6. SLOPE DEFLECTION METHOD

6.1 SLOPE DEFLECTION METHOD - AN OVERVIEW

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6.2 INTRODUCTION

As mentioned earlier, it is a displacement based analysis for indeterminate structures - Unknown displacements are first written in terms of the loads by using load-displacement relationships; then these equations are solved for the displacements. Once the displacements are obtained, unknown loads are determined from the compatibility equations using load-displacement relationships.

- Nodes: Specified points on the structure that undergo displacements (and rotations)
- Degrees of Freedom: These displacements (and rotations) are referred to as degrees of freedom

6.2 Introduction

To clarify these concepts we will consider some examples, beginning with the beam in Fig. 1(a). Here any load P applied to the beam will cause node A only to rotate (neglecting axial deformation), while node B is completely restricted from moving. Hence the beam has only one degree of freedom, θ_A. The beam in Fig. 1(b) has node at A, B, and C, and so has four degrees of freedom, designed by the rotational displacements θ_A, θ_B, θ_C, and the vertical displacement Δ_C. Consider now the frame in Fig. 1(c). Again, if we neglect axial deformation of the members, an arbitrary loading P applied to the frame can cause nodes B and C to rotate nodes can be displaced horizontally by an equal amount. The frame therefore has three degrees of freedom, θ_A, θ_B, Δ_B.

6.2 INTRODUC

Fig. 1 (a)

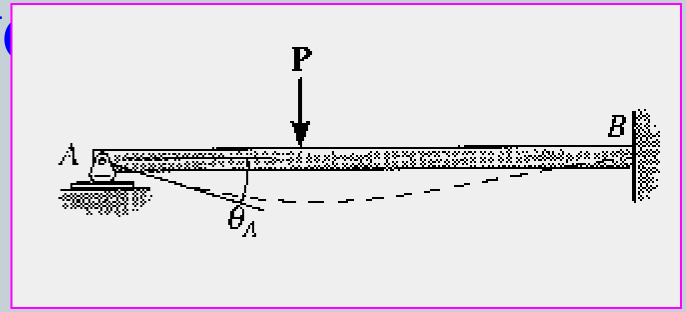


Fig. 1 (b)

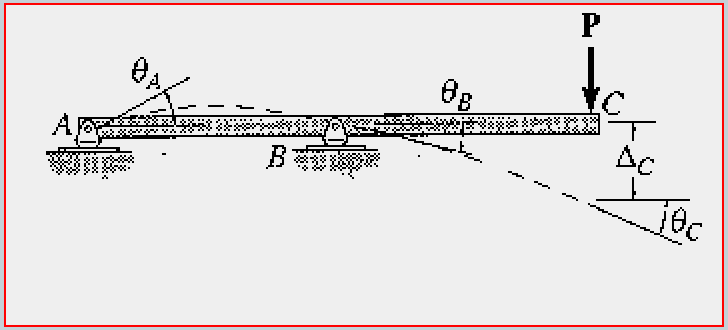
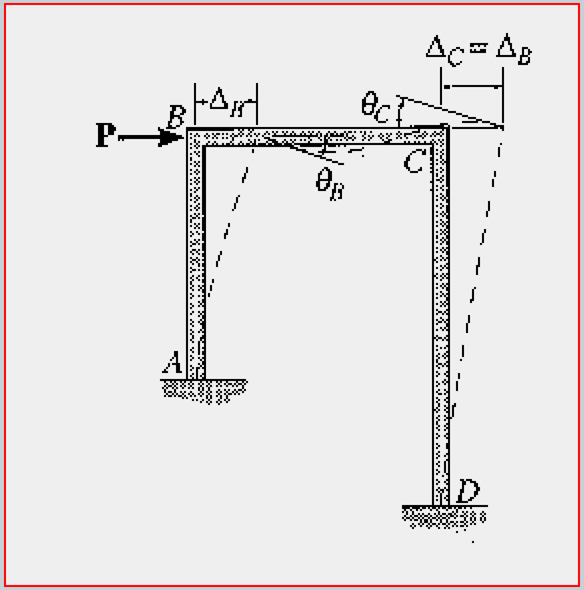
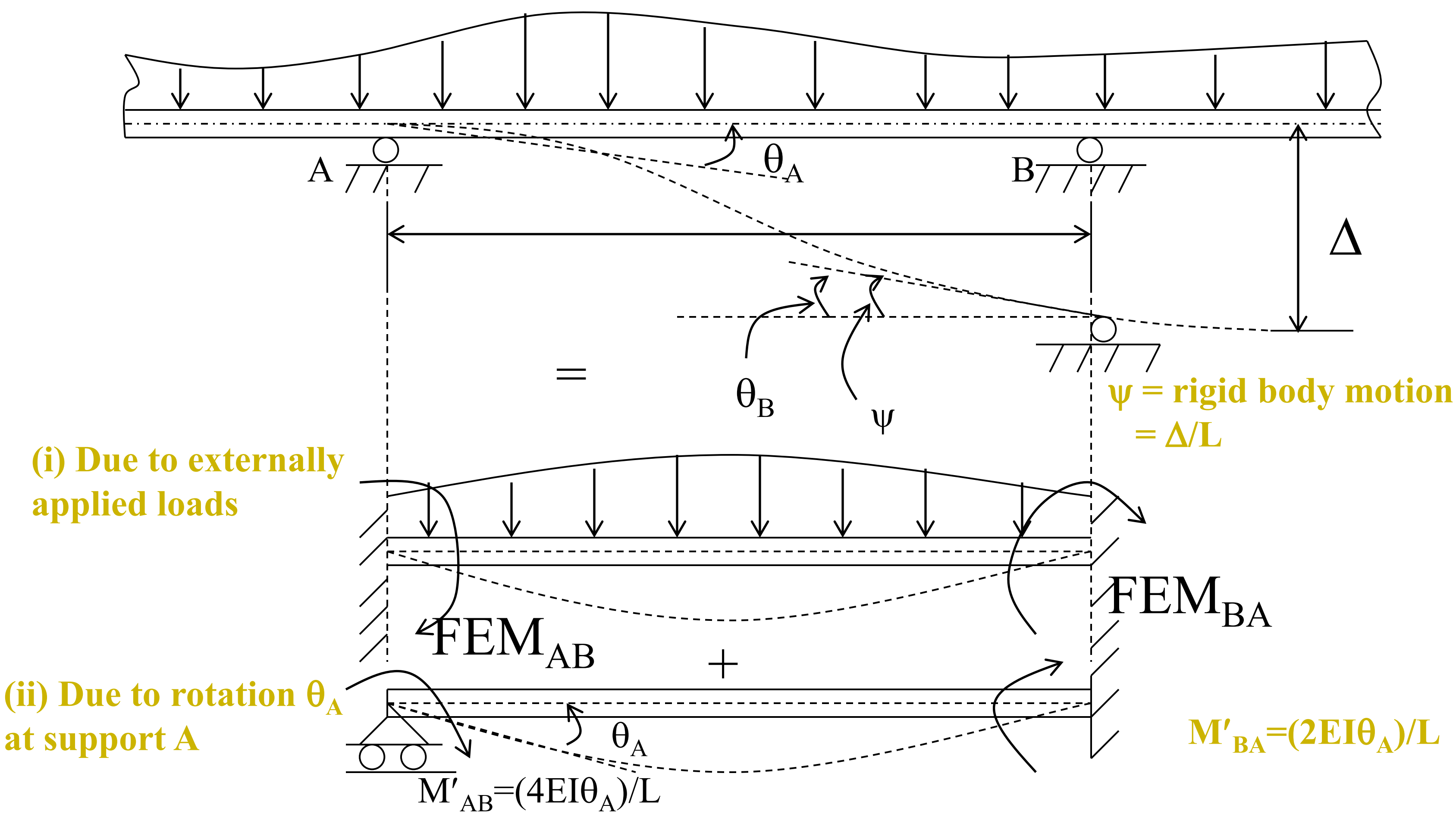


Fig. 1 (c)



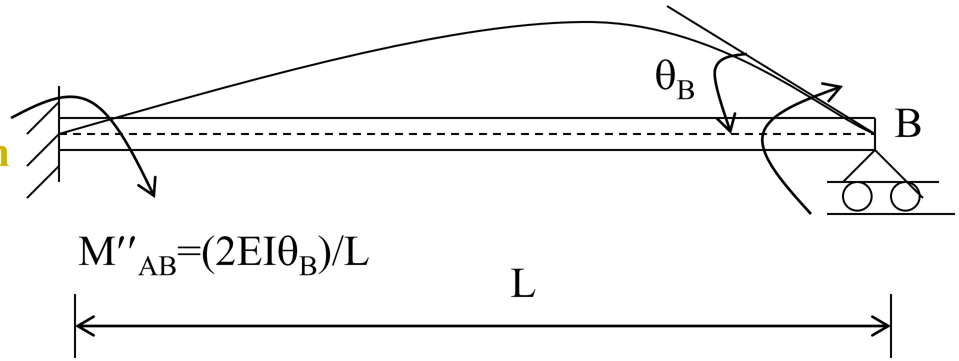
6.3 Slope Deflection Method

Consider portion AB of a continuous beam, shown below, subjected to a distributed load w(x) per unit length and a support settlement of Δ at B; EI of the beam is constant.



+

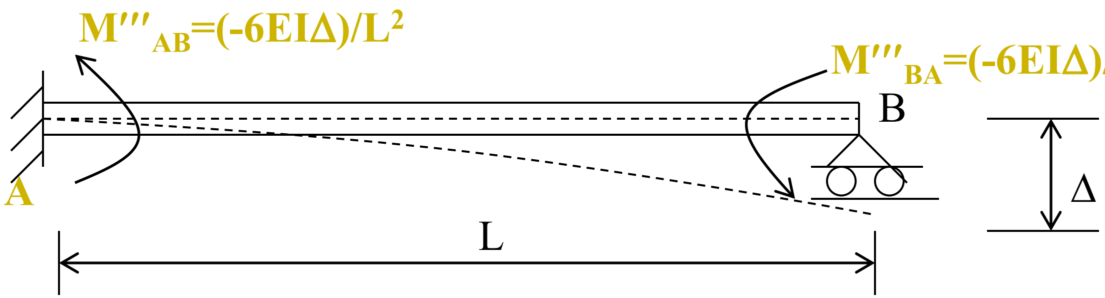
(iii) Due to rotation θ_B at support B



$M''_{BA}=(4EI\theta_B)/L$

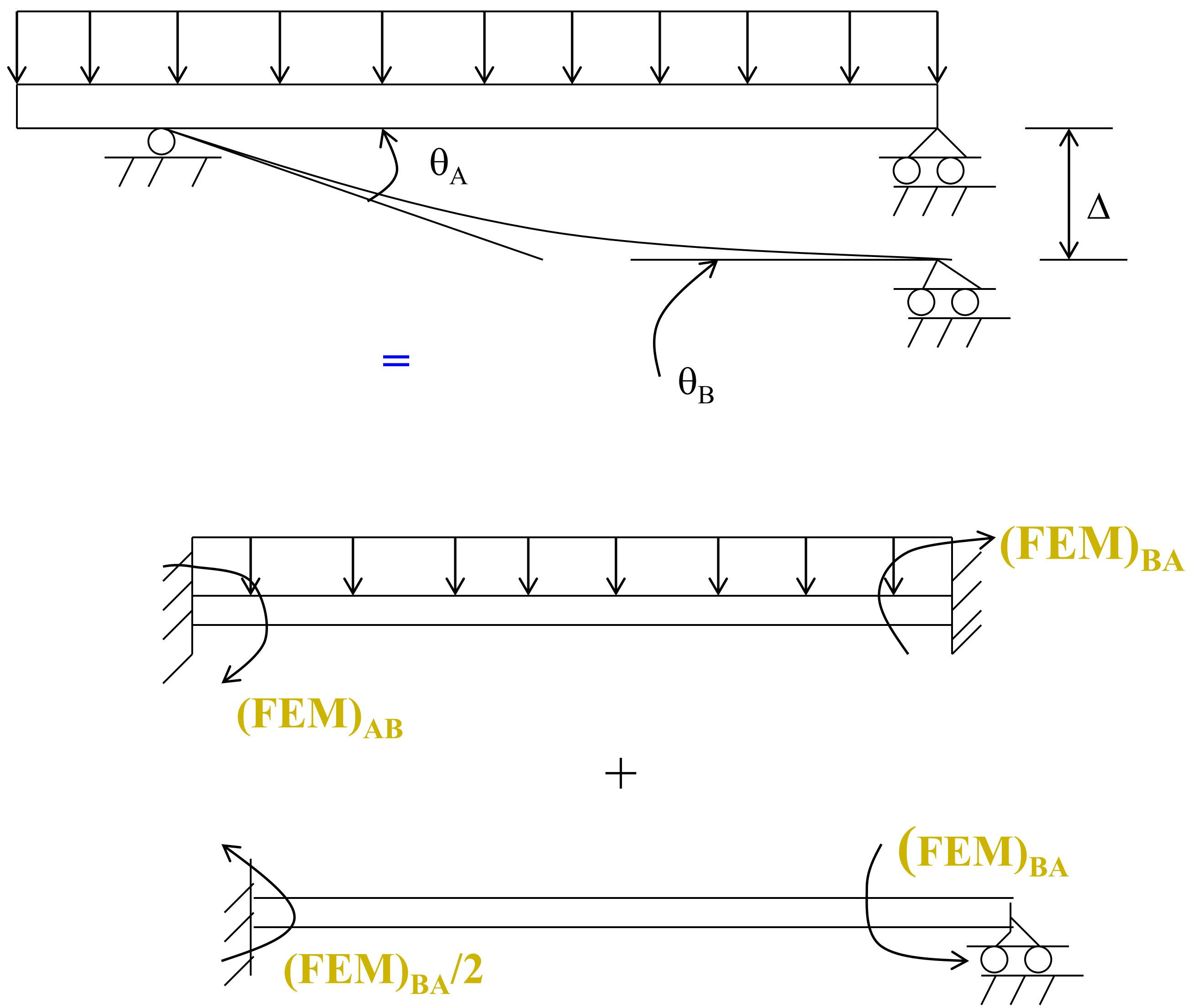
+

(iv) Due to differential settlement of Δ (between A and B)

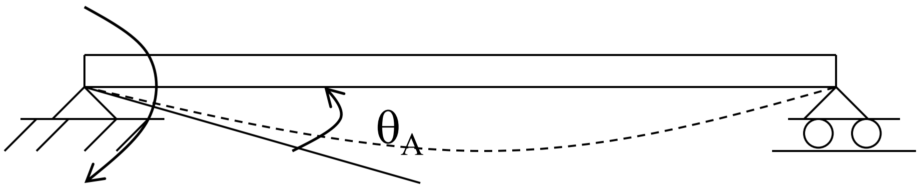


$$M_{AB} = (FEM)_{AB} + M'_{AB} + M''_{AB} + M'''_{AB} = (FEM)_{AB} + \frac{4EI\theta_A}{L} + \frac{2EI\theta_B}{L} - \frac{6EI\Delta}{L^2} = \frac{2EI}{L}\left(2\theta_A + \theta_B - \frac{3\Delta}{L}\right) + (FEM)_{AB}$$

$$M_{BA} = (FEM)_{BA} + M'_{BA} + M''_{BA} + M'''_{BA} = (FEM)_{BA} + \frac{2EI\theta_A}{L} + \frac{4EI\theta_B}{L} - \frac{6EI\Delta}{L^2} = \frac{2EI}{L}\left(\theta_A + 2\theta_B - \frac{3\Delta}{L}\right) + (FEM)_{BA}$$

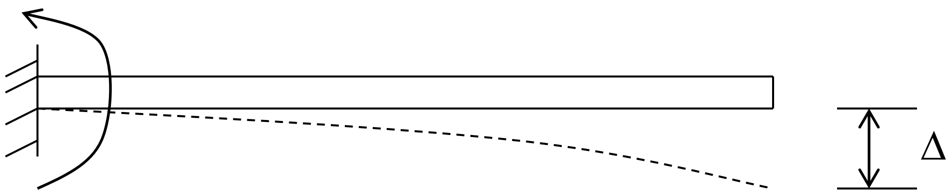

θA
Δ
θB
=
(FEM)BA
(FEM)AB
+
(FEM)BA
(FEM)BA/2

+



$M''_{AB}=(3EI\theta_A)/L$

+



$M'''_{AB}=(3EI\Delta)/L^2$

$\Delta = PL^3/(3EI)$,
$M = PL = (3EI\Delta/L^3)(L) = 3EI\Delta/L^2$

$$M_{AB} = [(FEM)_{AB} - (FEM)_{BA}/2] + (3EI\theta_A)/L - (3EI\Delta)/L^2$$

Modified FEM at end A