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COMPARATIVE STUDY OF LOW RISE RESIDENTIAL BUILDINGS INTERMS OF PLATE STRESS AND ECONOMIC EVALUATION WITH SOLID SLAB AND RIBBED SLAB: STATIC ANALYSIS

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ABSTRACT

In this thesis paper, the comparison of frame with solid slab vs composite slab for seismic loading and gravity load are analyzed using manual and staad.provi8 software to insure either frame with solid slab or frame with ribbed slab are economical, stable and one of either capable to withstand designed load over its designed life.Additionally the structure is modeled and analyzed using staad.prov8i software and compared in terms of plate stresses, deflection and economic evaluation of low rise Residential building with solid slab or rib slab-concrete block slab using linear static analysis under gravity & lateral loading.

Finally as per analysis and design, it is proved that the residential building with solid slab can resist the required structural stresses like lateral deflection, bending stress, shear deflection and provide the required structural stability against lateral and uplift pressures than structure with ribbed slab.

KEYWORDS: Low rise frames, Plate stress, Solid slab, Ribbed slab, Gravity load, Seismic Load.

I. INTRODUCTION

In Ethiopia, Low Rise Residential building developments have been highly increasing and constructed throughout different region of the country. In the past three to four decades, the building is simply constructed laterally on the environment of area. Now a days they are going to build along upward than building over lateral level. As the building going constructed along upward direction; it have advantage of effective utilization of land and accommodate large quantity of inhabitants.

The introduction of low rise residential structure of framed reinforced concrete building construction in our country and as throughout world are going to exercised widely due to shortage of land on which the construction are going to constructed and improvement of living standard of community.in the late forth decades, engineers have recognized that peoples are willingness to have and live in low-to-high rise residential building. As result to fulfill the interest, the engineers design and construct the low rise of building throughout the country. Recently, the selection of type of structural frame constructed from different components of building for a building's framing system brings numerous benefits to a project. Construction to desired shape, sustainability, strength and aesthetic, Efficient Design and durability are some advantage of reinforced structure. Comparatively low rise residential buildings are heavy in weight which makes reinforced concrete structure not susceptible to lateral load and have more stability due to its gravity loads.

The residential building constructed from different components of building has high probability of the overall stability, strength, and have high strength of resisting lateral loads. The building constructed from solid slab and ribbed slab have different capacity of resisting plate stresses of the building that attached from gravity and lateral loads. The structure constructed from solid slab and ribbed slab have different capacities in terms of resisting of bending behavior, story shear, seismic weight and story displacement. These criteria are some of which used to select which frame is going to be designed and constructed for different region of the country.

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II. OBJECTIVE

- ★ Comparison of Vertical Displacement for RCC frame with Solid slab and RCC frame with Ribbed slab
- ★ Comparison of overall plate stress for RCC frame with solid slab and RCC frame with Ribbed slab
- ★ To identify and select the frame which effectively withstand both gravity and lateral loadings throughout service period

III. METHODOLOGY

- ✪ The STAAD.PROVi8 software – structural analysis and design software: - model was developed first and the basic material and member properties were assigned.
- ✪ Manual calculations and analysis raw data with Microsoft excel 2013

The general data for the frame was as follows

1. Specimens

This research is studied using two sections of residential building frame modeled in order to compare the frame whether it withstand with both lateral and vertical loads.

- ✪ Moment resisting frame with solid slab
- ✪ Moment resisting frame with ribbed slab

2. General Data

- ★ Building Function = Residential [Super-Structure]
- ★ No. of Storey = G+4
- ★ Regularity Criteria = Symmetry in Plan & Elevations
- ★ Floor plan = Typical all floors
- ★ Type of slab = Solid slab Vs. Rib slab
- ★ Structural system = Moment Resisting Frame
- ★ Structural Analysis = STAAD ProV8i Software
- ★ Structural Design = Manuel Calculation
- ★ Load combinations = Dead, Live & Seismic
- ★ Assumed Floor Finish Load = 1.5 KN/m2
- ★ Typical Floor Height = 3.5 m
- ★ Assumed depth of foundation = 1.5 m
- ★ Assumed Support Condition = Fixed Support
- ★ Seismic Zone = Zone IV
- ★ Sub soil class = A

References

- ★ EBCS 1-Basis of Design and Actions on Structures
- ★ EBCS 2-Structural use of Concrete
- ★ EBCS 8-Design of Structures for Earthquake Resistance
- ★ IS 456 -Plain and Reinforced Concrete

3. Material Property

Reinforcement steel

$$f_{yk} = 400\text{MPa} \quad (1)$$

$$\gamma_s = 1.15 \quad (2)$$

$$f_{ctd} = \frac{f_{yk}}{\gamma_s} = \frac{400\text{MPa}}{1.15} = 347.83\text{Mpa} \quad (3)$$

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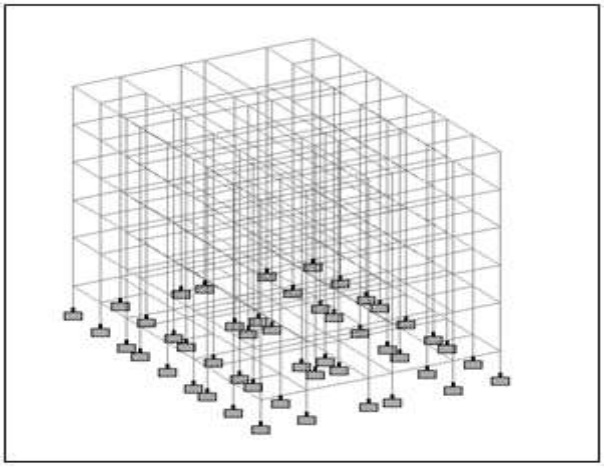

Figure 1.G+4 Reinforced Concrete Frame

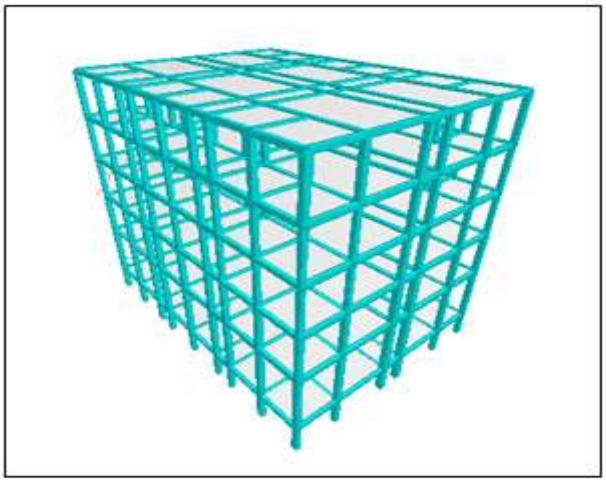

Figure 2.*G+4 Dimensional Rendered View of Reinforced Frame*

IV. RESULTS AND DISCUSSION

a. Quantity Comparison of Concrete Quantity (M^3)

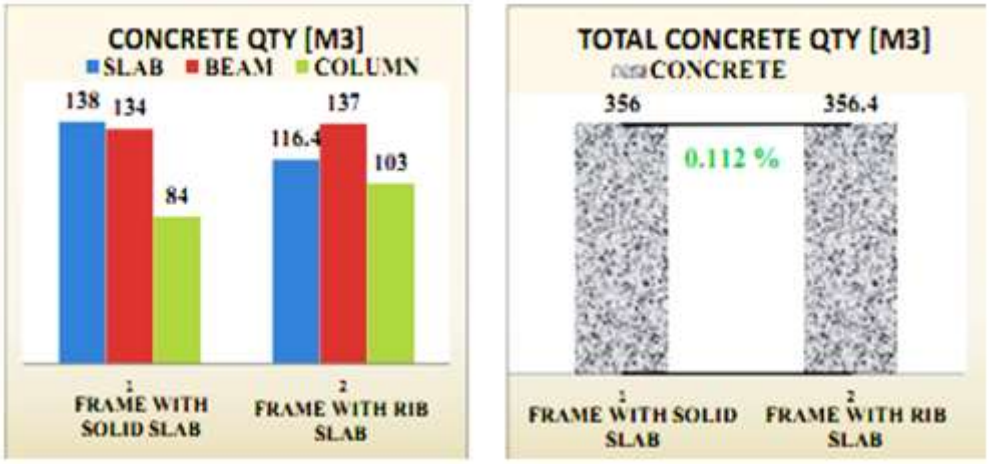

Figure 3. Concrete Volume Comparison

As shown from analysis and diagram above the total concrete quantity (m^3), the frame with ribbed slab have 0.112% concrete quantity than solid slab frame.

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b. Quantity Comparison of Steel quantity (MT)

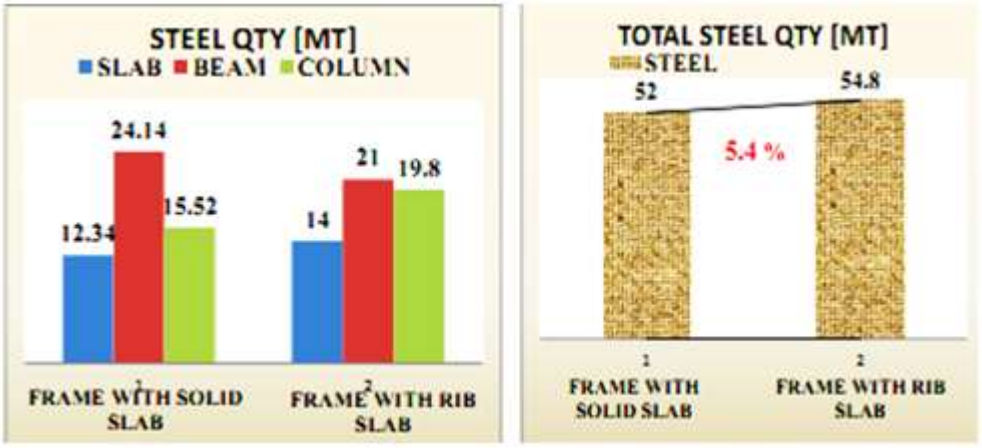

Figure 4.Steel Mass Comparison

Analysis shows the total steel quantity of frame with ribbed slab has 5.4% steel mass more than solid slab frame which indicate the residential building with solid slab require less mass of steel quantity.

c. Quantity Comparison of HCB Quantity

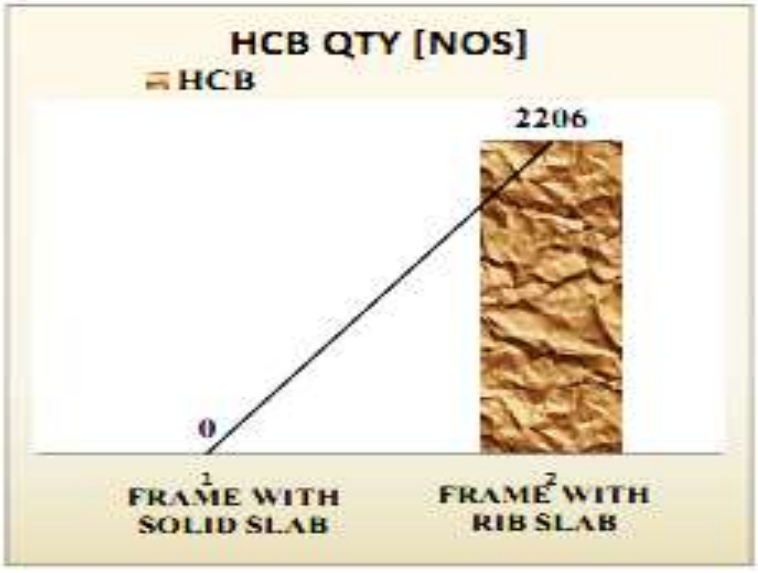

Figure 5. HCB quantity comparison of frames

As shown the residential building frame, the frame with solid slab not require HCB quantity and the frame with ribbed slab require 2206 HCB.

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d. Total Cost comparison (ETB)

e.

Figure 6. Total Cost Comparison of Frame

The total cost of residential building frame constructed with ribbed slab require 4.8% more Ethiopian Birr [ETB] money than solid slab frame. As result constructing residential building with solid slab frame is more economic than one with ribbed slab frame.

f. Overall bending pattern

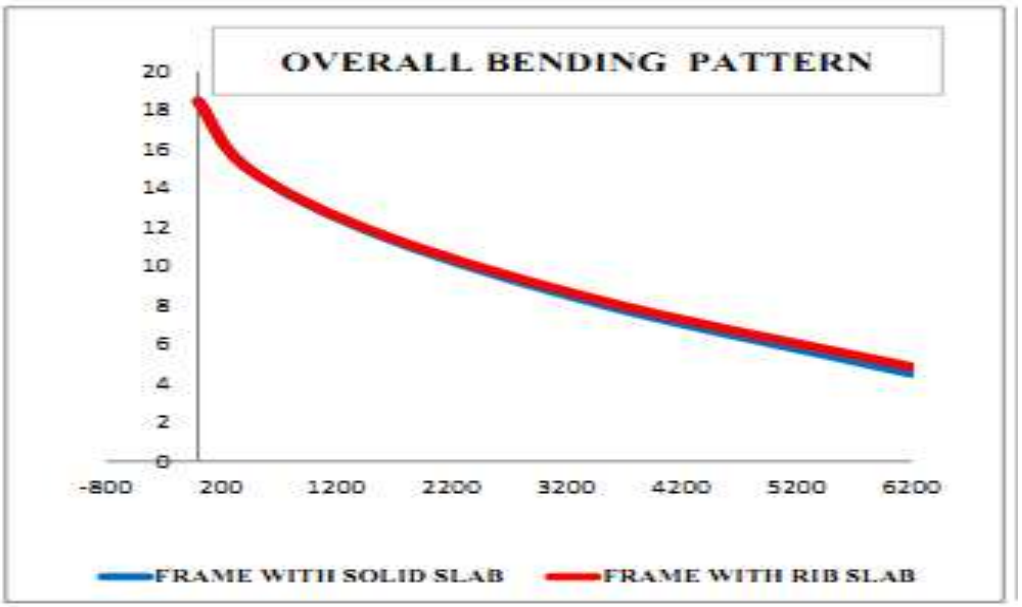

Figure 7. Overall Bending Pattern

The overall bending pattern developed due to gravity and lateral loading of frame with solid slab is less than frame with rib slab as sown in the figure above.

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g. Overall shear pattern

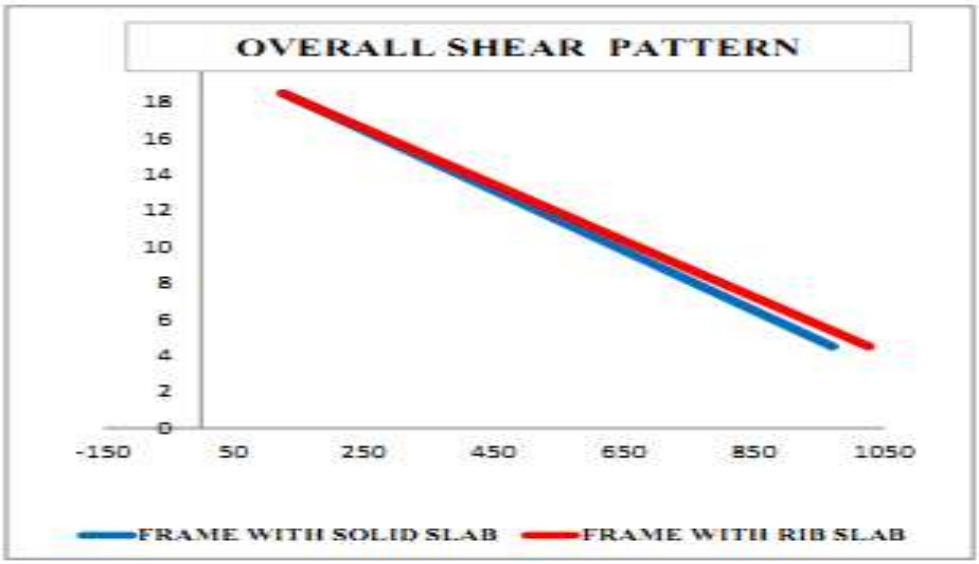

Figure 8. Overall Shear Pattern

After all analysis and design the frame, the overall shear pattern of frame with solid slab is less than frame with rib slab.

h. Overall story displacement

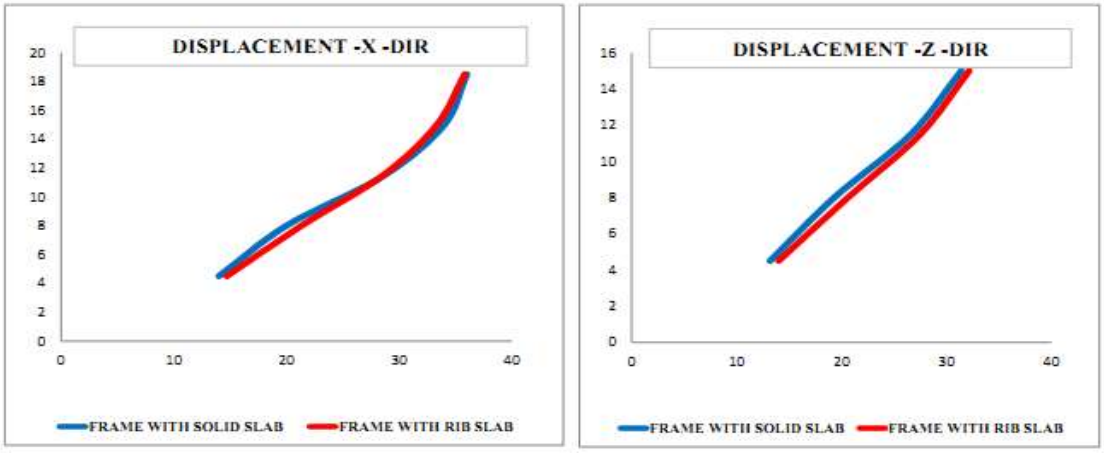

Figure 9. Overall Story Displacement

The overall story displacement of modeled building frame in X-direction and Z-direction of frame with rib slab is greater than frame with solid slab.

V. OVERALL COMPARISON-SEISMIC WEIGHT

Frame with Solid Slab (from STAAD.Provi8 software)

- Total dead Load of the Building = 15449kN
- Horizontal Seismic Coefficient = 0.0705
- Seismic Weight of the Building = 1089.2kN

Frame with Rib Slab (from STAAD.Provi8 software)

- Total dead Load of the Building = 16191kN
- Horizontal Seismic Coefficient = 0.0705
- Seismic Weight of the Building = 1141.5KN

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Seismic Weight Comparison

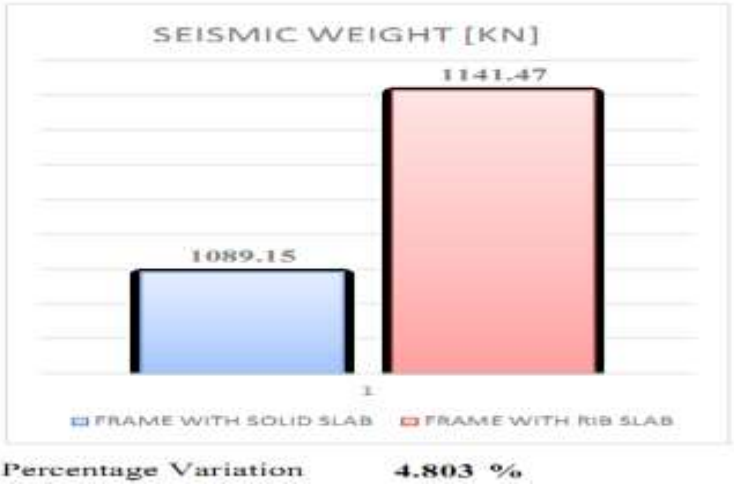

Figure 10. Seismic Weight Comparison

The seismic weight of modeled frame building of frame with ribbed slab is higher seismic force than a frame with solid slab which the frame possess percentage variation of 4.803% than frame with solid slab.

VI. CONCLUSIONS

After overall analysis and design, the comparison frame of residential building constructed from solid slab require lesser quantity of material (steel and concrete) by 5.512% than structure constructed from rib slab. The overall behavior and storey displacement of solid slab structure has lower in both x-and z- direction as compared to ribbed slab structures. Structures made from ribbed slab become popular and economic under medium to long span and lightweight structures. Introducing voids to the soffit of a slab reduces dead weight and increases the efficiency of the concrete section. A slightly deeper section is required but these stiffer floors facilitate longer spans and provision of holes. The base bending moment of solid slab structure has lower value due to lateral and gravity loads as compared as to ribbed slab structures.

Generally the solid slab frames has lesser magnitudes of seismic weight, story displacement and story shear of building. In additionally the frame constructed with solid slab can provide sufficient capacity throughout designed period of structure.

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