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Structural Modification of Proposed Reinforced Concrete Building

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Abstract

This research describes the structural modification of proposed building in TU(MTLA), Meiktila City, Myanmar. First of all, the differences between proposed design and existing structure and stability of the structure have been introduced. The propose building is three-storeyed residential reinforced concrete building. The proposed design structure is analyzed to get optimum sizes by ETABS software and results obtaining from analyzing are mentioned. And then, the existing structure of proposed building with actual existing data is also analyzed by ETABS software and results are mentioned. The structural elements are deigned according to ACI-318-99. Load considerations are based on UBC-97. Wind and Seismic load is considered as external lateral load in equivalent static analysis procedure. Design results of proposed and existing structure are compared to know the differences between.

Keywords; Proposed building; Existing building; ETABS software; ACI-318-99; UBC-97.

1. Introduction

This study focuses the different effects between analysis and design results of proposed and existing structure of TU(MTLA). There are a number of sources of uncertainly between the analysis, design and construction of actual reinforced concrete structure. Actual load may differ from those design loads. The assumption and simplification inherent in any analysis may result in calculated load effects moments, shear, etc different from those that, in fat act in the structure. Actual member dimension may differ from those specified. Actual material strength may be different from that specified. Therefore, the safety of the actual structure and designed structure may differ, which must be control in construction stages. The idealized structure is always different from such idealization must be kept within reasonable limits. If it is over the reasonable limits, the stability of the structure will be danger or can cause distress in the structure. The strength of the structure depends on the strength of the materials from which it is made. The single most important characteristics of any structural member is its actual strength, which must be large enough to resist, with same margin to spare, all foreseeable loads that may act on it during the life of the structure. Sometime the beam will be inserted in the actual structure. So, there will be changes in the strength of the structure. Therefore, the actual concrete strength should be tested and used in the analysis of the actual structure. The proposed structure must be analyzed with the data mentioned at the design specification. The actual structure must be analyzed with the data collection from the existing site. And then, the analyzed design structure and analyzed existing structure must be compared to know the differences. Thus, the stability and safety of the structure

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between the actual and design will be notice and can be control the failure of this structure. In this study, the superstructure of TU(MTLA) was designed to accept as the capacity of 3000 students. This structure is acted by the loads such as gravity loads and environmental loads. Since the design structure and actual structure may differ, these loads will be tolerance. Moreover, Meiktila is located near Bagan-Nyaung Oo seismic zone, it must be considering the seismic effect. Also it is located at the summit which is created by filling, it suffers wind pressure, which must be considered in analysis.

2. Reinforced Concrete Structural Element

A concrete building system is a combination of reinforced concrete structural elements, e.g., slabs, columns, beams, and footings. Columns are structural members in buildings carrying roof and floor loads to the foundations. Columns primarily carry axial loads, but most columns are subjected to moment as well as axial load. In column, main longitudinal bars resist compression and transverse steel prevent to bursting. Most columns are termed short columns and fail when the material reaches its ultimate capacity under the applied loads and moments. Slender columns buckle and the additional moments caused by deflection must be taken into account in design columns and fail when the material reaches its ultimate capacity under the applied loads and moments. All reinforcement beams crack, generally starting at loads well below service level, and possibly even prior to loading due to restrained shrinkage. Tension crack in beams may be wide enough to be visibly disturbing, or may even permit serious corrosion of reinforcing bars. These and other questions, such as vibration or fatigue, required consideration. Excessive cracking can lead to cracking of supported walls and partitions, ill-fitting doors and windows, poor roof drainage, misalignment of sensitive machinery and equipment, or visually offensive sag. It is important to maintain control of cracking.

A reinforced concrete wall is a wall containing at least the minimum quantity of reinforcement. The reinforcement is taken into account in determining the strength of the wall. External curtain walls that carry self-weight and lateral wind loads. External and internal infill walls in framed structures that may be designed to provide stability to the building but do not carry vertical building loads; the external walls would also carry lateral wind loads. Internal non-load bearing walls of block work or light movable partitions that divide space only. Loads are applied to walls in the following ways:

1. Vertical loads from roof and floor slabs or beams supported by the wall
2. lateral loads on the vertical wall slab from wind, water or earth pressure
3. Horizontal in-plane loads from wind when the wall is used to provide lateral stability in a building as shear wall.

In reinforced concrete construction slabs are used to provide flat, useful surfaces. Slabs may be supported on two opposite side only, in which case the structural action of the slab is essentially one way, the load being carried by the slabs in the direction perpendicular to the supporting beam. Here may beams on all four sides, so that two-way slab action is obtained. If the ratio of length to width of one slab pall is larger than about two, most of the load is carried in the shot direction to the supporting beams and one-way action is obtained in effect, even though supports are provided on all sides.

A spread footing is an enlargement at the bottom of the column or bearing wall that spreads the applied structural loads over a sufficiently large soil area. Typically, each column and each bearing wall has its own spread footing, so each structure may include dozens of individual footings. Spread footings are by the far most common types of foundation, primarily because of their low cost and ease of construction. They are most often used in small to medium size structure on site with moderate to good soil condition, and can even be used on some large structures when they are located at sites underline by exceptionally good soil or shallow bed rock.

Structure failed due to following causes.

1. incorrect selection of materials
2. errors in design calculations and detailing
3. poor construction methods and inadequate quality control and supervision
4. chemical attack
5. external physical and/or mechanical factors including alterations made to the structure

Moreover, the structure can fail due to external factor.

1. Restraint against movement
2. Overloading
3. Structural alterations
4. Settlement.

3. Analysis of Existing Proposed Structure

In existing proposed building, the structure consists four expansions joint and is divided into five portions. The structure is symmetric and the portions are similar. Block 1 and 5 are similar and Block 2 and Block 4 are similar. Block 3 is middle portion. Proposed building of TU (MTLA) is three-storied R.C building. Length of building is 535ft. Width of building is 90 ft. Shape of building is U – Shaped. Height of foundation is 14.5 ft. Height of typical floor is14 ft. Overall height of building is70.5 ft. 3D view and portions of proposed structure and elevation view are shown in Fig.1, Fig.2 and Fig 3 respectively. As material properties of proposed building, modulus of elasticity E is 3122 ksi, poisson's ratio υ is 0.2, coefficient of thermal expansion of 5.5 x 10^{-6} in/in per degree F. Bending reinforcement yield stress fy is 50000 psi, Shear reinforcement yield stress (f_{ys}) is 50,000 psi, Crushing strength concrete fc' is 3000 psi.

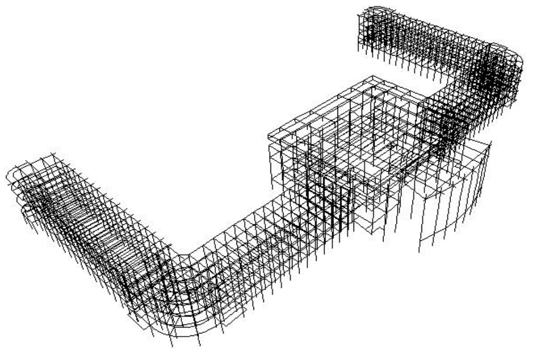

Fig. 1. 3D View of Proposed Building

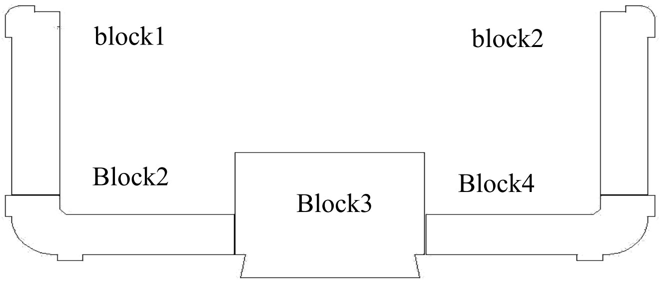

Fig. 2. Portions of Proposed Building

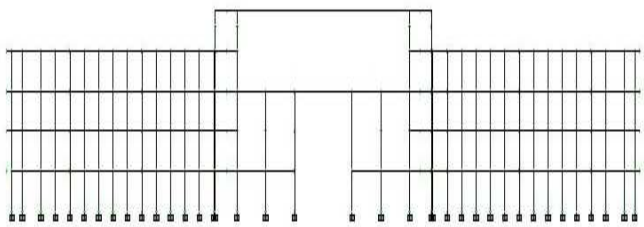

Fig. 3. Elevation View of Proposed Building

3.1. Loading

The self-weight of concrete as assumed to be 150 pcf, wall weight loading of 100 psf, partition weight loading of 55 psf, finished weight loading of 12.5 psf was considered. The roof load was to be 20 psf. As live load, 80 psf for corridors, 40 psf for classrooms areas and 20 psf for toilet were applied to the case study building.

Only wind load is considered as lateral load. For wind load, exposure type of type C, basic wind velocity of 80mph and effective height is 66 ft. Importance factor is 1. Load combinations are ACI- 318-99. 18 numbers of load combinations are used.

3.2. Analysis and Design Result of Existing Proposed Structure

In existing proposed building, column sizes, beam sizes and slab sizes are analyzed as given data taken from Kyaw Thar construction co;ltd. In given data, seismic load is not included. Moreover, when seismic load is considered as lateral load, some columns are failed in all block. So seismic load is not considered and wind load is only considered as lateral load. In proposed building, columns and beams are not failed due to gravity load and wind load for block 2, 3 and 4. But two number column are failed at block 1 & 5 due to their required steel area exceed maximum allowable. Therefore, structural element of proposed building in block 2, 3 and 4 are satisfied for design. But, two columns are not satisfied for design although beams size are satisfied at block 1 & 5.

3.3. Checking for Safety of Structure

The structure has been checked in following cases.

(1) Story Drift
(2) Overturning Effect
(3) Resistance to Sliding
(4) Torsional Irregularity
(5) P-Δ effect

In existing proposed structure, the stability checking of story drift, overturning Effect, resistance to sliding and P-Δ effect are satisfied but torsional irregularity is not satisfied for block 1, 2, 4 and 5. For block 3, torsional irregularity is satisfied. In block 1 and block5, torsion for Y-direction is satisfied but X- direction is not. In block 2 and 4, X- direction is satisfied and Y- direction is not.

4. Analysis of Modification Proposed Structure

In modification proposed building, area of structure, length, widths, area of class room are similar to proposed building. Material properties of the structure and load acting on the structure are similar. Seismic load and wind load are considered as lateral load. As structural modification, in third floor of Block (1) and (5), four numbers of RB (9x18) are changed to RB (9x12) and column C3 and C8 which are failed in proposed building are changed from (C9x9) to (C20x20). Other block, block 2, 3, 4 are unchanged column size, beams and other structural member. Wind load and seismic load is considered as lateral load due to this structure locate in seismic zone 3. Wind force is similar to proposed building. For seismic load, Zone factor for Meiktila, Z is 0.3g, Importance factor is 1, Soil profiled type is S_D and Response modification factor, R is 8.5. (34) numbers of load combinations are used when seismic and wind load is considered as lateral load.

4.1. Analysis and Design Result of Modification Proposed Structure

In modification proposed building, RB(9x18) are changed to RB(9x12) and at grid line (X2, Y3) and (X3, Y2) where columns are changed from (C9x9) to (C20x20) at block 1 and block 5. When the structure is analyzed with gravity and wind load, columns and beams are not failed and the superstructure is safe. But, when seismic load is applied to structure, some columns are failed. Therefore, these columns should be changed to resist seismic effect. Columns failed caused by seismic load should be changed for stability of structure and shown in Table1.

Table.1. Failed columns size and changed columns size

Block	Storey	Grid Line	Failed Col; Size due to seismic	Changed Column Size
Block 1 and 5	No failed columns			
Block 2 and 4	1F	X25,Y5	C(9x9)	C(12x12)
	1F	X25,Y7	C(9x9)	C(12x12)
	1F	X26,Y8	C(9x9)	C(12x12)
	1F	X28,Y8	C(9x9)	C(12x12)
Block 3	1F	X18,Y26	C(18)	C(20)

4.2. Checking for Stability of Modification Proposed Structure

The superstructure should be checked in following cases.

(1) Story Drift
(2) Overturning Effect
(3) Resistance to Sliding
(4) Torsional Irregularity

(5) P-Δ effect
In modification proposed structure, the stability checking is satisfied for block 1, 2, 3,4 and 5.

4.3. Compare Existing and modification proposed Structure

In existing proposed building, the required data are taken from the given data for TU (MTLA). When the structure is analysed by ETABS software, there are two failed columns in block 1 & 5 due to As (req) exceed maximum allowable steel area but beams are satisfied for design. For block 2, 3 and 4, beams and columns are satisfied for design. But, only wind load is considered as lateral load because seismic load is excluded in given data. Moreover, when seismic load is considered in proposed building some columns are failed in block 2, 3and 4. Therefore, it is sure that seismic load is not considered in existing proposed building.

In modification proposed building, seismic and wind load is considered as the lateral load. Because of design results, as structural modification, columns and beams size are changed only in block 1 and 5. Some cantilever beam, in third floor are changed from (9x18) to (9x12). Column, C3 and C8 are changed from (9x9) to (20x20) in all storeys. Other blocks, block 2, 3 and 4 are similar to column and beam sizes with proposed building.

When modification proposed building is analysed, block 1 and block 5 are satisfied for safety and there are no failed column and beams. But, columns C (212), C (213), C (217) and C (220) at block 2 and block 4 and column C (297) at block 3 are failed at first floor level. The cause of failure of these columns is that required steel area for these columns exceeds maximum allowable steel area. Therefore, to convenience these problems columns size should be changed. Beams are satisfied for all block although seismic load is considered.

5. Conclusion

In this study, the performance of existing proposed building and modification proposed building are compared and checked, in term of stabilities. ETABS.9.5. software is used as design aids for numerical completion of analysis of the model. Equivalent static analysis procedure is used with load combinations according to (ACI-318.99). In proposed building, material strength properties are considered as given data taken from Kyaw Thar construction co;ltd. In existing proposed building is designed with considering gravity and wind load is included and seismic load is excluded. Two number of columns are failed in block 1 & 5 but beams are not failed. In existing proposed structure, the stability checking of story drift, overturning Effect, resistance to sliding and P-Δ effect are satisfied but torsional irregularity is not satisfied for block 1, 2, 4 and 5. For block 3, torsional irregularity is satisfied. In block 1 and block5, torsion for Y-direction is satisfied but X-direction is not. In block 2 and 4, X- direction is satisfied and Y- direction is not.

If seismic load is applied to existing proposed building called modification proposed building, some columns and beams will fail in more block. The modification proposed building design is satisfied for stability when seismic load is adding applied. columns are failed near the stair at block 2, 4 and block 3. In this study this problem can be solved in redesign results by changing the beams and column sizes. Since these some columns are failed due to required steel area exceed maximum allowable, column size should be changed to their reliable sizes by further encouraging these columns with concrete. As further study, this problem can also solve by using some strengthening methods.

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References

Farzad Naeim & James M.Kelly, " Principal of Reinforced Concrete structure "
Nilson, A.H.1997. "Design of Concrete Structure".12th edition. Singapore: McGraw-Hill Companies.
American Concrete Institute Committee. " Building Code Requirements for Structural Concrete and Commentary (ACI-318-99)" U.S.A.
David. A.F. and Javeed A.M: "Design of Low-Rise Concrete Building for Earthquake Forces", 2nd edition. Singapore: MC Graw-Hill Companies. Inc, (1997)
International Conference of Building Officials. 1997, "Structural Engineering Design Provision". Uniform Building Code. Volume 2. U.S.A.
Computers and Structures: *Inc. ETABS (Nonlinear Version 9.7.4) Computer Software*. Berkeley, California (2011). 10 December (2012)