3.1 MOMENT DISTRIBUTION METHOD

Objectives:

Definition of stiffness, carry over factor, distribution factor. Analysis of continuous beams without support yielding – Analysis of continuous beams with support yielding – Analysis of portal frames – Naylor's method of cantilever moment distribution – Analysis of inclined frames – Analysis of Gable frames.

3.1.1 INTRODUCTION

The end moments of a redundant framed structure are determined by using the classical methods, viz. Clapeyron's theorem of three moments, strain energy method and slope deflection method. These methods of analysis require a solution of set of simultaneous equations. Solving equations is a laborious task if the unknown quantities are more than three in number. In such situations, the moment distribution method developed by Professor Hardy Cross is useful. This method is essentially balancing the moments at a joint or junction. It can be described as a method which gives solution by successive approximations of slope deflection equations.

In the moment distribution method, initially the structure is rigidly fixed at every joint or support. The fixed end moments are calculated for any loading under consideration. Subsequently, one joint at a time is then released. When the moment is released at the joint, the joint moment becomes unbalanced. The equilibrium at this joint is maintained by distributing the unbalanced moment. This joint is temporarily fixed again until all other joints have been released and restrained in the new position. This procedure of fixing the moment and releasing them is repeated several times until the desired accuracy is obtained. The experience of designers points that about five cycles of moment distribution lead to satisfactory converging results.

Basically, in the slope deflection method, the end moments are computed using the slopes and deflection at the ends. Contrarily in the moment distribution method, as a first step — the slopes at the ends are made zero. This is done by fixing the joints. Then with successive release and balancing the joint moments, the state of equilibrium is obtained. The release-balance cycles can be carried out using the following theorems.

In Conclusion,when a positive moment M is applied to the hinged end of a beam and a positive moment of M will be transformed to the fixed end.

3.1.2 IMPORTANT FACTORS

- Carry over moment carry over factor
- Relative stiffness or stiffness factor
- Distribution moment and distribution factor.

3.1.3 BASIC DEFINITIONS OF TERMS IN THE MOMENT DISTRIBUTION METHOD

(a) Stiffness

Rotational stiffness can be defined as the moment required to rotate through a unit angle (radian) without translation of either end.

(b) Stiffness Factor

(i) It is the moment that must be applied at one end of a constant section member (which is unyielding supports at both ends) to produce a unit rotation of that end when the other end is fixed, i.e. $k = 4EI/l$.

(ii) It is the moment required to rotate the near end of a prismatic member through a unit angle without translation, the far end being hinged is $k = 3EI/l$.

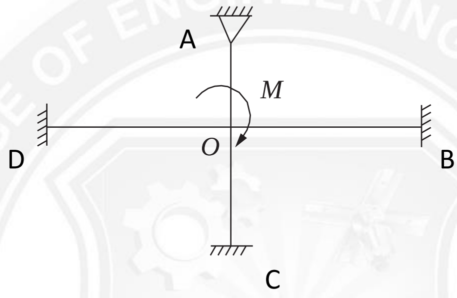
(c) Carry over factor

It is the ratio of induced moment to the applied moment (Theorem 1). The carry over factor is always (1/2) for members of constant moment of inertia (prismatic section). If the end is hinged/pin connected, the carry over factor is zero. It should be mentioned here that carry over factors values differ for non-prismatic members. For non-prismatic beams (beams with variable moment of inertia); the carry over factor is not half and is different for both ends.

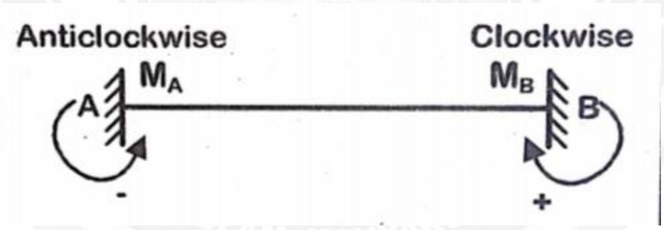
Carry over factor = Carry over moment / Applied moment

(d) Distribution Factors

Consider a frame with members *OA*, *OB*, *OC* and *OD* rigidly connected at *O* as shown in Fig. 2.6. Let *M* be the applied moment at joint *O* in the clockwise direction. Let the joint rotate through an angle θ. The members *OA*,*OB*,*OC* and *OD* also rotate by the same angle θ.



3.1.4 SIGN CONVENTION



Clockwise moments are considered positive and anticlockwise moments negative.

3.1.5 BASIC PROCEDURES IN THE MOMENT DISTRIBUTION METHOD

- Assuming all the members as fixed at the both ends.
- Calculate fixed end moments due to external loads.
- At hinged supports (or) simply supported supports,release the points by applying equal and opposite moment.
- Calculate stiffness factor at each joint.
- Unbalanced moment at a point,is distributed to the adjacent spans according to their distribution factors.
- Proceed this process to get the required degree of precision.