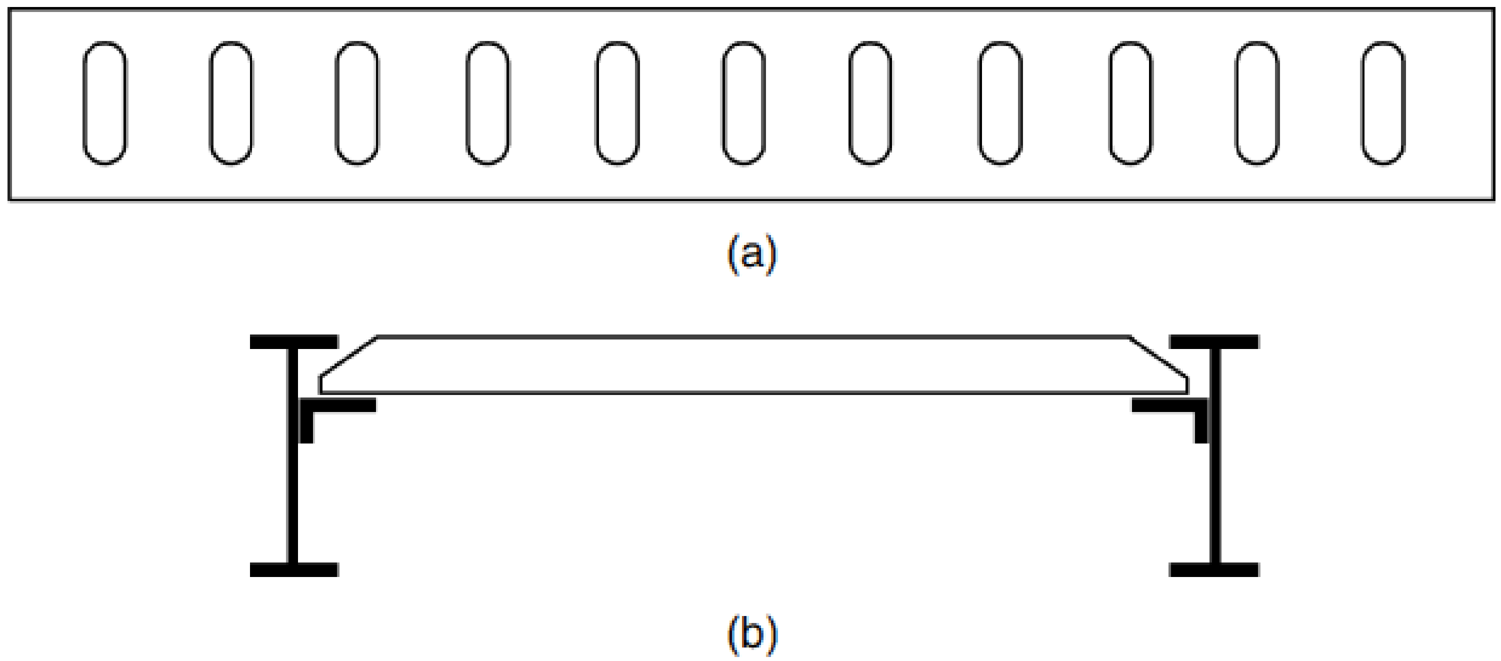
FLOOR SYSTEMS FOR STEEL FRAMED STRUCTURES

FLOOR TYPES

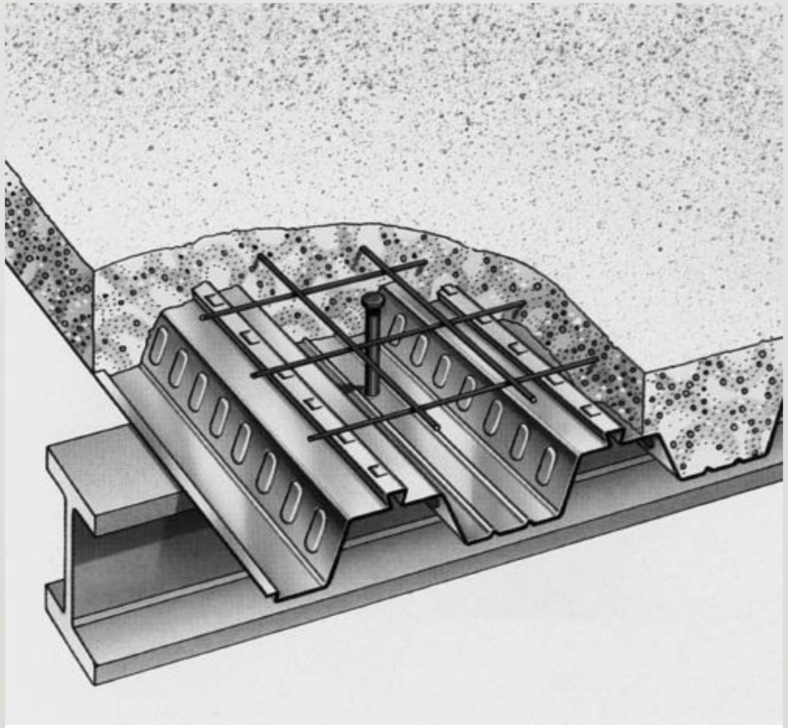
COMMON TYPES INCLUDE:

- PRECAST CONCRETE FLOORS
- IN-SITU CONCRETE FLOORS CAST ON CONVENTIONAL REMOVABLE SHUTTERING
- IN-SITU CONCRETE FLOORS CAST ONTO PERMANENT METAL DECKING

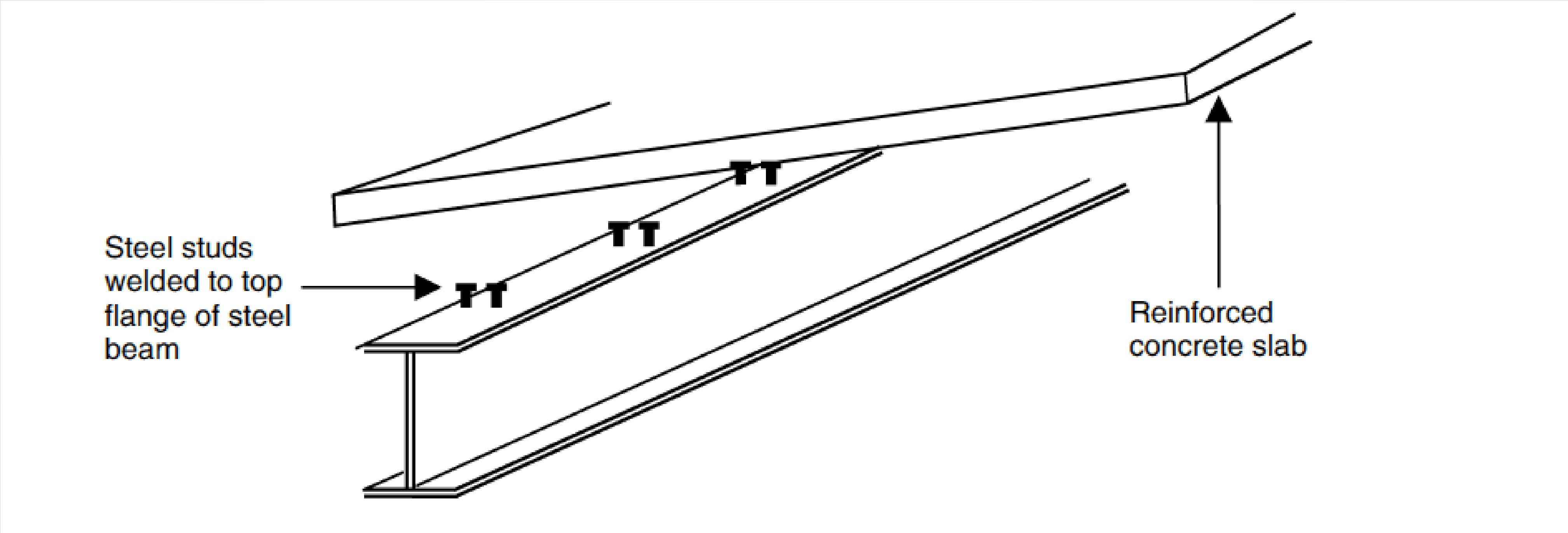
PRECAST CONCRETE FLOOR



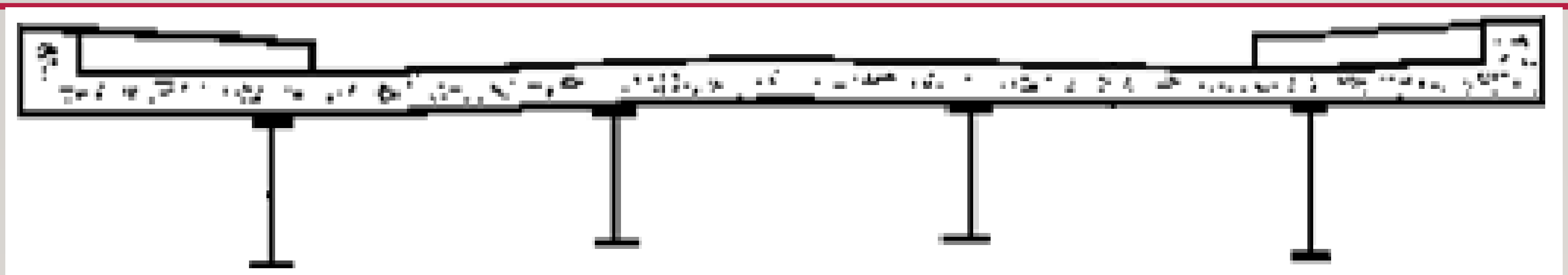
IN-SITU CONCRETE FLOOR CAST ONTO PERMANENT METAL DECKING



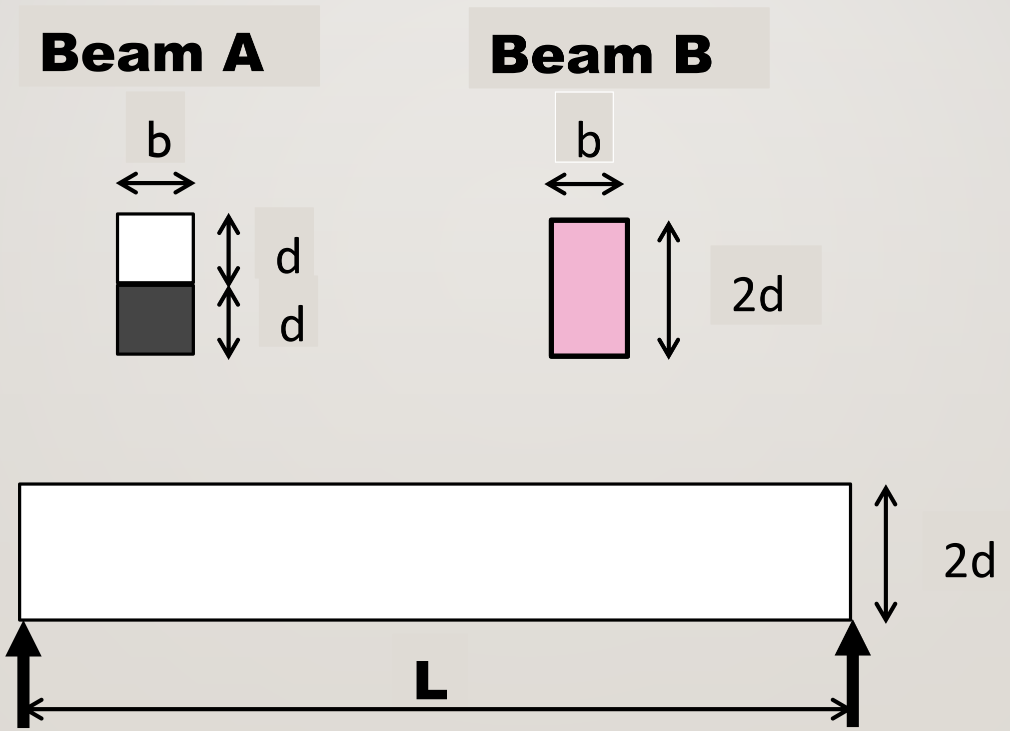
IN-SITU CONCRETE FLOOR CAST ON CONVENTIONAL REMOVAL SHUTTERING



STEEL-CONCRETE COMPOSITE BRIDGE DECK



COMPOSITE CONSTRUCTION



STRENGTH

FROM BEAM THEORY

$$\mathbf{M = \sigma Z \Rightarrow M \propto Z}$$

$$Z_A = 2\left(\frac{I}{y}\right) = 2\left(\frac{\frac{bd^3}{12}}{\frac{d}{2}}\right) = \frac{bd^3}{3}$$

$$Z_B = \frac{I}{y} = \frac{\frac{b(2d)^3}{12}}{d} = 2\left(\frac{bd^3}{3}\right)$$

$$\Rightarrow \frac{M_B}{M_A} = 2$$

STIFFNESS

$$\delta_A = \frac{5\omega L^4}{384EI_A}$$

$$\delta_B = \frac{5\omega L^4}{384EI_B}$$

$$\Rightarrow \frac{\delta_A}{\delta_B} = \frac{\frac{5\omega L^4}{384EI_A}}{\frac{5\omega L^4}{384EI_B}} = 4$$

ADVANTAGES

- **SAVINGS IN STEEL WEIGHT**
- **POSSIBLE TO USE SHALLOWER MEMBERS**

DESIGN OF COMPOSITE ELEMENT

COMPOSITE SLABS

- **EC4**
- **BS 5950: PART 4**
- **MANUFACTURER'S LITERATURE**

COMPOSITE BEAMS

- **EC4**
- **BS5950: PART 3.1**

DESIGN OF COMPOSITE BEAMS

THE FOLLOWING SHOULD BE CHECKED AND SATISFIED

- **MOMENT CAPACITY**
- **SHEAR**
- **SHEAR CONNECTORS**
- **LONGITUDINAL SHEAR**
- **DEFLECTION**

BEHAVIOUR OF COMPOSITE BEAMS IS SIMILAR TO THAT OF REINFORCED CONCRETE BEAMS EXCEPT THAT

- **STEEL BEAMS CAN SUPPORT SIGNIFICANT LOADS IN THEIR OWN RIGHTS**
- **IN COMPOSTE BEAMS THERE IS INSUFFICIENT BOND WITH THE CONCRETE**
- **THE SECOND MOMENT OF AREA OF THE STEEL SECTION CANNOT BE IGNORED**

EFFECTIVE WIDTH OF CONCRETE FLANGE

For simply supported beams (and assuming a single row of shear studs):

$$\boldsymbol{b_{eff} \leq \frac{L_e}{4} \leq b_i}$$

where

L_e **– Distance between points of zero moment**

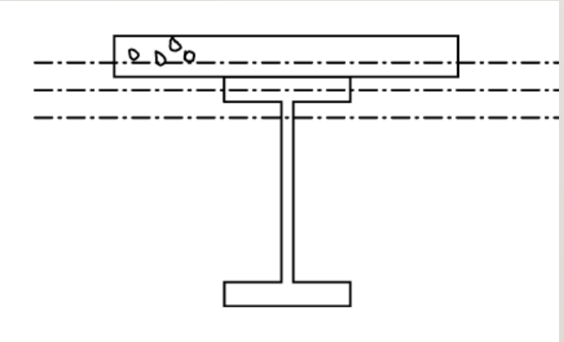
b_i **– Distance between adjacent webs**

MOMENT CAPACITY

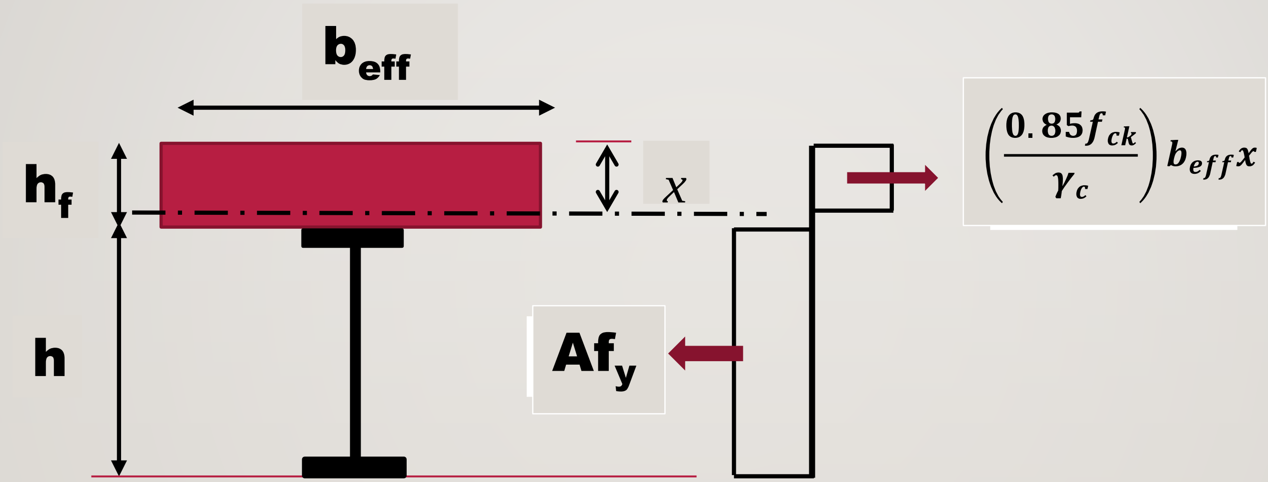
CALCULATED USING PLASTIC THEORY ASSUMING RECTANGULAR STRESS BLOCKS

TWO CASES MAY ARISE:

- **NEUTRAL AXIS OCCURS IN THE SLAB**
- **NEUTRAL AXIS OCCURS IN THE STEEL SECTION**

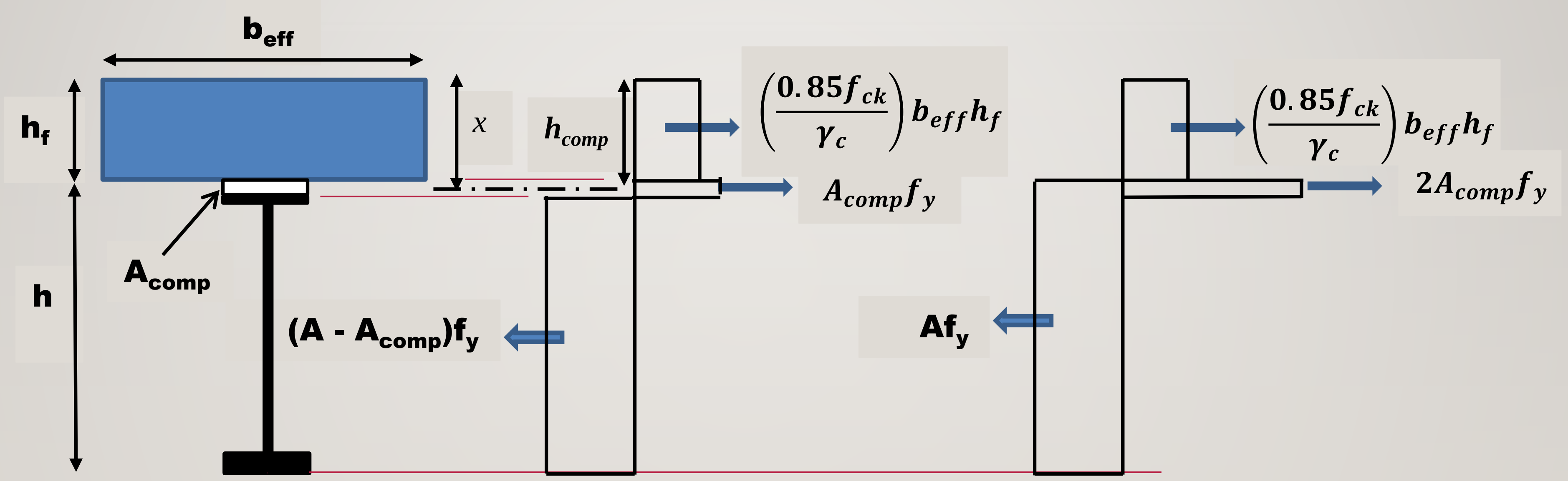


NEUTRAL AXIS IN SLAB



$$M_{Rd} = Af_y\left(\frac{h}{2} + h_f - \frac{x}{2}\right)$$

NEUTRAL AXIS IN STEEL SECTION

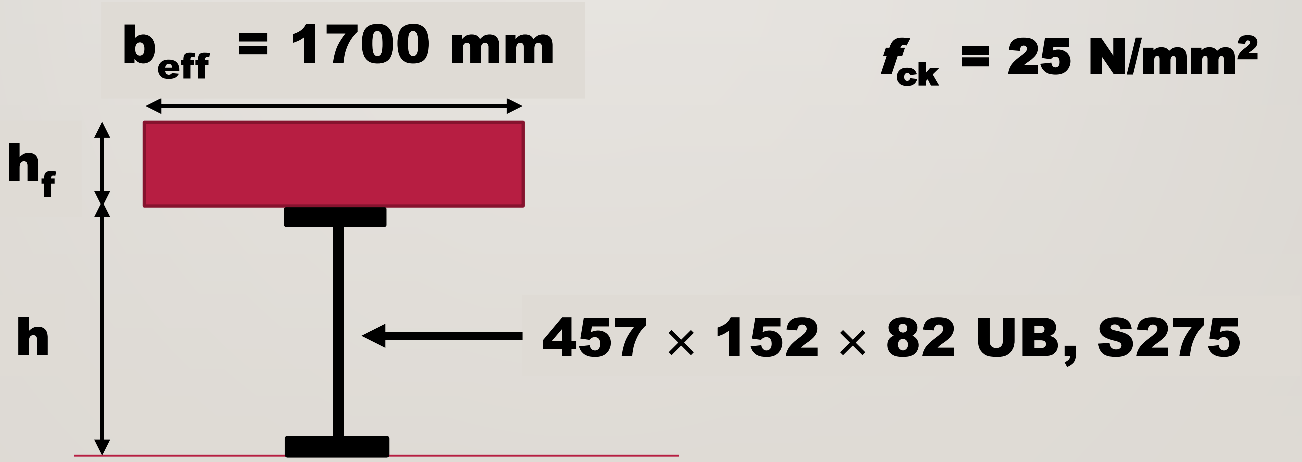


$$Af_y = \left(\frac{0.85f_{ck}}{\gamma_c}\right)b_{eff}h_f + 2A_{comp}f_y$$

$$M_{Rd} = Af_y\left(\frac{h}{2} + \frac{h_f}{2}\right) - 2A_{comp}f_y\left(h_{comp} - \frac{h_f}{2}\right)$$

EXAMPLE: MOMENT CAPACITY

Determine the moment capacity of the beam shown below for the following slab depths: (a) 175 mm (b) 100mm



f_{ck} = 25 N/mm²

SHEAR CAPACITY

THE SHEAR CAPACITY OF A COMPOSITE BEAMS, $V_{pl,Rd}$, IS GIVEN BY

$$V_{pl,Rd} = \frac{A_{v} f_y}{\gamma_{MO}\sqrt{3}}$$

WHERE A_v = A -2bt_f + (t_w +2r)t_f < $\eta h_w t_w$

SHEAR CONNECTORS

PURPOSE

- **PREVENT SLIP BETWEEN STEEL BEAMS AND CONCRETE SLAB**
- **CARRY TESION BETWEEN STEEL AND CONCRETE AND CONTROL SEPARATION**

DESIGN OF CONNECTORS

NUMBER OF STUDS, N

$$N = \frac{R}{P_{Rd}}$$

WHERE R – RESISTANCE FORCE AT CONCRETE/STEEL INTERFACE

WHEN $x \leq h_s$

$$R_C = \left(\frac{0.85 f_{ck}}{\gamma_C}\right) b_{eff} x$$

WHEN $x > h_s$

$$R_S = \left(\frac{0.85 f_{ck}}{\gamma_C}\right) b_{eff} h_s$$

HEADED STUDS

THE DESIGN RESISTANCE OF HEADED STUDS SHOULD BE DETERMINED FROM

$$P_{Rd} = \frac{0.8 f_u \pi d^2/4}{\gamma_v} \quad \textbf{OR} \quad P_{Rd} = \frac{0.29 d^2 \sqrt{f_{ck} E_{cm}}}{\gamma_v}$$

WHICHEVER IS SMALLER, WITH $\alpha = 0.2\left(\frac{h_{sc}}{d} + 1\right) \; for \; 3 \le \frac{h_{sc}}{d} \le 4$

$$\alpha = 1 \qquad for \; \frac{h_{sc}}{d} > 4$$

WHERE

γ_v	**PARTIAL FACTOR = 1.25**
d	**DIAMETER OF SHANK OF STUD, 16mm ≤ d ≤ 25 mm**
f_u	**ULTIMATE TENSILE STRENGTH OF MATERIAL OF THE STUD ≤ 500 N/mm^2**
f_{ck}	**CYLINDER STRENGTH OF CONCRETE**
h_{sc}	**NOMINAL HEIGHT OF STUD**

EXAMPLE: SHEAR CONNECTOR DESIGN