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# Sway Analysis of Rigid Jointed Portal Frame by Using Simplified Approach Method in Rotation Contribution Method (Kani's Method)

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**ABSTRACT**
Analysis of rigid jointed portal frame involves lots of complication and tedious calculation by using displacement factor and conversion factor in Kani's method. Displacement factor is required in Kani's method during the sway analysis. As support condition, modulus of rigidity, or height of portal change etc, it becomes tedious to analysis the frame. In this work sway analysis of rigid jointed portal frame has been carried by using simplified approach method instead of tedious calculation of the displacement factor and conversion factor. In this work non sway analysis and sway analysis done separately and final moments are calculated by using ratio of sway force and arbitrary applied sway force.

***Keywords:*** Displacement factor, Kani's Method, Portal Frame, Rotation Contribution Method, Simplified approach Method, Slope Deflection Method.

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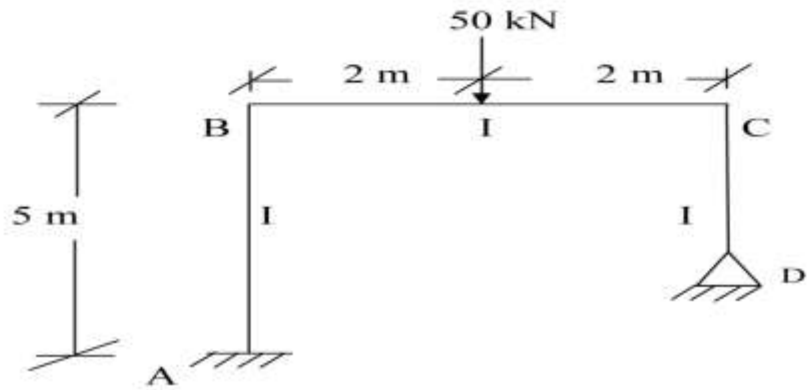
## I. INTRODUCTION

An elegant and systematic approach for analysis of rigid-jointed portal by hand computations was proposed by Gasper Kani in Germany. The calculations are made easier by analyzing the non sway and sway analysis separately without incorporation displacement & conversion factor. Non sway analysis is carried out by applying imaginary resisting force. The moments are calculated as per the Rotation Contribution method. Arbitrary displacement is applied and sway force is calculated by conventional Kani's method without requirement of displacement factor. The final moment are calculated by considering the ratio of sway force and applied sway force due to arbitrary displacement. Methodology adopted in this paper for sway analysis of rigid-jointed portal frame by simplified approach method i.e. without incorporation of displacement& conversion factor and same numerical is solved by Slope Deflection method and results are compared.

**ANALYSIS OF RIGID JOINTED PORTAL FRAME**



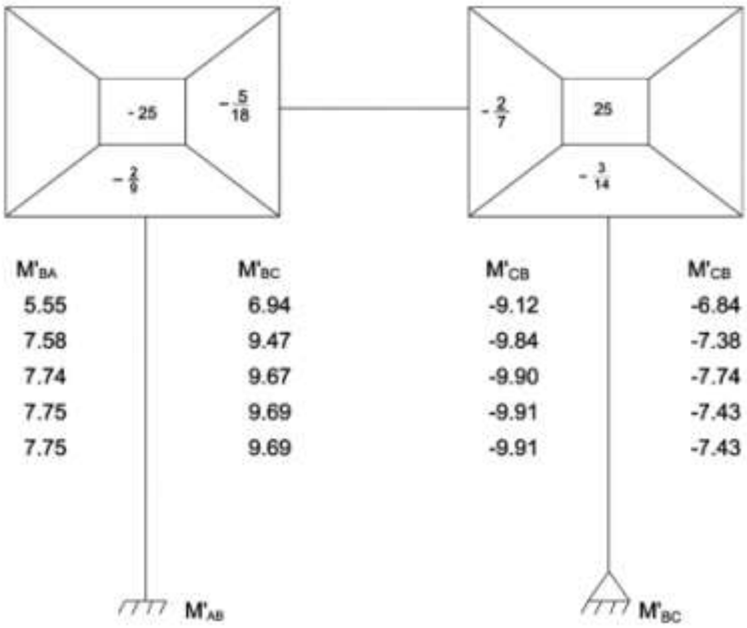
**Calculation of rotation factor**

| Joint | Member | Stiffness | Total stiffness | Distribution factor | Rotation factor |
|---|---|---|---|---|---|
| B | BA | I/5 | 0.45I | 4/9 | -2/9 |
| | BC | I/4 | | 5/9 | -5/18 |
| C | CB | I/4 | $\frac{7}{16}$I | 4/7 | -2/7 |
| | CD | ¾ I/4 | | 3/7 | -3/14 |

**Non-Sway analysis:-**
Calculation of fixed end moment
1) For member AB and CD = 0
2) For member BC

$$\overline{M}_{BC} = \frac{Wab^2}{L^2} = \frac{-50 \times 2 \times 2^2}{4^2} = -25\ kN\text{-m}$$

$$\overline{M}_{CB} = +\frac{Wa^2b}{L^2} = +25\ kN\text{-m}$$



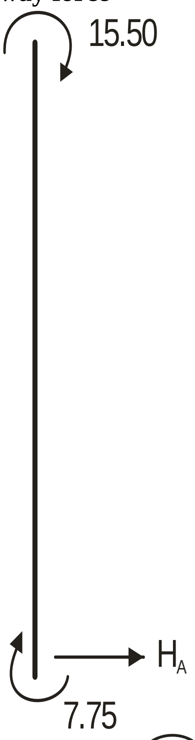

$$M_{AB} = \overline{M}_{AB} + 2M'_{AB} + M'_{BA}$$
$$= 0 + 7.75 + 0 = 7.75\ kN - m$$
$$M_{BA} = 0 + 2 \times 7.75 + 0 = 15.50\ kN - m$$
$$M_{BC} = \overline{M}_{BC} + 2M'_{BC} + M'_{CB}$$
$$= -25 + 2 \times 9.69 - 9.91 = -15.53\ kN - m$$
$$M_{CB} = \overline{M}_{CB} + 2M'_{CB} + M'_{BC}$$
$$= 25 - 2 \times 9.91 + 9.69 = 14.87\ kN - m$$

$$M_{CD} = \overline{M}_{CD} + 2M'_{CD} + M'_{DC}$$

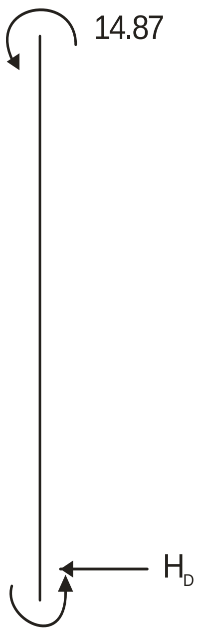
$$= 0 - 2 \times 7.43 + 0 = -14.87\ kN - m$$

$$M_{DC} = 0.00\ kN - M$$

**Calculation of sway force**



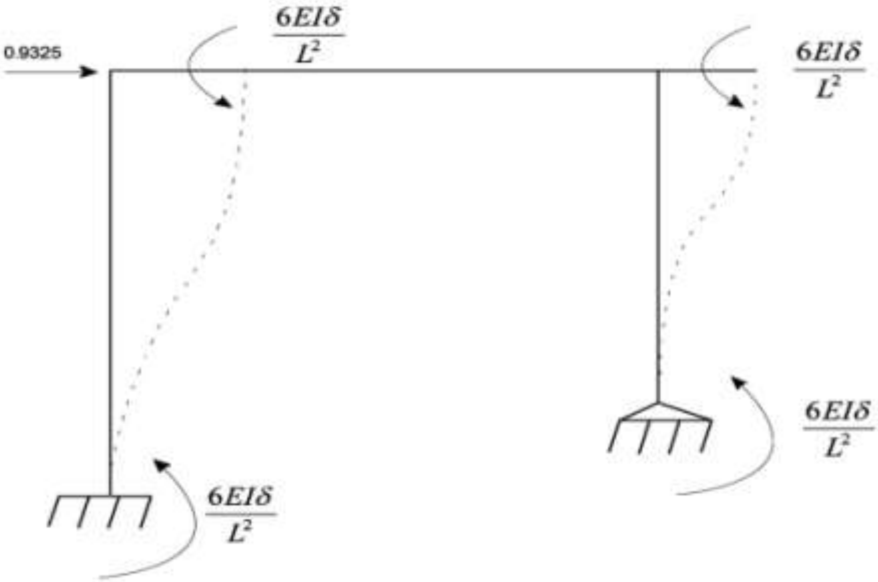

$$H_A = \frac{15.50 + 7.75}{5} = 465 kN$$




$$H_D = \frac{14.87}{4} = 3.71\ kN$$

$$Sway\ \ force = 4.65 - 3.71 = 0.93\ \ kN$$

**Assume all supports are fixed**



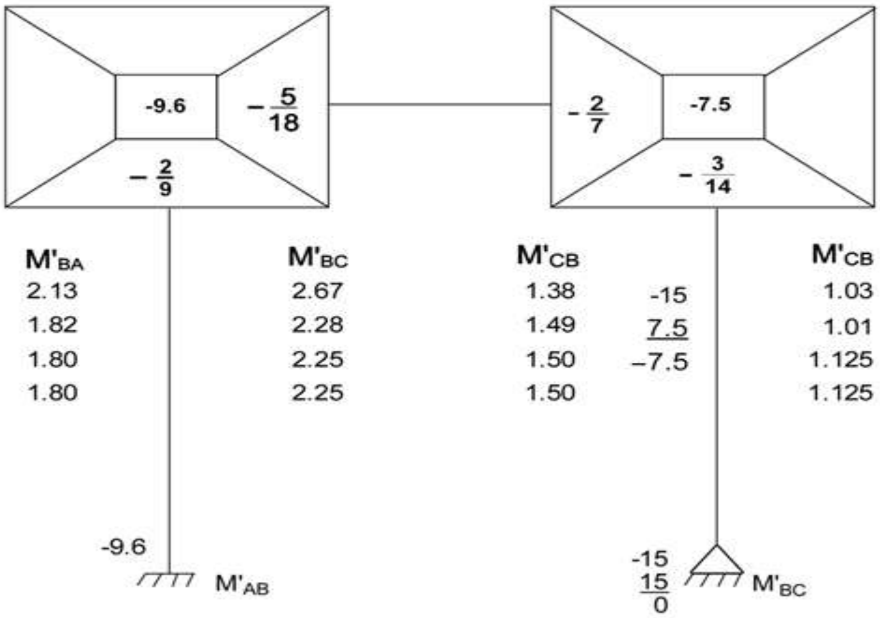

**Assume the value of** $EI\,\delta = 40$
**Fixed and moment due to sway force**

$$\overline{M}_{AB} = \frac{-6 \times 40}{5^2} = -9.6 \; kN - m$$

$$\overline{M}_{BA} = -9.6 \; kN - m$$

$$\overline{M}_{CD} = \frac{-6 \times 40}{4^2} = -15 \; kN - m$$

$$\overline{M}_{BC} = -15 \; kN - m$$



$$M_{AB} = -9.6 + 0.00 + 1.80 = -7.80 \ kN - m$$

$$M_{BA} = -9.6 + 2 \times 180 + 0.00 = -6.0 \ kN - m$$

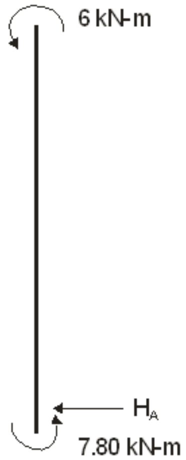
$$M_{BC} = 0.00 + 2 \times 2.25 + 1.50 = 6.0 \ kN - m$$

$$M_{CB} = 0.00 + 2 \times 1.5 + 2.25 = 5.25 \ kN - m$$

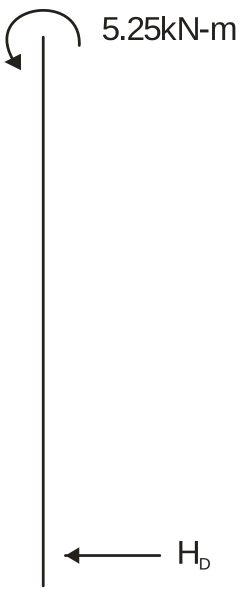
$$M_{CD} = 0.00 - 7.5 + 2 \times 1.125 = -5.25 \ kN - m$$

$$M_{DC} = 0.00 \ kN - m$$

**Calculation of sway force due to arbitrary force:-**




$$H_A = \frac{6 + 7.80}{5} = 2.76 \ kN$$




$$H_D = \frac{5.25 + 0}{4} = 1.312$$

$$Sway \ \ force = 1.312 + 2.76$$

$$= 4.072 \rightarrow kN$$

$$Correction\ Factor = \frac{0.93 \rightarrow}{4.072 \rightarrow}$$

$$= 0.228$$

**FINAL MOMENTS CALCULATION**

| Member / Moment | Member AB | | Member BC | | Member CD | |
|---|---|---|---|---|---|---|
| | **AB** | **BA** | **BC** | **CB** | **CD** | **DC** |
| **Non-Sway Moment (kN-m)** | 7.75 | 15.50 | -15.50 | 14.87 | -14.87 | 0 |
| **Sway Moment (kN-m)** | -7.8 | -6.00 | 6.00 | 5.25 | -5.25 | 0 |
| **Correction Moment (kN-m)** | 0.228x(-7.8) = -1.77 | 0.228x(-6.0) = -1.36 | 0.228x6.0 = 1.36 | 0.228x5.25 = 1.197 | 0.228x(-5.25) = -1.197 | 0 |
| **Final Moment (kN-m)** | 5.98 | 14.14 | -14.14 | 16.06 | -16.06 | 0 |
| **Slope Deflection Method (kN-m)** | 5.96 | 14.134 | -14.134 | 16.08 | -16.08 | 0 |

## II. CONCLUSION

This study shows that incorporation of simplified approach method in kanis method is easier, quick and reduce the tedious calculation, and no need of liner displacement factor and conversion factor. By incorporation of simplified approach method, sway analysis for single storey rigid jointed frame is analyzed and results are compared with slope deflection method. Simplified approach method is same for asymmetry in height of column, asymmetric support condition and asymmetric moment of inertia.

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