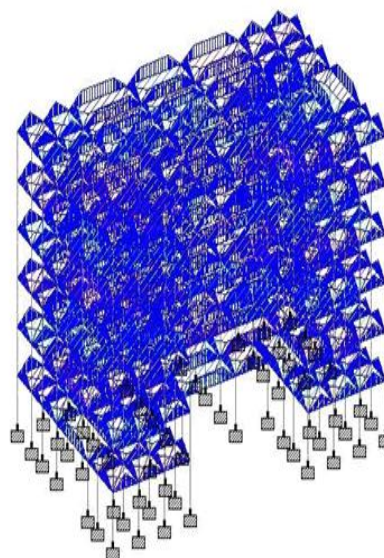
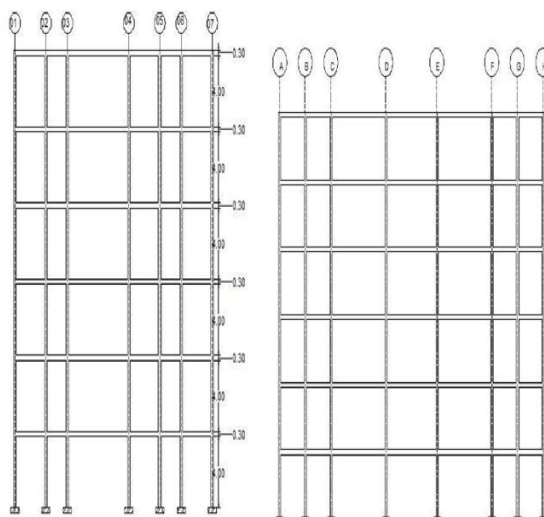
motion significantly reduced the shear capacity in vertical members.

**Griffith and Pinto (2009)** investigated a 4-storey, 3-bay reinforced concrete frame test structure with unreinforced brick masonry (URM) infill walls for its weaknesses with regard to seismic loading. The concrete frame was shown to be essentially a “weak-column strong-beam frame” which was likely to exhibit poor post yield hysteretic behavior.

**Di Sarno and Elnashai (2011)** assessed the seismic performance of a 9-storey steel perimeter MRF (moment resisting frame) using the three types of bracings: special concentrically braces (SCBFs), buckling-restrained braces (BRBFs) and mega-braces (MBFs).

### Summary of literature Review

The present study aims to design a Hospital building in Afghanistan using Equivalent Static analysis method. The base shear is calculated on the basis of mass and fundamental period of vibration and mode shape. The base shear is distributed along the height of structure in terms of forces according to IS 1893 (2002) Code formula. No similar code for design is available in Afghanistan. The Equivalent Static method is usually used for low, medium height buildings. This method is simple and accurate enough to use.



### 4.3.1 General Data

Structure

Floor height (First Floor to Fifth Floor)

Grade of concrete (for all structural elements)

Unit weight of concrete

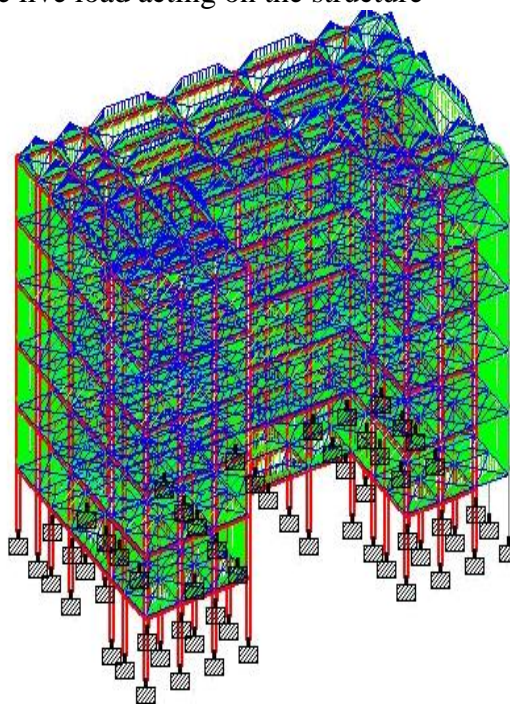
Unit weight of cement mortar

Unit weight of water

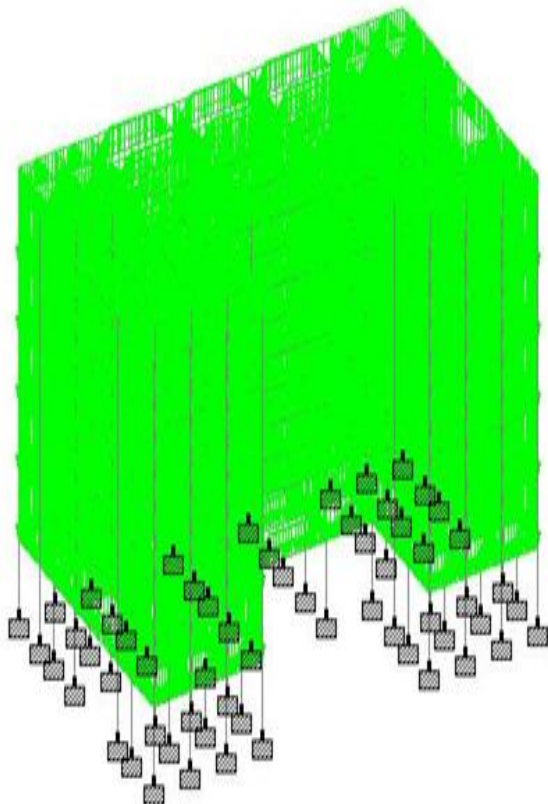
Unit weight of Brick

A slab load of  $3.75 \text{ KN/m}^2$  is considered for analysis. The wall load is taken as  $20 \text{ KN/m}$ . A floor finish load of  $1.5 \text{ KN/m}^2$  is applied on all beams of the RC building as per IS 875 (part1) [8]. A live load of  $4 \text{ KN/m}^2$  is provided as per IS 875 (part2) [9]. Table 4.1 shows the gravity loads taken for the building.

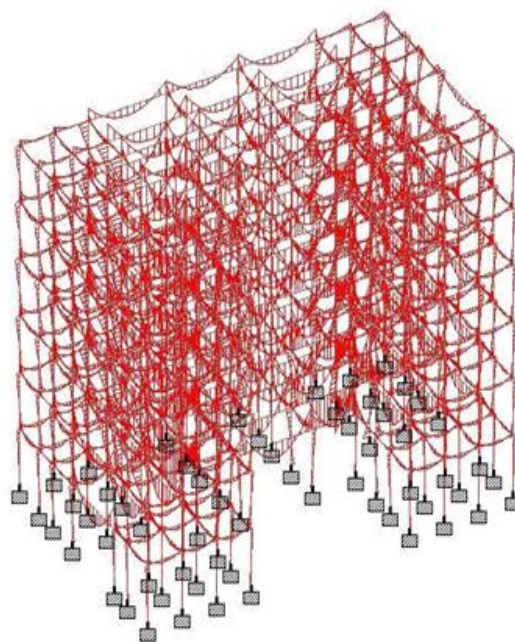
The live load acting on the structure



Floor load of the structure



Combination load of the structure



Bending moment diagram of the building

### Material Properties

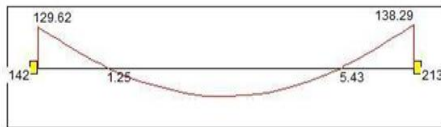
Table 4.2: Properties of Concrete and Steel bar as per IS 456[7]

Concrete Properties		Steel Bar Properties	
Unit weight ( $\gamma_c$ )	25 kN/m <sup>3</sup>	Unit weight ( $\gamma_s$ )	76.33kN/m <sup>3</sup>
Modulus of elasticity	21718.8MPa	Modulus of elasticity	2x10 <sup>5</sup> MPa
Poisson ratio ( $\nu_c$ )	0.17	Poisson ratio ( $\nu_s$ )	0.3
Thermal coefficient ( $\alpha_c$ )	1x10 <sup>-5</sup>	Thermal coefficient( $\alpha_s$ )	1.2x10 <sup>-5</sup>
Shear modulus ( $\zeta_c$ )	9316.95MPa	Shear modulus ( $\zeta_s$ )	76.8195MPa
Damping ratio ( $\zeta_c$ )	5%	Yield strength	415MPa

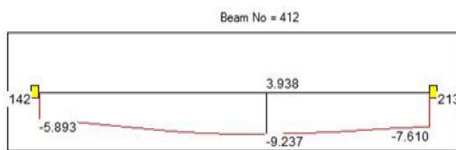
Compressive strength ( $F_c$ )	25MPa	Compressive strength ( $F_s$ )	485MPa
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### Reinforced Structural design

Having decided on a plan of the building and having obtained the beam and column dimensions and decided on the loads as per the relevant IS codes, the next steps in the project are the analysis and determining of the maximum moments, thrust and shears in beams, design of section and reinforcement arrangements for slab, beam, columns and walls and detail drawings and bar schedules.

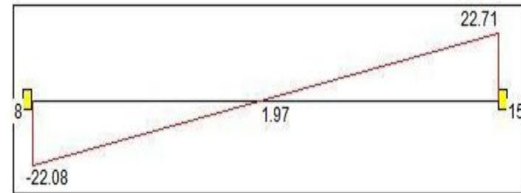


Bending moment diagram of beam No.412



### Designing of Columns

A column is a member carrying direct axial load which causes compressive stresses. All columns are designed separately. The columns are subjected to bending moment and axial loads. The column section is designed just below the beam column joint and just above the beam column joint and larger of the two reinforcements is adopted. The numbers of columns are 606.



Bending moment diagram of column No. 14

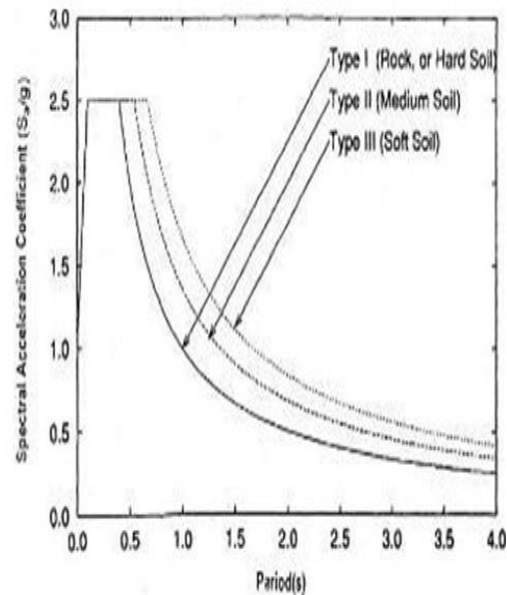
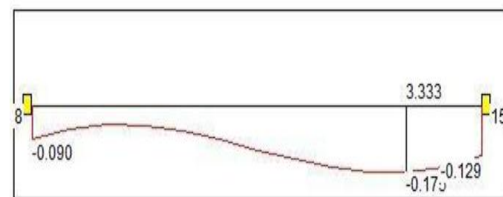
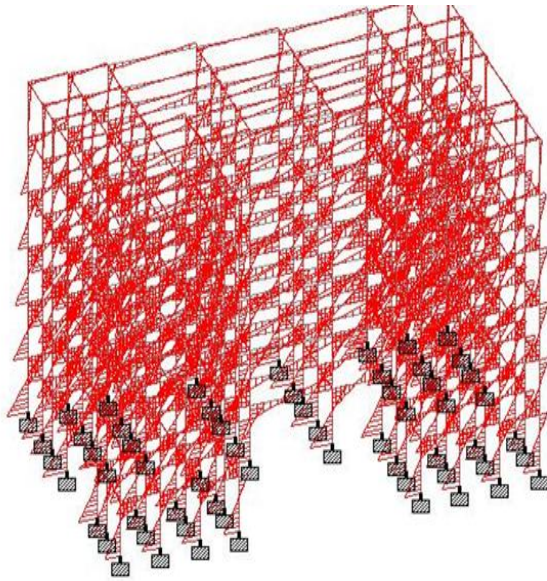
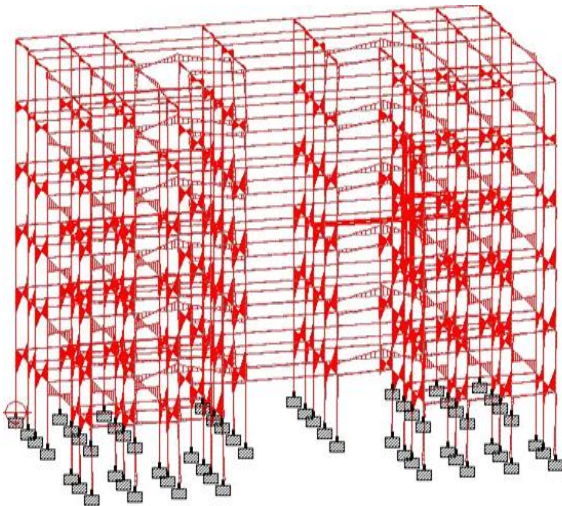


Figure 6.2: Classification of Soil Graph



Bending moment diagram due to seismic force from +x direction



Bending moment in y-direction

## Conclusion

NSP technique shows great estimation of target relocation for DBE reactions, in any case it overestimates target dislodging for MCE reactions by as much as 33.3% in this specific case. • Results recommend that NSP is equipped for giving great estimation to segment activities with restricted malleability requests, for example, segment and prop

pivotal powers yet may not be for part activities with bigger pliability requests, for example, minute edge shaft pivot revolutions. • Modal NSP is better than the NSP utilizing first mode sidelong load profiles when contrasting building story float profile shapes and the NLRHA; this is particularly the case at MCE level. • For adaptable structures, considering the higher mode impacts utilizing modular NSP gives preferred general estimation of reaction over first mode NSP. • Understanding the upsides of each of the strategies permits their viable use in picking up knowledge to likely building conduct and execution than both of the procedures can exclusively in this manner taking into consideration a more vigorous auxiliary plan.

In the present study, G+5 Hospital building has been drawn in Auto CAD software and designed (Beams, Columns, Footings and Seismic load analysis by using Equivalent Static method) using STAAD Pro software. The dead load, live load and earthquake loads are calculated using IS: 456-2000 and IS 1893: 2002. Concrete grade M25 and HYSD bars Fe415 as per IS: 1786-1985 are used.

Originally, the building was designed without earthquake loads as per IS456:2000. Then building is designed considering the earthquake loads as per IS1893: 2002. The detailing has been done as per both approaches. Since Afghanistan does not have any earthquake code, Indian Standard codes have been used in the analysis and design.

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