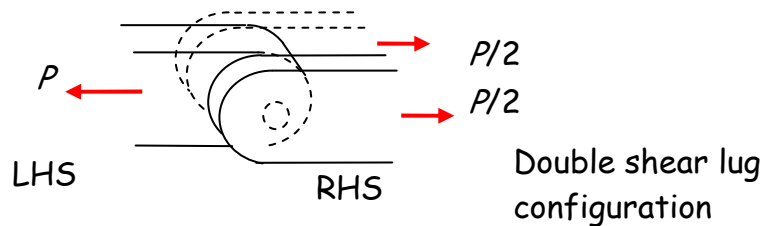


StM1 Joint Examples

Q1. Pinned joint

A double shear pin joint (i.e. two lugs on one side, one on the other) is detailed below. For an ultimate joint load, $P = 10\text{kN}$ evaluate all major failure mode stresses and quote the reserve factors



Lug width	w	$= 30 \text{ mm}$
Lug end radius	R	$= 15 \text{ mm}$
Lug end distance	e	$= R$
Outer lug thickness	t_o	$= 5 \text{ mm}$
Inner lug thickness	t_i	$= 10 \text{ mm}$
Pin diameter	d	$= 6 \text{ mm}$
Gap	g	$= 0 \text{ mm}$

Lug "Allowables" (strengths, i.e. stress at failure)

Material		$= \text{Ally (aluminium alloy)}$
Ultimate direct strength	σ_{ULT}^*	$= 400 \text{ N/mm}^2$
Ultimate shear strength	τ_{ULT}^*	$= 230 \text{ N/mm}^2$
Ultimate bearing strength	σ_{Br}^*	$= 1.5 * \text{direct ultimate}$

Pin " Allowables"

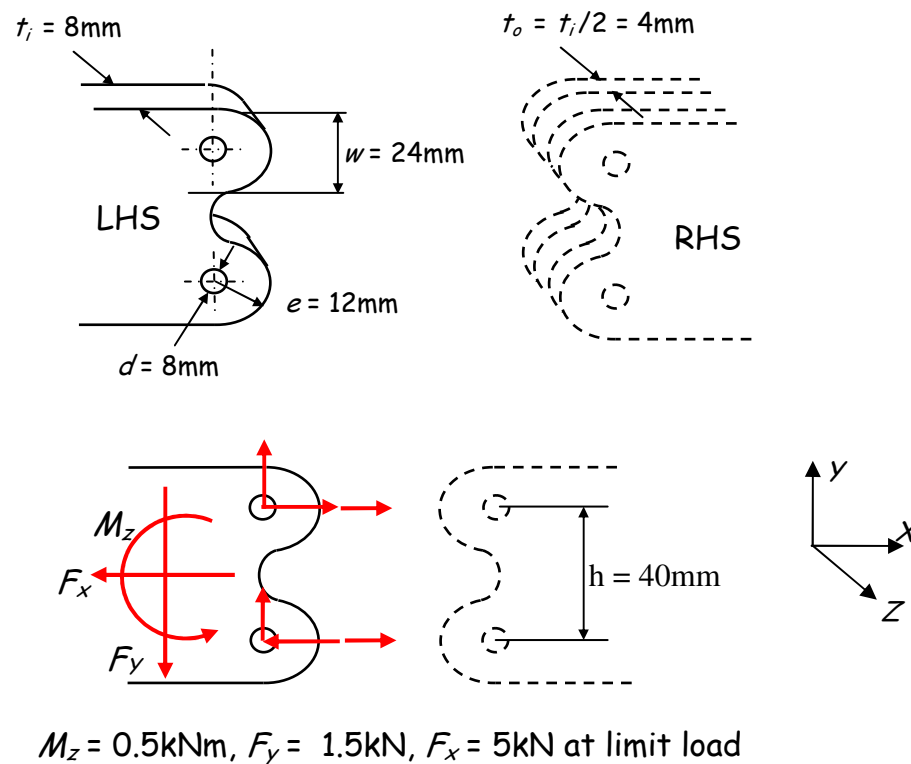
Material		$= \text{HighTensile steel}$
Ultimate direct tensile strength	σ_{ULT}^*	$= 1000 \text{ N/mm}^2$
Ultimate shear strength	τ_{ULT}^*	$= 580 \text{ N/mm}^2$
Ultimate bearing strength	σ_{ULT}^*	$= 1500 \text{ N/mm}^2$

Applied load at ultimate	P	$= 10\text{kN}$
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RF = Allowable/Actual

Q2 Fixed Joint – two fasteners

Two beams are joined through pairs of lugs in a double shear configuration as illustrated in figure Q2. The lugs are made from 2024-T351 aluminium alloy (see Aero h/b). The pins are HT steel with an ultimate tensile strength of 1200N/mm^2 and ultimate shear strength of 700N/mm^2 . Internal loads are shown at limit load at the end of the beam and these are reacted across the double pin joint. Regarding the moment as a couple loading and considering all primary modes of failure, calculate the joint stresses and reserve factors. Use an ultimate safety factor of 1.5.



Q3 Fixed joint - multiple fasteners

The steel joint-plate shown in figure Q3 is 2mm thick and is connected to sub-structure by six 6mm diameter fasteners. A limit load of 20kN is applied to the plate as shown. Using an ultimate safety factor of 1.5 find the ultimate load carried by each fastener and quote the minimum shear and bearing reserve factors, i.e. for the highest loaded fastener.

Allowable fastener shear strength = 500MPa

Allowable fastener bearing strength = 1000MPa

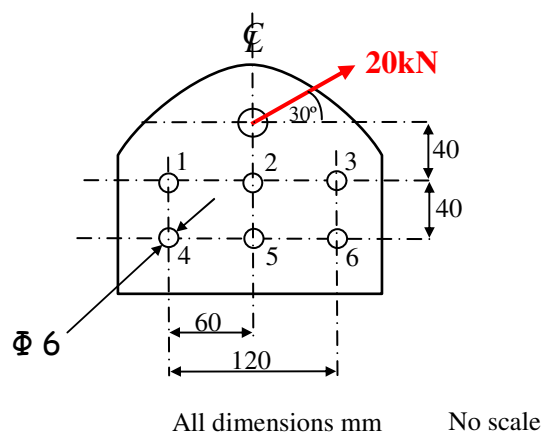


Figure Q3