Performance and Comparing RCC beam with Post Tension beam using Dynamic Load Condition of Larger Span Structure

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Abstract:- **In ordinary Reinforced cement concrete beam, compressive stresses are taken up by concrete and tensile stresses by steel alone. The concrete below the neutral axis is ignored since it is weak in tension. Although steel takes up the tensile stresses, the concrete in the tensile zone develops minute cracks. The load carrying capacity of such concrete sections can be increased if steel and concrete both are stressed before the applications of external loads. This is the concept of prestressed concrete. Internal prestressing can be done by two methods Pre-tensioning and Post-tensioning. In Pre-tensioning system, the tendons are first tensioned between rigid anchor blocks cast on ground or in a column or unit-mould type pre-tensioning bed, prior to the casting of concrete in the moulds. In Post-tensioning, the concrete units are first cast by incorporating ducts or grooves to house the tendons. When the concrete attains sufficient strength, the high-tensile wires are tensioned by means of jack bearing on the end face of the member and anchored by wedges or nuts. The space between the tendons and the duct is generally grouted after the tensioning operation. Referring particularly to post tensioning applications, it is generally recognized how it opens the possibility to improve economy, structural behaviour and aesthetic aspects in concrete solutions. As in modern days post tensioning has been most economical method when compared to the RCC works. The study is subjected to evaluation of performance of RCC deep beam and PT beam slab with multi-storey building system with seismic loading performance using analysis tool ETABS.**

Keywords ***RCC Beam, ETABS, PT Beam, Storey displacement, Storey Shear, Storey Drift.***

I. INTRODUCTION

RCC Structures are commonly utilized for residential and industrial buildings in Asian countries. For small span buildings, PT beams are rarely used. There was a huge disadvantage of expert staff for Pre-Stressing job two decades ago. However, there are currently a significant number of agencies for the execution of a comparable work. Due to deflection limitations in RCC Beams, the depth of the beam increases as the span increases. The depth of the beam is reduced in pre-stressed sections, therefore pre-stressed beams are less expensive for long spans.

PSC is the most recent main type of structural engineering construction introduced. Because the technology is currently available on the market in both developed and developing countries, it has become a well-established construction technique. Today, prestressing is employed in buildings, subterranean structures, communication towers, floating storage and offshore structures, power plants, apparatus boats, and a variety of bridge systems.

The primary style goals for structural engineers are safety, practicability, economy, and current lawfulness of style. Engineers and designers must comprehend the proper use of posttensioned concrete as well as the effects that will result when choosing a structural construction system. If properly evaluated and constructed, concrete buildings composed of high-quality components will offer a superior combination of durability, sound management, and fireplace safety in today's construction market. Given the current market aspects of value options, material availability, and lower floor-to-floor heights, as well as market developer finance, Concrete is generally regarded as a more cost-effective material than steel. Concrete that generates internal stresses of sufficient magnitude and distribution to significantly offset the stresses caused by a given external force.

II. OBJECTIVES

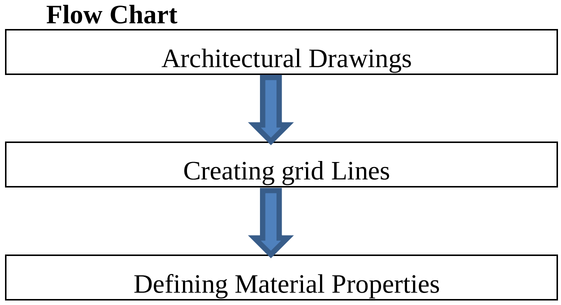
- To analyze the dynamic performance of RCC beam and PT beam of multistorey building system.
- To compare the results of Base Shear, Storey Displacement, Storey drift of RCC beam with PT beam of the multistorey building system.

III. METHODOLOGY

This chapter describes the standard step-by-step method for modelling the two different regular structure with RCC Beam and PT Beam

- Model Type 1- RCC Structure
- Model Type 2- Post-Tension Structure

Flow Chart



Defining Section Properties

Slab Details

Assigning Properties

Definition and assigning Loads

Assigning Supports

Defining Response Spectrum

Analyzing the building

STEP-BY-STEP METHOD FOR MODELLING OF THE STRUCTURE

Step1: Collection of data related to RCC and PT structure considering software implementation

Number of Stories	G+10
Plan Dimension	16*15
FL to GL	1.5m
F to F height	3m
Materials	M40 grade concrete and Fe500 Steel
Size of Column	300mm X 800mm
Size of Beam	500mm X 500mm
Slab Thickness	150mm
Seismic Zone	Zone IV

Step2: Modeling Both RCC and PT Structures in ETABS

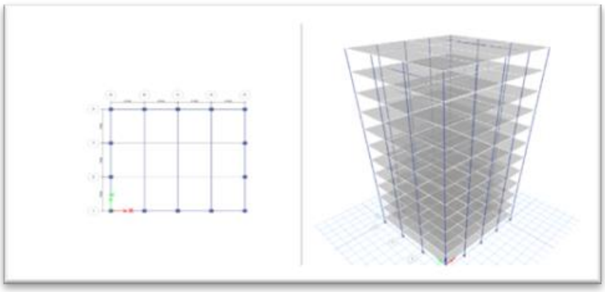


Fig-1: Plan of RCC Building

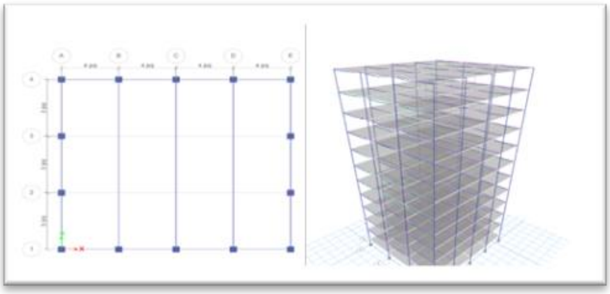


Fig-2: Plan of PT Building

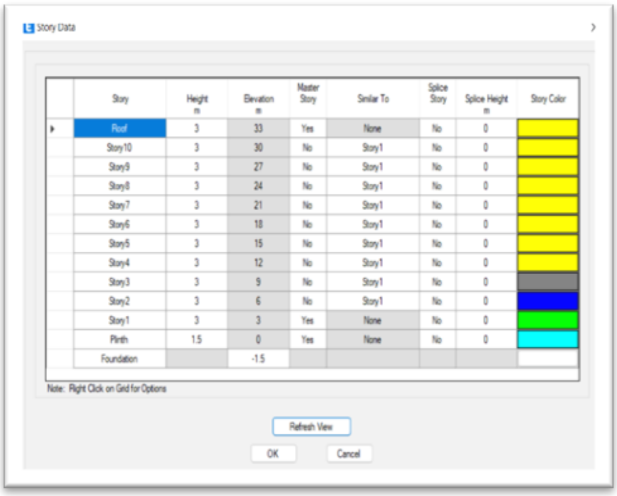


Fig-3: Storey Data

Step 3: Generating Material Properties (M40 & HYSD500)

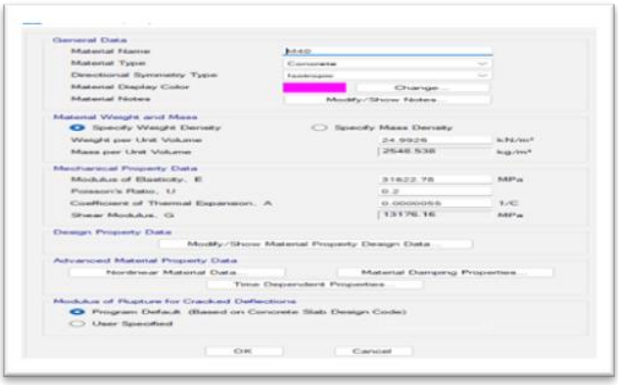


Fig-4: M-40 Concrete

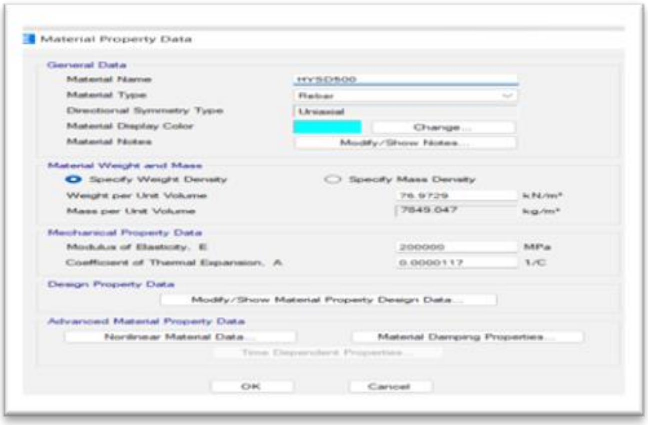


Fig-5: HYSD500

Step 4: Creating beam and column section of the structure

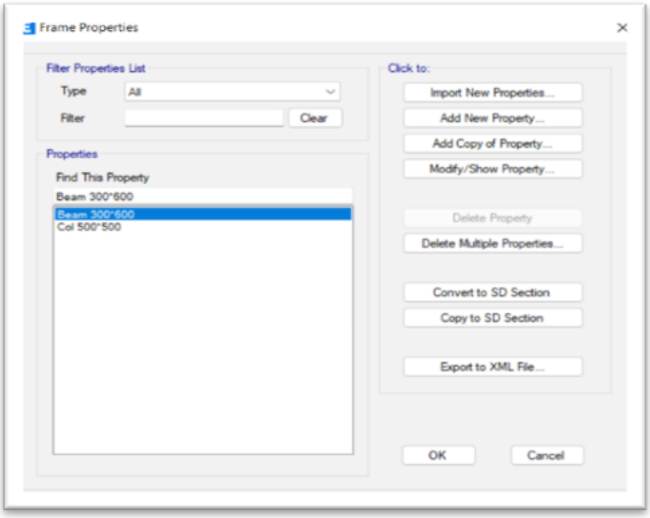


Fig-6: Section Properties of a Frame

Step 5: Drawing Tendons to the beams for PT Structure

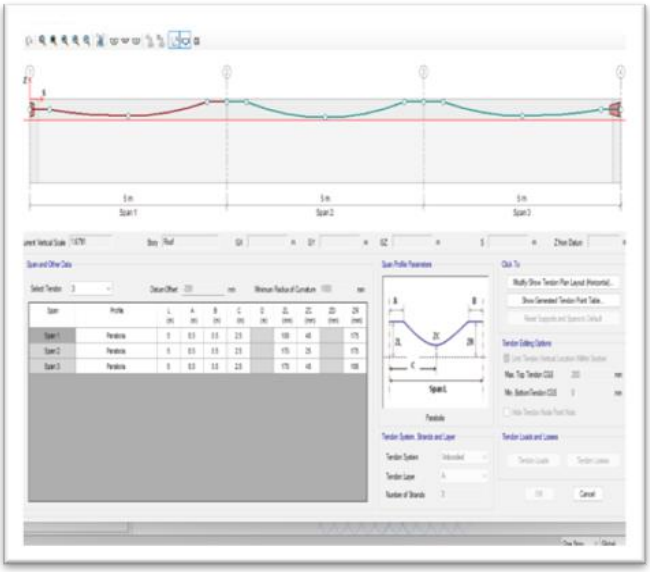


Fig-7: Tendon Vertical Profile

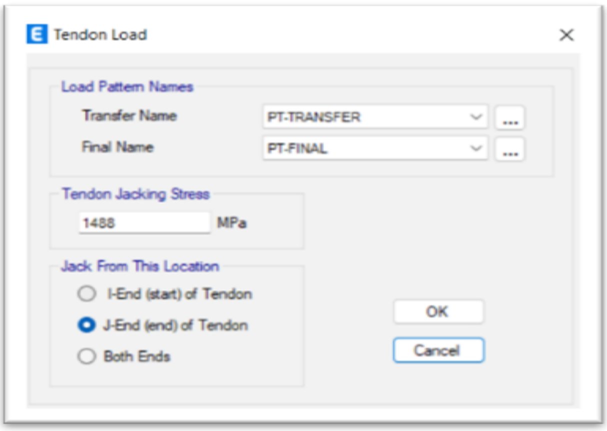


Fig-8: Tendon Load

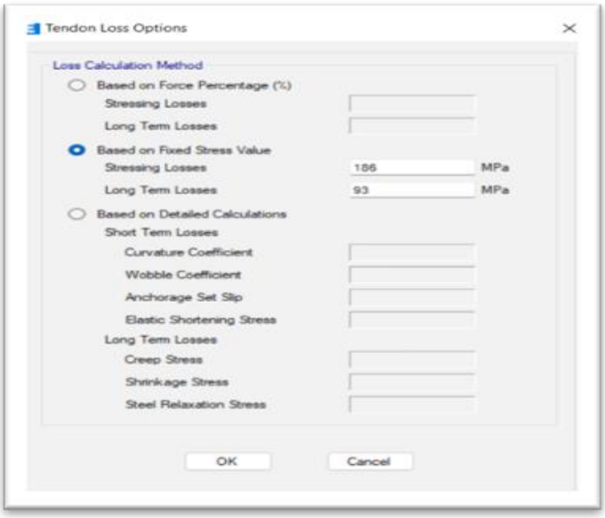


Fig-9: Tendon Losses

Step 7: Defining Seismic Load

The loading due to earthquake is assessed based on the provisions of IS: 1893-2016

Seismic zone	= IV
Zone Factor	= 24
Response reduction factor	= 5
Importance facto	= 1.2
Method of analysis	= Response Spectrum Analysis

Step 8: Load Combinations:

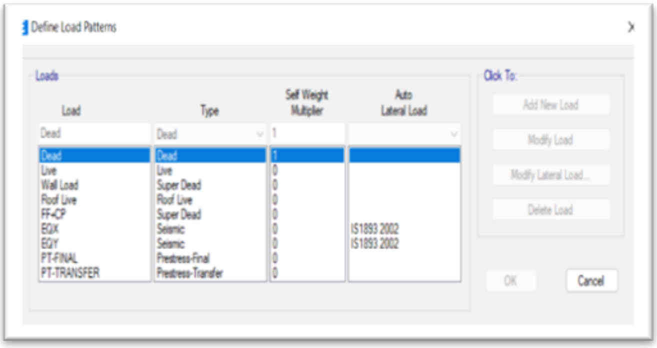


Fig-10: Load Cases

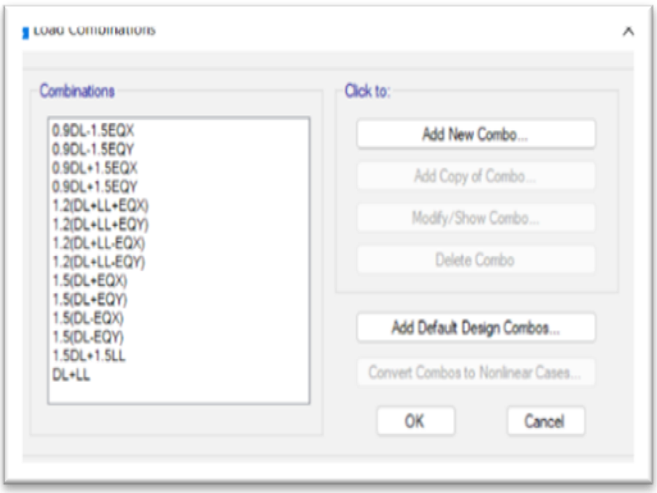


Fig-11: Details of Load combinations for RCC structure

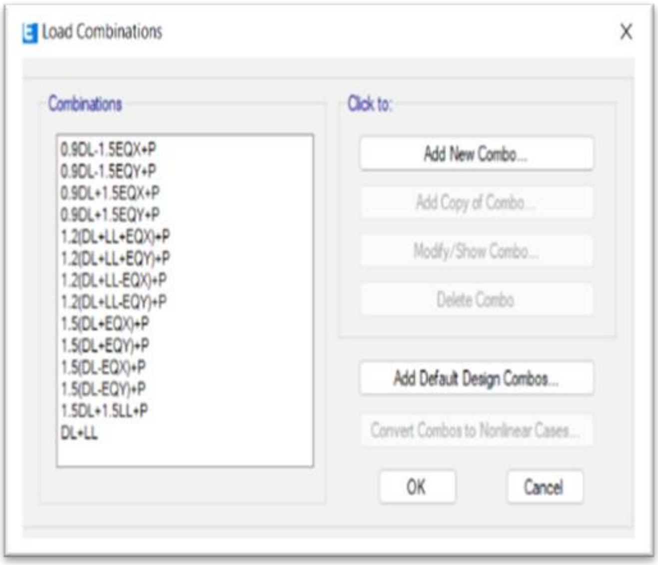


Fig-12: Details of Load combination for PT structure

STEP 9: Defining Response Spectrum Function I.S. 1893: I:2002

A designer is rarely concerned with the building's reaction at all times; maximal response is enough information to design a suitably strong structure. This approach graphs the relationship between maximum spectral acceleration and A construction of many historical periods is created for some ground. Every occurrence of acceleration and structural response Time is not taken into account. It is the response spectrum approach. Method of linear dynamic analysis This procedure entails the only the greatest displacement values are calculated and member forces in each vibrational mode This technique utilizes the average of many smooth design spectra earthquake movements Different earthquakes will have different results. response spectrum, but for the convenience of the structural engineer IS 1893:2002 specifies a general-purpose response spectrum which is deduced from considering few big earthquakes from past.

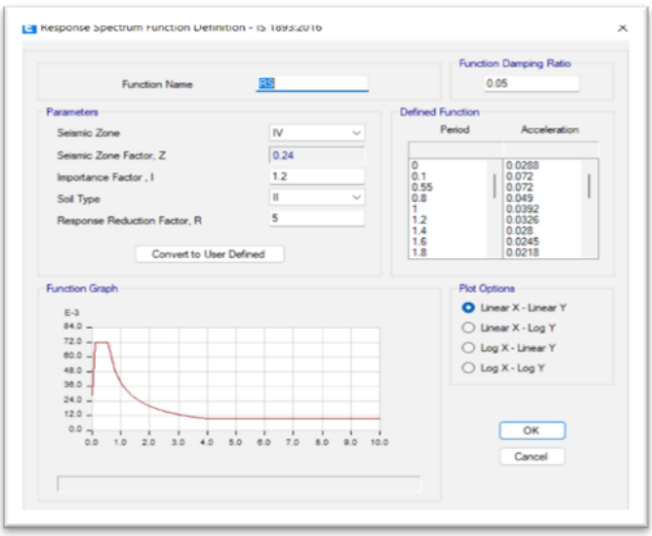


Fig-13: Response spectrum as per I.S. 1893: I:2002

IV. RESULTS AND DISCUSSION

In the present study, RC Structure and PT structure of same structural properties are modelled and analyzed using ETABS 2019. Structures are analyzed for Response Spectrum analysis methods as per IS 1893 2002. Core results are extracted and presented in the present chapter 4 as below and conclusions are made in chapter 5 based on the brief discussion of results.

Following Graphs demonstrates the max Storey displacement, Storey Drift, Time Period, Base Shear of PT Structure and RC Structure carried out by Response Spectrum Analysis (RSA)

A. STOREY DISPLACEMENTS

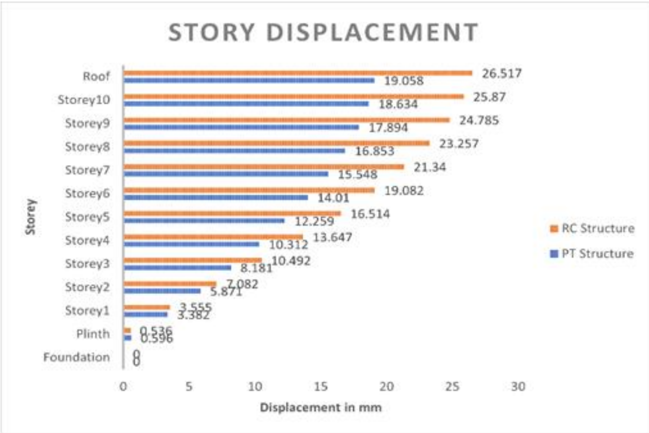


Chart-1: Storey vs Displacement

Storey displacement results are presented in the form of graphs in Chart 1. From the results, it can be seen that structures with PT beams have fewer displacements than structures with RCC beams. A RCC structure has a maximum displacement of 26.517mm at roof whereas a PT structure has a maximum displacement of 19.058mm, which is 28.13% less than the RC structure.

B. STOREY DRIFT

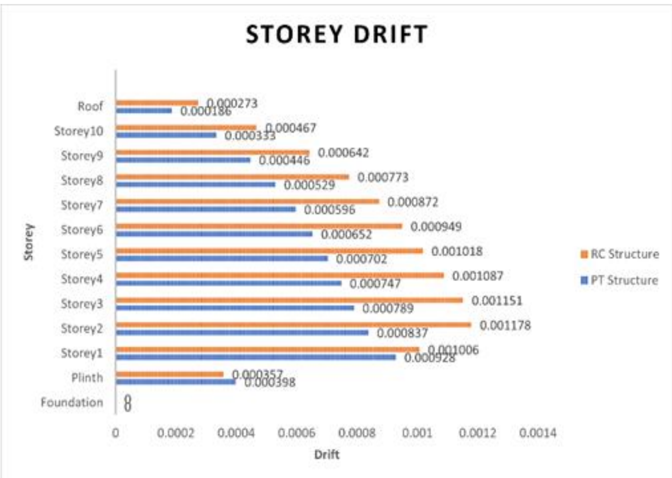


Chart -2: Storey vs Drift

Storey drift results are presented in the form of graphs in Chart 2. From the results, it can be seen that structures with PT beams have less storey drift than structures with RCC beams. The max drift that occurs in the RC structure is

0.001178mm, where as in the PT structure it is 0.000837, i.e., a 29% decrease.

C. BASE SHEAR (KN)

TABLE 1 BASE SHEAR

	PT Structure	RC Structure
Base Shear (KN)	**668.3024**	**954.477**

Base Shear values are shown in Table -1, From the results it can be seen that Base Shear value decreased by 30% in PT structure.

STOREY SHEAR

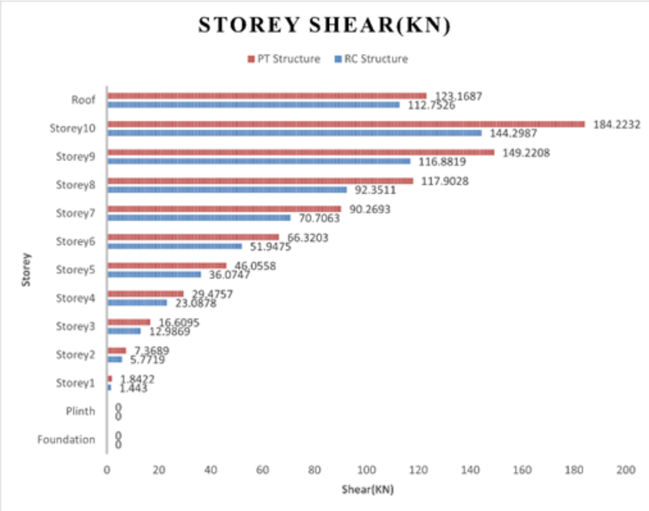


Chart-3: Storey shear

Storey Shear is shown in chart-3, from the results it can be seen that, maximum storey shear occurs at storey 10. The PT structure has a Soc 21.67% lower storey shear than the RCC structure at storey10.

V. CONCLUSIONS

The following conclusions are drawn from the present study:

- As shown in Chart-1, PT structures have lower storey displacements when compared to RCC structures.
- As shown in Chart-2, PT structures have lower storey drift when compared to RCC structures.
- When the RCC beam is replaced with a PT beam, the base shear decreases as shown in Table 1.

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