2.4. SUPPORT SETTLEMENTS IN SLOPE DEFLECTION METHOD.

2.4.1 SUPPORT SETTLEMENT IN STRUCTURAL ANALYSIS:

Support settlements may be caused by **soil erosion**, dynamic soil effects during earthquakes, or by partial failure or settlement of supporting structural elements. Supports could also potentially heave due to frost effects (this could be considered a negative settlement).

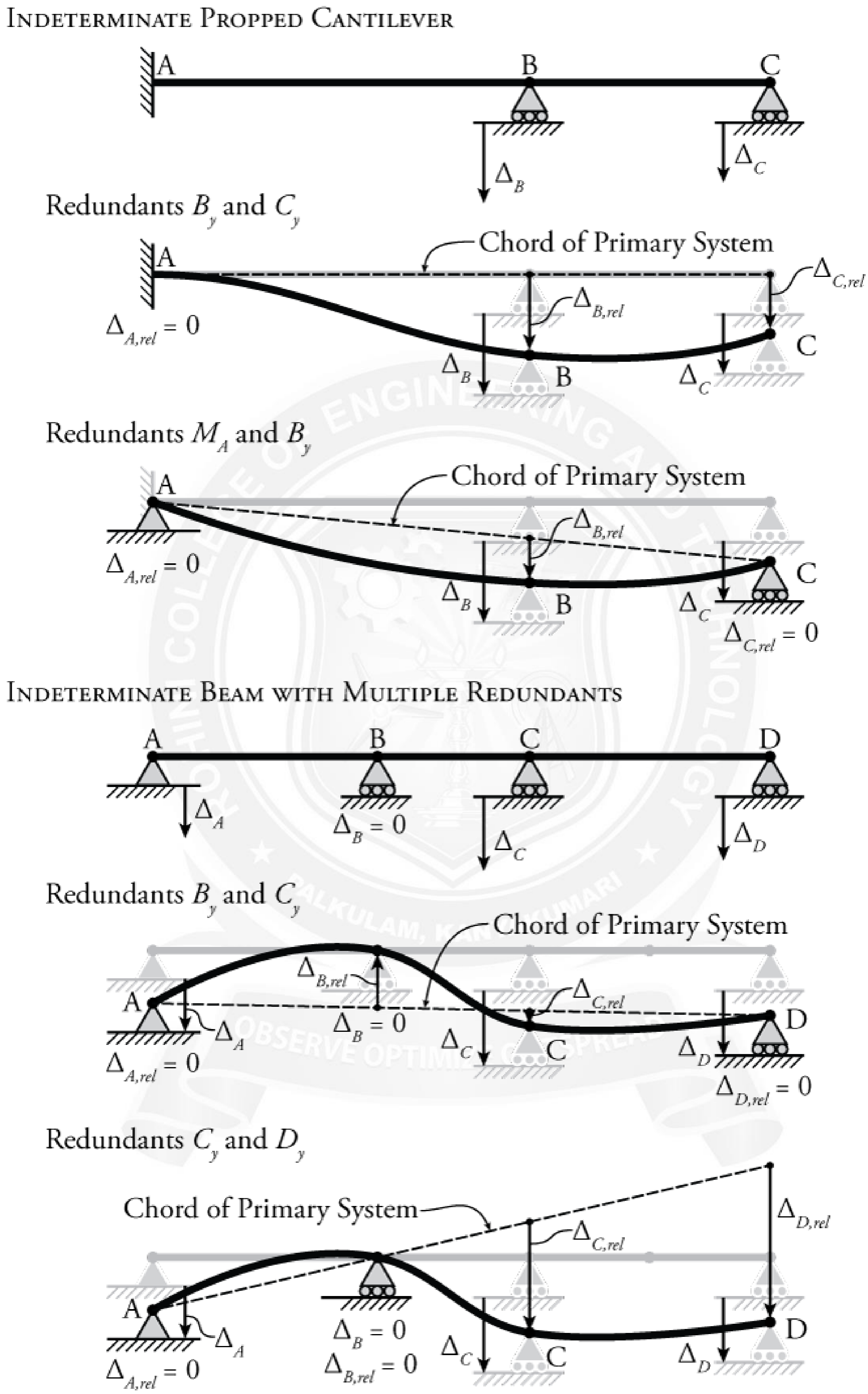
2.4.2.INTRODUCTION:

In the last lesson, the force method of analysis of statically indeterminate beams subjected to external loads was discussed. It is however, assumed in the analysis that the supports are unyielding and the temperature remains constant. In the design of indeterminate structure, it is required to make necessary provision for future unequal vertical settlement of supports or probable rotation of supports. It may be observed here that, in case of determinate structures no stresses are developed due to settlement of supports. The whole structure displaces as a rigid body. Hence, construction of determinate structures is easier than indeterminate structures.

The statically determinate structure changes their shape due to support settlement and this would in turn induce reactions and stresses in the system. Since, there is no external force system acting on the structures, these forces form a balanced force system by themselves and the structure would be in equilibrium. The effect of temperature changes, support settlement can also be easily included in the force method of analysis. In this lesson few problems, concerning the effect of support settlement are solved to illustrate the procedure.

2.4.3.SUPPORT DISPLACEMENTS:

The whole structure displaces as a rigid body. Hence, construction of determinate structures is easier than indeterminate structures. **The statically determinate structure changes their shape due to support settlement** and this would in turn induce reactions and stresses in the system.



Support settlements in continuous beams

2.4.4. NUMERICAL EXAMPLES ON(CONTINUOUS BEAMS):

PROBLEM NO:01

Analysis the continuous beam shown in fig.2.10,Calculate the support moments using slope deflection method.Support B settlememts by 10mm.Take E = 2 x 10^5 N/mm^2,I = 16 x 10^7 mm^4.Sketch the SF and BM diagrams.

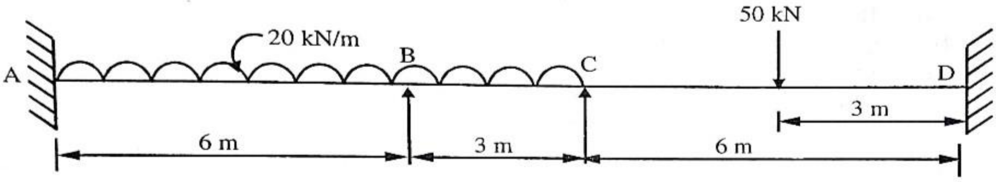


Fig. 2.10

Solution:

- **Fixed End Moments:**

  MFAB = $-Wl^2/12$ = - 20x6^2/12 = - 60 kNm;

  MFBA = $Wl^2/12$ = 20x6^2/12 = 60 kNm;

  MFBC = $-Wl^2/12$ = - 20x3^2/12 = - 15 kNm;

  MFCB = $Wl^2/12$ = 20x3^2/12 = 15 kNm;

  MFCD = -Wl/8 = - 50x6/8 = - 37.5 kNm;

  MFDC = Wl/8 = 50x6/8 = 37.5 kNm;

- **Slope Deflection Equations:**

  MAB = MFAB + 2EI/6(2θA + θB + 3δ/l)

  = - 60 + EI/3(0 + θB – 1/200) --- (1)

  MBA = MFBA + 2EI/6(2θB + θA + 3δ/l)

  = 60 = EI/3(2θB – 3 x 10/6000) --- (2)

  MBC = MFBC + 2EI/3(2θB + θC + 3δ/l)

  = - 15 + 2EI/3(2θB + θC + 1/100) --- (3)

  MCB = MFCB + 2EI/3(2θC + θB + 3δ/l)

  = 15 + 2EI/3(2θC + θB + 1/100) --- (4)

  MCD = MFCD + 2EI/6(2θC + θD + 3δ/l)

  = - 37.5 + EI/3(2θC) --- (5)

$MDC = MFDC + 2EI/6(2\theta D + \theta C + 3\delta/l)$

$= 37.5 + EI/3(\theta C)$ --- (6)

- **Joint Equilibrium Equations:**

Joint B:

$MBA + MBC = 0$

$EI/3(6\theta B+2\theta C+3/200) = - 135$ --- (7)

Joint C:

$MCB + MCD = 0$

$EI(\theta B+3\theta C+1/100) = 33.75$ --- (8)

Equvating (7 & 8);we get

$\theta C = - 1/464$; $\theta B = - 1/402$

- **Final Moments:**

MAB = - 139.843 kNm;

MBA = - 46.354 kNm;

MBC = 46.3 kNm;

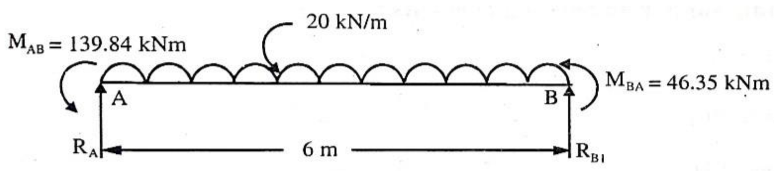
MCB = 83.35 kNm;

MCD = - 83.477 kNm;

MDC = 14.51 kNm;

- **To Draw S.F.D:**

Span AB:

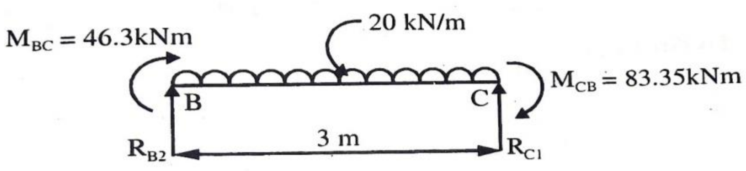


Taking moments about A.

$20 \times 6^2/2 - 46.35 - 139.84 - RB1(6) = 0$; $RB1 = 28.97$ KN

$RA = 20 \times 6 - 28.97$; $RA = 91.03$ KN

Span BC:

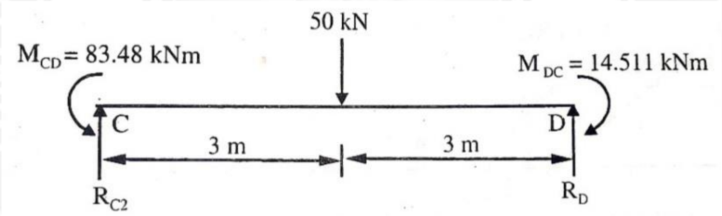


Taking moments about B.

$20 \times 3^2/2 + 83.35 + 46.3 - RC1(3) = 0$; $RC1 = 73.22$ KN

$RB2 = 20 \times 3 - 73.22$; $RB2 = -13.21$ KN

Span CD:



Taking moments about C.

$14.511 + 50(3) - 83.48 - RD(6) = 0$;

$RD = 13.5$ KN; $RC2 = 36.5$ KN

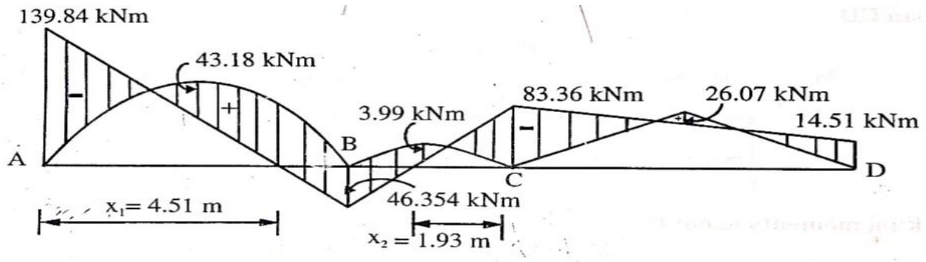
- **Free BMD:**

  $MAB = Wl^2/8 = 20 \times 6^2/8 = 90$ kNm

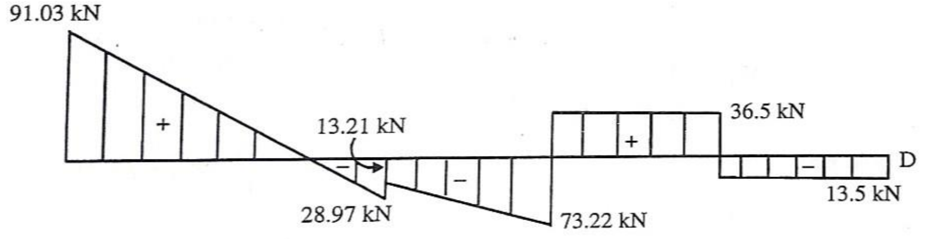
  $MBC = Wl^2/8 = 20 \times 3^2/8 = 22.5$ kNm

  $MCD = Wl/4 = 50 \times 6/4 = 75$ kNm

- **BMD and SFD:**



Bending moment diagram



Shear force diagram