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Review on Understanding of One Way Ribbed Through the Geisel Library

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Abstract— The efficiency of structural design in any architectural project plays a vital role. Every public structure requires column free spaces for which long span structural systems are beneficial. The criteria such as column spans, slab depth, use of material helps in improving the efficiency of long span structures. Hence, the review paper aims to understand one such system i.e. ribbed slab in slab and beam structures of section active system through Geisel Library. This review paper analyses and focuses on the study of ribbed slabs, different researches related to the ribbed slab and try to understand its workability in Geisel Library.

Index Terms— Brutalism, Cantilevered building, Cost effective, Grid slab, Long spans, Ribbed slab, Section active systems.

1 INTRODUCTION

SECTION active structural systems are made up of rigid, solid, linear parts in which sectional forces are used to redirect forces. The bending resistance of section-active structural systems is caused by the combined action of compressive and tensile stresses within the beam section, as well as shear stresses. An internal rotation moment is activated as a result of bending deflection, counteracting the external rotation moment.

Different types of Section Active systems include:

A beam structure is a load-bearing structural element that resists bending. A bending moment is the bending force induced in the beam's material as a result of external loads, its own weight, span, and external reactions to these loads. The profile (cross-section shape), length, and material of beams are all factors to consider.

Frame structures resist lateral and gravity loads by combining a beam, column, and slab. These are typically used to counteract the large moments that develop as a result of the applied load.

A slab is a flat piece which is installed on a structure's walls or columns and can be used as a walking surface or a load-bearing member, as in slab homes.

The flat slab is a two-way reinforced structural system with drop panels or column capitals at columns to resist heavier loads and allow for longer spans. One of the quickest methods is to build flat slabs and is one of the most common types of construction, lead times are extremely short.

This process is compared to a case study of The Geisel Library and inferred in this research paper.

The architect William Leonard Pereira, known for his futuristic ideas associated with the space era, constructed the Geisel Library in 1970. The student library building, which contains four of the university's nine libraries, is an inverted pyramid that raises six stories above ground.

The architect designed the library spherically, so that it was as close to the visitors' study spots as appropriate, 91m or 2 minutes away from each point. Its modernist design began as a spherical architecture with a concealed structure inside, steel and glass structure. Where ribbed slab supported the structure, the diagonal structural components, on the other hand, moved significantly outward.

2 RIBBED SLAB

2.1 One-way Ribbed Slab System

A one-way joist floor slab is made up of a number of tiny, reinforced concrete T beams joined by girders that are supported by the building column. T beams are also known as joists, and they're made by spreading steel pans evenly. To construct such ribs, concrete is formed between certain spacings, and the slab is cast as well, and the slab becomes the T beam's flange.

Adding voids to a slab's soffit decreases dead weight and

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improves the concrete section's efficiency. Although a somewhat the deeper section is required, the stronger flooring allows for greater spans and the placement of holes. In the 8 to 12 m range, it is cost-effective.

3 LITERATURE REVIEW

In this research, optimum design of reinforced cement concrete (RCC) ribbed slab the authors Imran S. M., Raghunandan Kumar R., Arun Kumar presented the best design of reinforced cement concrete (RCC) ribbed slab. The combined cost of the reinforcement, concrete, and formwork, which totals the cost of the ribbed slab, is the objective function. The research revealed that improving the reinforced concrete ribbed slab may result in savings of up to 25%.

The entire cost of a ribbed slab is related to the slab's depth and inversely proportionate to the steel's area and weight. [1]

From the research on Comparative Study of the Seismic Performance of RCC Building with Ribbed Slab and Grid Slab by Atif Zakaria, M. Shiva Rama Krishna, S.V.Surendhar some of the conclusions are taken from the findings as follows:

a) Correct slab system selection is important for the structure's stability against lateral and gravitational forces.

b) A grid slab building has a better seismic response than a ribbed slab construction.

c) As the total height of the structure increases, the base shear, displacement, Storey shear, and drift all increase simultaneously.

d) The base shear and storey shear account for a significant portion of the base. [2]

The goal of the research on Study on Economical Aspects of Long Span Slabs by Ibrahim. S. Vepari, Dr. H.S.Patel is to look at the economics of long-span buildings with both flat and grid slabs. Both slabs were modelled and analysed, and the cost was determined in three stages: amount of steel, volume of concrete to be utilised in slabs and beams, and form work costs.

According to the study's findings, the unit cost of a flat slab rises gradually as the span range grows. The unit cost of a grid slab does not considerably rise if the span range is raised. Flat slabs have shown to be cost-effective for lower spans, but grid slabs become more cost-effective as the span range increases. As opposed to a flat slab, Grid slab has proven to be more cost effective for long span slabs. [3]

Reinforced concrete ribbed slabs with wide-beam is the study by P. V. P. Sacramento, M. S. Picanço, D. R. C. Oliveira where the tests were conducted, all boundary circumstances have an impact on the behavior of structural slabs and drastically alter their performance. When compared to a slab without shear reinforcement, the results revealed that increasing wide-beam depth resulted in lesser displacements, and the shear reinforcement in the ribs resulted in a more ductile behavior (L1). Because shearing causes the ribs to fracture prematurely, concrete and steel have modest strain rates. With significant longitudinal fractures along the tensioned surface of the wide-beam-ribs connection, the cracking pattern was distinct from that of the solid flat slab. The wide-beam-ribs connection would have a greater loading level than the wide-beam column connection, according to the study. Solid slabs' behavior isn't appropriate in some instances. The current research, on the other hand, offered the circumstances for a more precise assessment of the behavior of this type of slab. [4]

4 GEISEL LIBRARY

Fig. 1. View of Geisel Library

4.1 Specification

Architect: William L. Pereira
Technical Architect: Robert A. Thorburn
Structural Engineer: Brandow& Johnston
Electrical Engineer: Frumhoff& Cohen
Floors - 6
Construction Company: Neilsen Construction Co
Developer: University of California San Diego
Built in: 1968 -1970
Remodeledin: 1990 - 1993
Height: 33, 53 m Width: 64 m
Built up area: 16.350, 93m2

4.2 Structure

Pereira's tower is a good example of brutalism architecture, rising 6 stories above ground with a height of 33.53 m and additional two subterranean levels. The building's largest point is on the sixth floor at 64m, while its narrowest point is in the forum at ground level.

Reinforced concrete and glass are used in the construction. Rough form board exposed concrete in a horizontal pattern with anodized aluminium window walls containing 38,000 square feet of plate glass is the overall finish. The structure is made of 17,000 cubic yards of concrete.

The bents curve upward at 45 degrees to the sixth level and are actually linked to their counterpart across the building at

both the fifth and sixth floors by up to 300 1/ 4-inch diameter high-tensile steel post-tensioning rods.

4.3 Materials Used

a. Steel structure: four huge steel trusses support the third storey of the spheroid, which is hidden beneath the second level.

b. Hybrid Steel: Concrete construction with steel trusses and concrete up to steel trusses

c. Reinforced Concrete structure : Featuring a 16-sloped beam column on the outside. Posttensioned beams connect the lower three spheroids laterally.

Factors influencing the choice of Reinforced Concrete construction:

a. Increasing steel consumption and widespread usage of steel in trusses.

b. Reduced spatial flexibility at the spheroid's second level.

c. The expense of fireproofing the steel.

d. High cost of connection at sites of material and load transfer junction.

4.4 Analysing working of ribbed slab

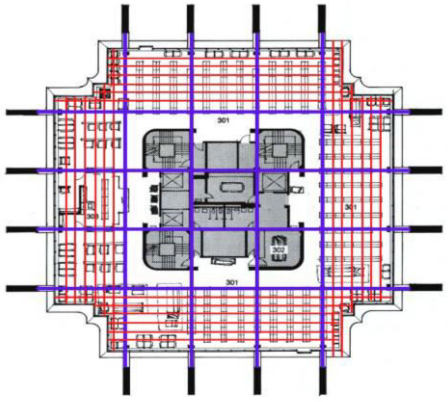

Fig. 2. Position of Primary beams and ribs

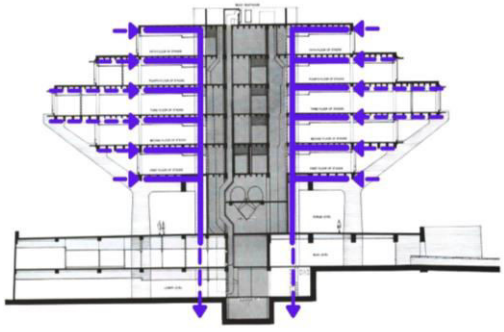

Fig. 3. Lateral loading through ribs

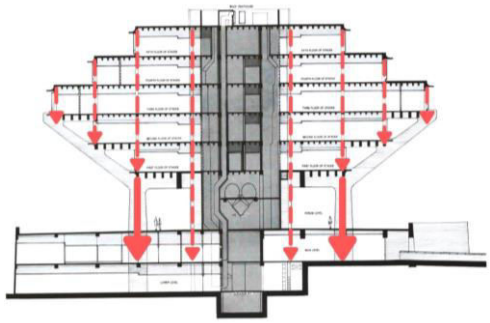

Fig. 4. Vertical through columns

4.5 Lateral Loading

Wind lateral loads are considerable, but not as significant as gravity loads from a concrete building. Seismic loads are a major issue since the bulk is so big. Tsunamis are also taken into account owing to San Diego's geopolitical location.

5 OBSERVATIONS

A sphere was determined to be the most logical form for a library, since it could optimise daylight to all the levels, allow a variety of flexible floor configurations, and retain an optimum central circulation system.

The resultant construction was an eight-story tower with two subterranean floors and six varying-sized stories above ground level. The sixth storey has the broadest above-ground level, which is more than 200 feet wide.

Furthermore, because the cube may provide clear floors, the collection can be grouped neatly into big blocks or sections. Because there are fewer floors, it is simpler to reach the books without relying on mechanical vertical circulation.

To prevent them from buckling outward due to the load transmitted by the floors, each pier is linked to its opposite through the ribs by almost three hundred quarter-inch steel tie rods that resist gravitational forces.

6 CONCLUSION

From the above review for long span structures with span more than 8 to 12m the ribbed slab preferred as it saves a lot of cost and is economically beneficial. As the ribbed slab system has more structural stability against the lateral and gravitational forces, it is more preferable.

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