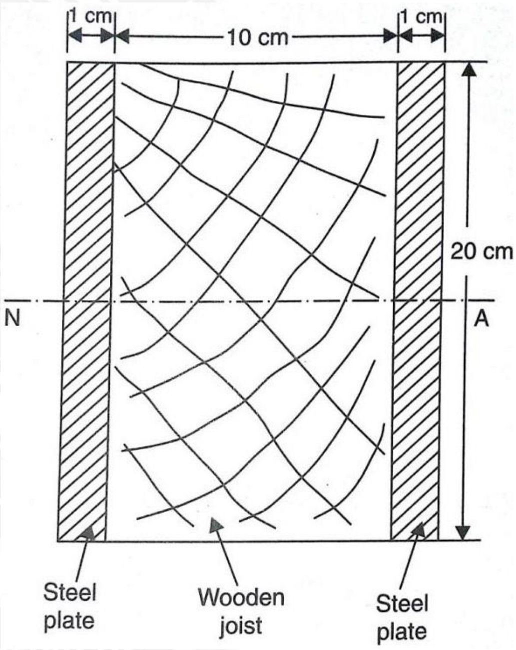
2.6.COMPOSITEBEAMS(FLITCHEDBEAMS)

A beam made up of two or more different materials assumed to be rigidly connected together and behaving like a single piece is known as a composite beam or a wooden flitched beam. The strain at the common surface will be same for both materials. Also the totalmoment of resistance will be equal to the sum of the moments of individual sections.

Problem 19. a flitched beam consist of a wooden joist 10cm wide and 20cm deep strengthed by two steel plates 10mm thick and 20cm deep. If the max stress in the wooden joist is 7 N/mm^2. Find the corresponding max stress attained in steel. Find also the moment of resistance of the composite section. Take youngs modulus for steel = 2×10^5N/$mm^2$and for wood = 1× 10^4N/mm^2

Given



Letwidthofwoodenjoistb_2=10cm Depth of wooden joist d_2= 20cm Width of one steel plate b_1= 1cm Depth of one steel plate d_1= 20cm Number of steel plate = 2

Maxstressinwoodσ_2=7N/mm^2E for steel E_1= 2× 10^5N/mm^2

EforwoodE_2=1×10^4N/mm^2

Solution:

M.O.I.ofwoodenjoistaboutN.A.

$$I_2 = b_2 d_2^2/12 = 6666.66 cm^4$$

M.O.IoftwosteelplatesaboutN.A

$$I_2 = 2 \times b_1 d_1^3 = 1333.33 \times 10^4 mm^4$$

Nowusing$\sigma_{1/E_1} = \sigma_{2/E_2}$

$$\sigma_1 = 20 \times 7 = \mathbf{140 N}/mm^2$$

TotalmomentM=M_1+M_2

Where $M_1 = \frac{\sigma 1}{y} \times I_1$

$$= \frac{140}{100} \times 1333.33 \times 10^4$$

$$= 18666.620 Nm$$

$M_2 = \sigma_2 \times \frac{I_2}{y}$

$= \frac{7}{100} \times 6666.66 \times 10^4$ Nmm

=4666.662Nm

M=$M_1 + M_2$

=18666.620+4666.662

=**23333.282Nm**

IMPORTANTTERMS

Shearforce	Adding of vertical forces from right sidetotheconsiderpointofthebeam Symbol: Downwardforce=+ve Upward force = - ve	**Diagram:** Point load (W) = vertical line (upward force = downward line Downwardforce=upwardline) UVL (w) – Inclined line UVL(w)–paraboliccurve CantileverBeam:+veside SSB : + ve or – ve OHB: + veor – ve
Bending moment	Adding of bending moment from rightsidetotheconsiderpointofthe beam. Symbol: Clockwise direction = - ve Anticlockwisedirection=+ve CLB : free end = 0 SSB : Both end = 0 OHB:Both end=0	**Diagram:** Point load (W) – Inclined line (upwardforce=downwardline Down force = upward line UVL (w) – parabolic curve UVL (w) – Cubic Curve Cantilever Beam : - ve side SSB : + ve OHB: + veor – ve
CantileverBeam	Addingofvertical forces	PL=addonlyW UDL = Add (Force x distance) UDLactingpoint=midpoint=$l/2$ UVL = add ($wl/2$) UVLactingpointfromsmallend= $2l/3$ UVLactingpoint from bigend=$l/3$
SSB	Step1:Tofindreactionforcesattwo support (R_A, R_B) TakemomentaboutA=0tofind Reaction R_B Sumofupwardforce=downward force; to find reaction R_A	

OHB	SameprocedureasSSB SF with Reaction & withoutreaction calculate	**Maximumbending moment** atshearforcebecomezero (SF=0) **Point of contrafluxture** act at Bendingmomentbecomezero(BM= 0)
BENDINGSTRESSIN BEAM		
BendingEquation	$\frac{M}{I} = \frac{\sigma_{max}}{y_{max}} = \frac{E}{R}$ Basedontypeofbeamwithsupport to find M which is available in **<u>IVunit table</u>**	M=BendingMoment I=MomentofInertia σ=Bendingstress y=distanceofNeutralaxis E=Youngsmodulus R=Bendingradius
Section Modulus	$Z = \frac{I}{y}$ $= \frac{bd^2}{6}$ for Rectangular section $= \frac{1}{6D}(BD^3 - bd^3)$ hollow Rect	$= \frac{\pi d^3}{32}$ for circular section $= \frac{\pi}{32D}(D^4 - d^4)$ hollow circlr
ForUnsymmetrical section	Step1: to find C.G of the section in ydirection = $\bar{y}$ but max value of yis used in bending eqn. Step2:tofindMomentofinertiaofthesection=I Step3: from Moment eqn to find unknown value	
Momentofresistanceof a section	$M = \sigma x Z$	
Composite beam(Flitchedbeams)	Strainremains same $e_1 = e_2 = \frac{\sigma_1}{E_1} = \frac{\sigma_2}{E_2}$	
ModularRatio	$= \frac{E_1}{E_2}$	