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Significance of Clause 24.2 of I.S. Code 456: 2000- Assumption of Substitute Frame

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Abstract: ***For the good design of any structure, it is very essential to first analyze it unerringly. Here my interest is with reinforced cement concrete framed structure. In my country, for the design of reinforced cement concrete framed structure buildings we adopt I.S. 456. As per clause 22 of I.S. 456:2000 "All structures may be analyzed by the linear elastic theory to calculate internal actions produced by design loads". Instead of rigorous elastic analysis, a simplified analysis as given in clause 22.4 for frames and as given in clause 22.5 for continuous beams may be adopted. The present work is carried out to check the significance of these assumptions mention in the code, when I analyze with substitute frame assumption. Here, we do the analysis as per clause 22.4 (with moment distribution method).***

Keywords: Substitute Frame, moment distribution method

1. Introduction

For this study, I take a frame structure building G + 2 and compare the results for gravity loading only. The whole plan area of this building is 108.16 square meters. The floor to floor height is 3.5m throughout. The height of columns from footing top to middle of the ground floor roof beam is 4.7 meters. Figure 1 shows the column layout and typical, beam arrangement.

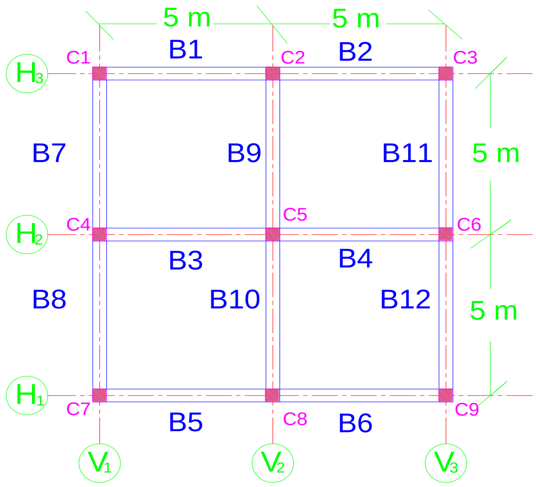

Figure 1: Typical Column Beam Layout of Structure

To nomenclature the nodes of the structure, I represent the node of the terrace roof level which lies at the intersection of the grid V_1 and grid H_3 as V_1H_3R and for convenience, I represent that node as 13R. Similarly, a node of the second floor at the same intersection of grids is represented as 13S, likewise, a node of the first floor and node at the footing junction at the same intersection of grids are represented as 13F and 13G'.

1) Load Calculations

To analyze this structure I considered some data. Live Load at the typical floor is 4 KN/m^2 and on the terrace, it is 2 KN/m^2. Dead Load of floor finishes $1KN/m^2$. Dead Load of terrace waterproofing is $2KN/m^2$. The floor and parapet walls are 230mm thick with a 12.5 mm plaster on both the faces. The density of reinforced cement concrete is taken 25 KN/m^3. The density of waterproofing on the terrace is 20 KN/m^3. The density of the floor finish is $1KN/m^3$ and the weight of movable wooden partitions is 1 KN per square meter floor area. The density of plastered brickwork is 20 KN/m^3. The slab thickness is 100mm. All beams and columns are of size 400mm by 400mm. The height of the parapet wall is 1m. Table 1 & 2 shows the dead load (D.L.) & live load (L.L.) component for the terrace and other floors respectively.

On terrace floor D.L. is 5.5 KN/m^2 and L.L. is 2.0 KN/m^2. On first and second floor D.L. is 4.5 KN/m^2 and L.L. is 4.0 KN/m^2.

Load on beam B1-B2 / B5-B6/ B7-B8/ B11-B12 of terrace floor per meter length = 15.975 KN/m (DL) + 2.5 KN/m (LL)

Load on beam B3-B4 / B9-B10 of terrace floor per meter length = 22.85 KN/m (DL) + 5.0 KN/m (LL)

Load on beam B1-B2 / B5-B6/ B7-B8/ B11-B12 of first and second floor per meter length = 25.435 KN/m (DL) + 5.0 KN/m (LL)

Load on beam B3-B4 / B9-B10 of first and second floor per meter length = 31.06 KN/m (DL) + 10.0 KN/m (LL)

2) Analysis of Building with Substitute Frame Assumption

"The simplifying assumptions as given in 22.4.1 to 22.4.3 may be used in the analysis of frames" Clause 22.4 of code [Indian Standard, I.S. Code 456: 2000]. In sub clause 22.4.2 code propose to use substitute frame if building is symmetrical or not very tall. As our building is symmetrical and not very tall I choose substitute frame assumption. As this building is simple and symmetrical so only two substitute frames for each story are sufficient to analyze that story. Fig 2.1- 2.2, 2.3 – 2.4 and 2.5 – 2.6 shows the substitute frame for terrace floor, second floor and first floor respectively. Substitute frame of beam B5 - B6, B7- B8 and B11 - B12 are identical in dimension, section properties and in loading to substitute frame of beam B1 - B2 at each floor respectively. Similarly, substitute frame of beam B9 - B10 is identical in dimension, section properties and in loading to substitute frame of beam B3 - B4 at every floor respectively.

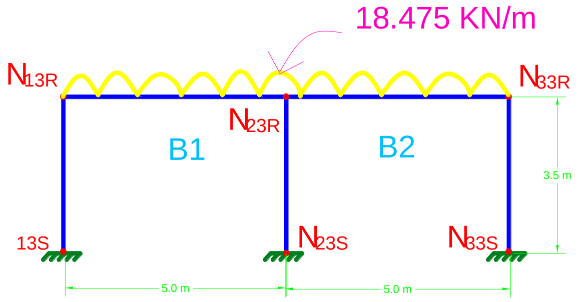

Figure 1: Substitute Frame -1 for the Terrace Floor Beam B1 - B2 (TSF1)

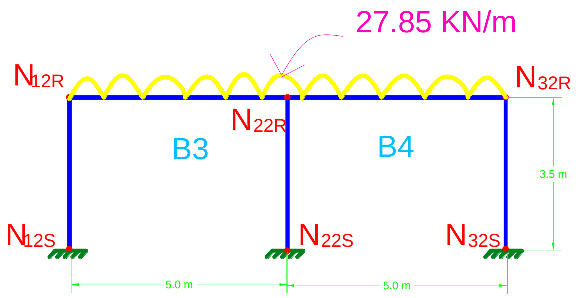

Figure 2: Substitute Frame - 2 for the Terrace Floor Beam B3 - B4 (TSF2)

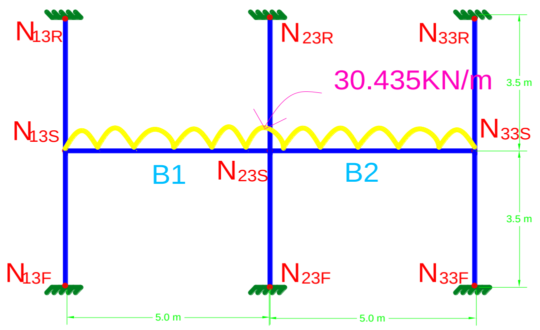

Figure 3: Substitute Frame -1 for the Second Floor Beam B1 - B2 (SSF1)

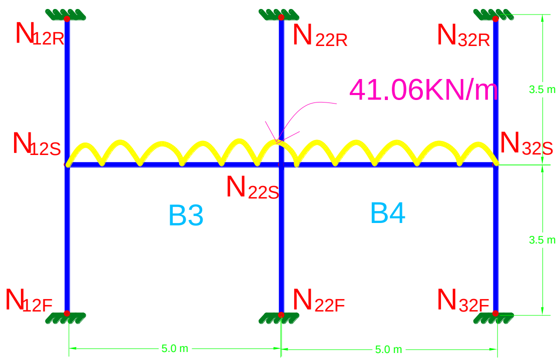

Figure 4: Substitute Frame -2 for the Second Floor Beam B3 – B4 (SSF2)

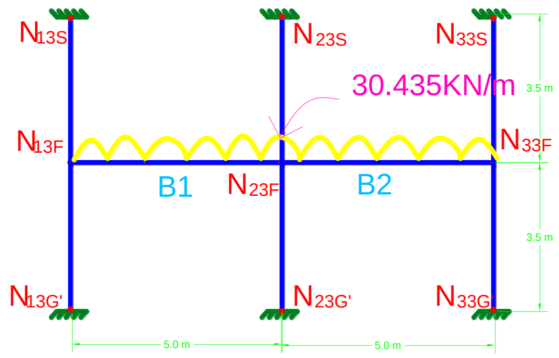

Figure 5: Substitute Frame -1 for the First Floor Beam B1 - B2 (FSF1)

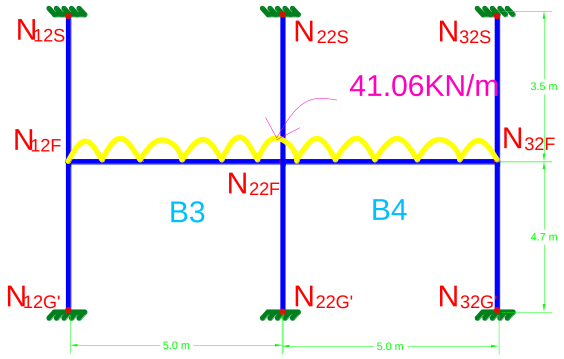

Figure 6: Substitute Frame -2 for the First Floor Beam B3 – B4 (FSF2)

2. Analysis Results

Table 1 to 6 shows the bending moment at the various locations.

Table 1: Result of Substitute Frame (TSF1)

		By analyze Substitute Frame
Maximum Hogging Moment in KN- m at Node	33R	22.78
	23R	45.91
	13R	22.78
Maximum Sagging Moment in KN- m for span	23R- 33R	23.971 2.25 m from 33R
	13R- 23R	23.971 2.25 m from 13R

Table 2: Result of Substitute Frame (TSF2)

Particulars		By analyze Substitute Frame
Maximum Hogging Moment in KN- m at Node	32R	34.34
	22R	69.20
	12R	34.34
Maximum Sagging Moment in KN- m for span	22R- 32R	36.135 2.25 m from 12R
	12R- 22R	36.135 2.25 m from 12R

Table 3: Result of Substitute Frame (SSF1)

Particulars		By analyze Substitute Frame
Maximum Hogging Moment in KN- m at Node	33S	47.17
	23S	71.16
	13S	47.17
Maximum Sagging Moment in KN- m for span	23S- 33S	36.319 2.34 m from 33S
	13S- 23S	36.319 2.34 m from 13S

Table 4: Result of Substitute Frame (SSF2)

Particulars		By analyze Substitute Frame
Maximum Hogging Moment in KN- m at Node	32S	63.64
	22S	96.01
	12S	63.64
Maximum Sagging Moment in KN- m for span	22S- 32S	48.998 2.34 m from 32S
	12S- 22S	48.998 2.34 m from 12S

Table 5: Result of Substitute Frame (FSF1)

Particulars		By analyze Substitute Frame
Maximum Hogging Moment in KN- m at Node	33F	45.61
	23F	71.79
	13F	45.61
Maximum Sagging Moment in KN- m for span	23F- 33F	36.862 2.327 m from 33F
	13F- 23F	36.862 2.327 m from 13F

Table 6: Result of Substitute Frame (FSF2)

Particulars		By analyze Substitute Frame
Maximum Hogging Moment in KN- m at Node	32F	61.53
	22F	96.85
	12F	61.53
Maximum Sagging Moment in KN- m for span	22F- 32F	49.73 2.33 m from 32F
	12F- 22F	49.73 2.33 m from 12F

3. Conclusion

Respected authors [B.C. Punmia, et al., 2000] write in his book that "A simple method of analysis, accurate enough for practical purpose, is used by analyzing substitute frame, rather than analyzing the whole frame". We compare the analysis results obtained from analyzing the whole structure and substitute frames; we observe that there is a slight variation in the sagging moment value.

References

[1] Indian Standard (I.S. Code 456: 2000) "Plain and Reinforced Concrete - Code of Practice".
[2] B.C. Punmia, Ashok Kumar Jain and Arun Jain. Theory of Structure SMTS- 2 of Laxmi Publications Pvt. Ltd. (2000), page number 885.