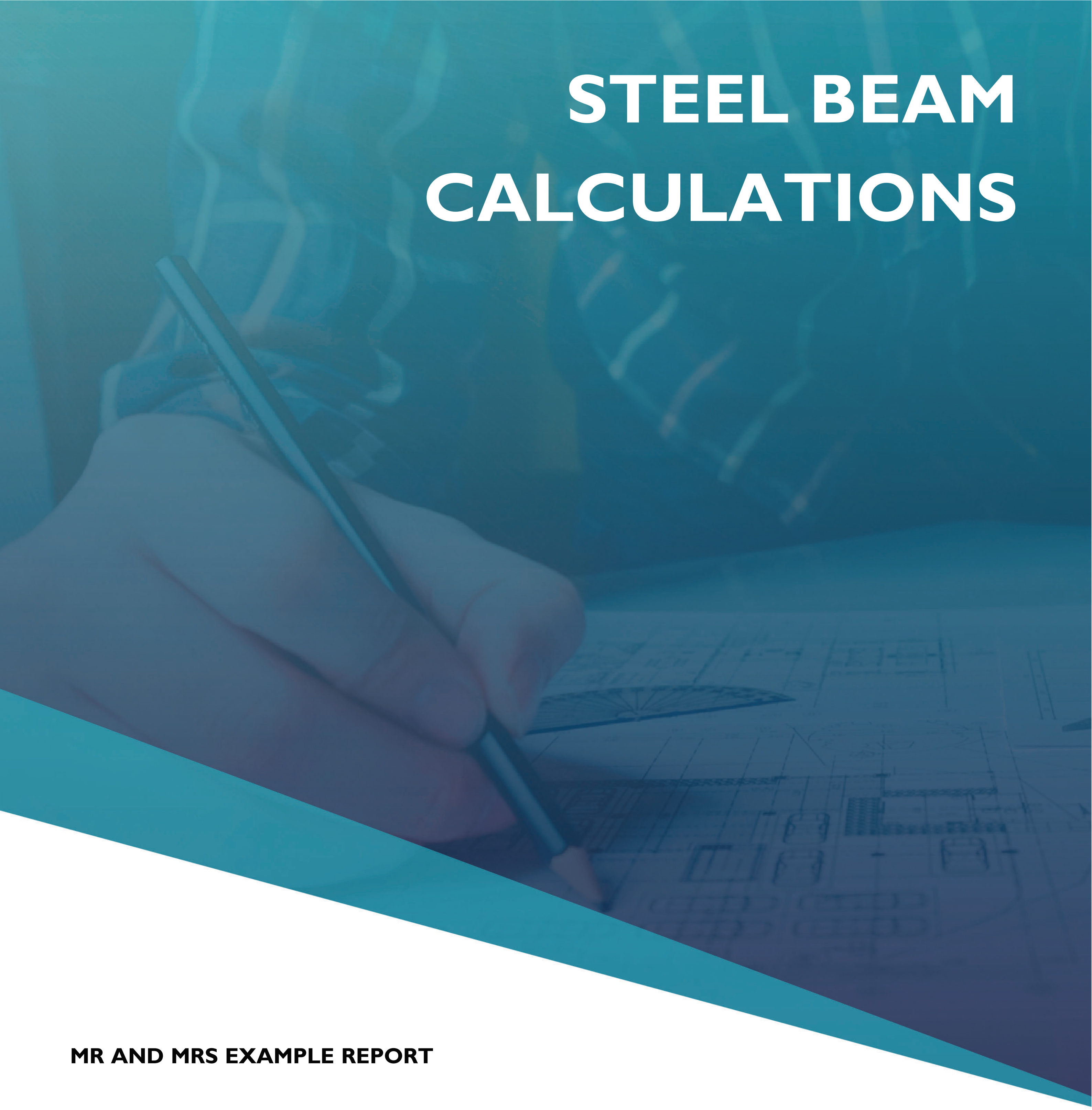


STEEL BEAM CALCULATIONS

MR AND MRS EXAMPLE REPORT

Second Floor
Woodbury Grove
Finchley London
N12 0DR

BEAMCALC.CO.UK

Thank you for using beamcalc.co.uk for your scheme. Please take the time to read these important notes and ensure that these are passed on to your Architect, Principle Designer, Project Manager and Principal Contractor.

These calculation sheets have been produced with professional care based upon the information and/or plans you provided to (us – defined as Beam Calculation Ltd). We assume that all information provided to us by the (client – defined as the person procuring our service) is accurate and a true reflection of the intended works. These calculations have been carried out using computer software which outputs structural calculations in accordance with British Standards. Loading used have been derived from British Standards and/or manufacturers declared details. Where required we may make assumptions, which we will clearly mark on our sheets. It is the responsibility of the person carrying out the building work or the clients appointed principle contractor and all other contractors to check that our assumptions are reflected on-site and report any discrepancies (our assumptions) back to us, where we will, free of charge, if required, alter the calculations accordingly.

The dimensions provided on our calculation sheets is the **clear span** of the structural member and allowances should be made when ordering beams. All structural steel specified within our calculation sheets is grade S355 unless noted within the calculation document, this should be noted before ordering. Steel beams will need a minimum of 200mm bearing length either side, when spanning in the plane of the wall and 100mm when spanning perpendicular, unless we specify otherwise. Timber members are required to have a minimum of 50mm end bearings. All steel beam spans and other structural members must be accurately measured on site by the person carrying out the building work before any materials are ordered, as is standard building practice. Beam Calculation Ltd will take no liability for abortive works due to members being ordered based upon sizes on our sheets.

Dimensions given for pad stones is the minimum size required by calculation, we aim to keep the size as close to the support conditions as practical and to recognized standardized dimension. Where this is not possible we would recommend using 140mm deep reinforced concrete lintels with a minimum strength of 50N/mm2 cut to size. Naylor or similar with BBA approval.
All padstones are to be factory made 50N/mm2 units with BBA approval.

Beam Calculation Ltd calculation service has been carried out on the strict understanding that all work we are asked to carry out is subject to a Building Regulation application and approval with either a Local Authority Building Control department or an Approved Building Inspector. In all cases approval must be gained by the Building Control Body who is appointed on the scheme before any structural works are carried out based upon our calculation sheets. We accept no liability for abortive works due to works being carried before Building Control approval is gained for the calculations contained within this document. If Building Control checking engineers require additional information based upon errors or omission on our part we will provide this free of charge to ensure you gain Building Regulation approval. If you make amendments to the scheme we must be notified immediately as we will take no liability for changes made to the design by third parties before or after our calculations have been approved by the Building Control Body. Changes made at this stage will incur additional fees.

We assume that all building work is being carried out by a competent contractor who is experienced in structural alterations, domestic building works and the requirements of the Building Regulations 2010 and associated Approved Document requirements. The contractor is responsible for all on site safety, temporary propping arrangements, lifting operations and associated safe working methods as the CDM regulations imposes. All information we provide to the client must be passed on to the client appointed principle designer and the client appointed principle contractor and all other contractors.

We do not provide Party Wall Act etc. services and our calculations are solely to enable Building Regulation approval. If you have any doubt regarding implications the Party Wall Etc… Act has on your scheme further information is available from the Planning Portal website. Or you should consult your Architect or Principle Designer on this matter.

Steel beams which are placed onto masonry increase local pressure and redistribute loadings onto that masonry and subsequently down through the foundations. The foundations on site should be exposed and checked by a suitably qualified person to ensure they are adequate to sustain additional loading as local underpinning may be required. If masonry supporting beams is in poor condition, then this may need to be locally rebuilt with suitable masonry, such as class B engineering bricks achieving a minimum compressive strength of 50N/mm2 in accordance with BS3921. If we have indicated that a beam is to sit on a wall we have assumed that the wall supporting the beam is load-bearing, is in good condition and has adequate foundations with ground conditions which achieve a minimum of 100kN/m2. This must be verified on site by the person carrying out the work and a suitably qualified person.

We assume for loading/foundation calculation purposes that the ground has a minimum bearing capacity of 100kN/m2 at 900mm below ground level which must be verified and approved on site by Building Control before any foundation trenches are covered over or filled with concrete.

If we specify multiple steel beams these are to be bolted together using M16 8.8 grade bolts and CHS to suit the supported wall dimensions. These are for holding in place only and should not be assumed to allow load transfer.

Where we have provided a steel beam splice for a beam the splices should be 1/3 and 2/3 of the beam span.
Under no circumstances should the splice detail be used at half span.

Multiple timber members should be bolted at 600mm with M12 8.8 bolts and 50mm shear connector plates. Additional bolts should be provided at point load locations. If a timber wall plate is to sit directly onto the compression flange of a steel beam then it should be bolted at 600mm (staggered pattern) with M12 4.6 bolts.

Timber floor joists are required to be provided with full depth noggins (minimum section thickness as main member) at 1/3 and 2/3 floor joist span positions.

We assume for calculation purposes that bifold doors are supported on a side and bottom rail and the top rail is not taking the load of the door. If the door manufacturers data sheets state otherwise we should be notified as further checks will be required.

All beams within our calculations have been designed as laterally unrestrained, unless restraint is provided by a connected perpendicular beam and the exposed section height / the web thickness is <27mm. We will then assume restraint has been provided at that position. The ends of all steel beams should be fully built into the masonry, where this is not possible then the beams should be either bolted down into the padstones or lateral restraint straps should be provided to strap the beam down onto the masonry.

If you have any problems interpreting any of our information or wish to seek further clarification, we can be contacted on the following, where we will be happy to assist you:

Email: info@beamcalc.co.uk

Office: 0208 423 8618

Mobile: 07376 805039

DESIGN STANDARDS AND LOADINGS

Design standards and loading used throughout calculation sheets have been based upon the following documents.

BS 5950:1 Structural use of Steelwork in Buildings

BS 8118:1 Structural Use of Concrete

BS 5628: 1 Structural use of Masonry

BS 5268:2 Structural use of Timber

BS 6399:2 Code of practice for dead and imposed loads

Dead Loadings

Pitched Roof (kN/m2)	**Service Loads**
Concrete Tiles	0.55 kN/m2
Battens and Felt	0.05 kN/m2
Trusses	0.23 kN/m2
Ceiling Board 12.5mm	0.15 kN/m2
Insulation	0.02 kN/m2
	1.0 kN/m2

Flat Roof

EPDM	0.02 kN/m2
Built up Felt	0.42 kN/m2
Timbers	0.11 kN/m2
Insulation	0.08 kN/m2
Ply	0.15 kN/m2
Ceiling Board 12.5mm	0.15 kN/m2
	0.91 kN/m2 / 0.51 kN/m2

First Floor

Boarding (22mm)	0.15 kN/m2
Joists	0.15 kN/m2
Ceiling Board 12.5mm	0.15 kN/m2
Insulation	0.02 kN/m2
Lath and Plaster	0.50 kN/m2
	0.82 kN/m2 / 0.47 kN/m2

External Cavity Walls

Brick 102.5mm	2.25 kN/m2
Block (100mm)	1.25 kN/m2
Plaster	0.25 kN/m2
Insulation	0.02 kN/m2
	3.77 kN/m2

Dense Blocks	**4.5 kN/m2**
Stone + Light Block	**3.82 kN/m2**

External Walls Solid

Brick 225mm	4.5 kN/m2
Plaster	0.25 x 2 kN/m2
	5.00 kN/m2

External Walls Timber (Tile Hung)

Tile Hanging	0.55 kN/m2
Timber Stud (100mm)	0.15 kN/m2
Plasterboard 12.5mm	0.15 kN/m2
Insulation	0.02 kN/m2
	0.87 kN/m2

Timber Framed Buildings (Inner Leaf)

Timber Framing (150mm)	0.30 kN/m2
Plasterboard 15mm	0.17 kN/m2
Insulation	0.06 kN/m2
OSB Sheathing 15mm	0.105 kN/m2
	0.63 kN/m2

Stud Partitions

Timber Stud (100mm)	0.15 kN/m2
Plasterboard X 2 12.5mm	0.50 kN/m2
	0.65 kN/m2

Imposed Loadings

Snow (Generic)	0.75 kN/m2
Storage	0.25 kN/m2
Domestic Floor	1.5 kN/m2
Wind	0.8 kN/m2

STEEL MEMBER DESIGN (BS5950)

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

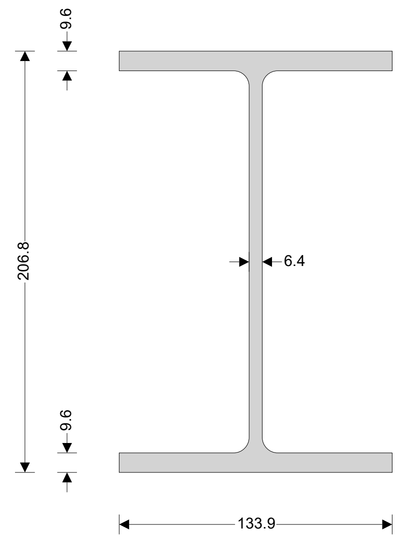
TEDDS calculation version 3.0.05

Section details

Section type	**UB 203x133x30 (BS4-1)**
Steel grade	**S275**

From table 9: Design strength p_y

Thickness of element	max(T, t) = **9.6** mm
Design strength	p_y = **275** N/mm^2
Modulus of elasticity	E = **205000** N/mm^2



Lateral restraint

Distance between major axis restraints	L_x = **5000** mm
Distance between minor axis restraints	L_y = **5000** mm

Effective length factors

Effective length factor in major axis	K_x = **1.00**
Effective length factor in minor axis	K_y = **1.00**
Effective length factor for lateral-torsional buckling	K_{LT} = **1.20** + 2 × D

Classification of cross sections - Section 3.5

$\varepsilon = \sqrt{[275 \text{ N/mm}^2 / p_y]}$ = **1.00**

Internal compression parts - Table 11

Depth of section	d = **172.4** mm	
	d / t = 26.9 × ε <= 80 × ε	Class 1 plastic

Outstand flanges - Table 11

Width of section	b = B / 2 = **67** mm	
	b / T = 7.0 × ε <= 9 × ε	Class 1 plastic

Section is class 1 plastic

Shear capacity - Section 4.2.3

Design shear force	$F_{y,v}$ = **50** kN
	d / t < 70 × ε

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BEAMCALC.CO.UK Beam Calculation Ltd info@beamcalc.co.uk	Calcs for AN EXAMPLE				Start page no./Revision 2	
	Calcs by DR	Calcs date 31/07/2019	Checked by	Checked date	Approved by	Approved date

Web does not need to be checked for shear buckling

Shear area	$A_v = t \times D =$ **1324** mm^2
Design shear resistance	$P_{y,v} = 0.6 \times p_y \times A_v =$ **218.4** kN

PASS - Design shear resistance exceeds design shear force

Shear capacity - Section 4.2.3

Design shear force	$F_{x,v} =$ **0** kN

Moment capacity - Section 4.2.5

Design bending moment	$M =$ **20** kNm
Moment capacity low shear - cl.4.2.5.2	$M_c = \min(p_y \times S_{xx}, 1.2 \times p_y \times Z_{xx}) =$ **86.5** kNm

Effective length for lateral-torsional buckling - Section 4.3.5

Effective length for lateral torsional buckling	$L_E = 1.2 \times L_y + 2 \times D =$ **6414** mm
Slenderness ratio	$\lambda = L_E / r_{yy} =$ **202.144**

Equivalent slenderness - Section 4.3.6.7

Buckling parameter	$u =$ **0.881**
Torsional index	$x =$ **21.493**
Slenderness factor	$v = 1 / [1 + 0.05 \times (\lambda / x)^2]^{0.25} =$ **0.655**
Ratio - cl.4.3.6.9	$\beta_W =$ **1.000**
Equivalent slenderness - cl.4.3.6.7	$\lambda_{LT} = u \times v \times \lambda \times \sqrt{[\beta_W]} =$ **116.766**
Limiting slenderness - Annex B.2.2	$\lambda_{L0} = 0.4 \times (\pi^2 \times E / p_y)^{0.5} =$ **34.310**

$\lambda_{LT} > \lambda_{L0}$ - Allowance should be made for lateral-torsional buckling

Bending strength - Section 4.3.6.5

Robertson constant	$\alpha_{LT} =$ **7.0**
Perry factor	$\eta_{LT} = \max(\alpha_{LT} \times (\lambda_{LT} - \lambda_{L0}) / 1000, 0) =$ **0.577**
Euler stress	$p_E = \pi^2 \times E / \lambda_{LT}^2 =$ **148.4** N/mm^2
	$\phi_{LT} = (p_y + (\eta_{LT} + 1) \times p_E) / 2 =$ **254.5** N/mm^2
Bending strength - Annex B.2.1	$p_b = p_E \times p_y / (\phi_{LT} + (\phi_{LT}^2 - p_E \times p_y)^{0.5}) =$ **99.7** N/mm^2

Equivalent uniform moment factor - Section 4.3.6.6

Equivalent uniform moment factor for LTB	$m_{LT} =$ **1.000**

Buckling resistance moment - Section 4.3.6.4

Buckling resistance moment	$M_b = p_b \times S_{xx} =$ **31.3** kNm
	$M_b / m_{LT} =$ **31.3** kNm

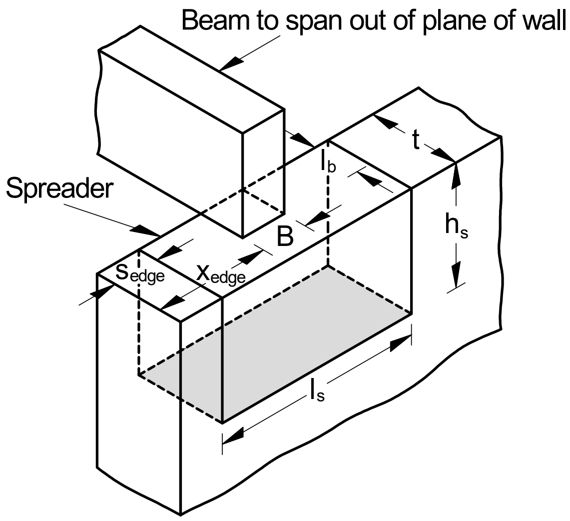
PASS - Buckling resistance moment exceeds design bending moment

MASONRY BEARING DESIGN TO BS5628-1:2005

TEDDS calculation version 1.0.05

Masonry details

Masonry type	**Aggregate concrete blocks (25% or less formed voids)**
Compressive strength of unit	p_{unit} = **7.3** N/mm^2
Mortar designation	**iii**
Least horizontal dimension of masonry units	l_{unit} = **100** mm
Height of masonry units	h_{unit} = **215** mm
Category of masonry units	**Category II**
Category of construction control	**Normal**
Partial safety factor for material strength	γ_m = **3.5**
Thickness of load bearing leaf	t = **100** mm
Effective thickness of masonry wall	t_{ef} = **133** mm
Height of masonry wall	h = **2400** mm
Effective height of masonry wall	h_{ef} = **2400** mm



Bearing details

Beam spanning out of plane of wall

Width of bearing	B = **133** mm
Length of bearing	l_b = **100** mm
Edge distance	x_{edge} = **100** mm

Compressive strength from Table 2 BS5628:Part 1 - aggregate concrete blocks (25% or less formed voids)

Mortar designation	Mortar = **"iii"**
Block compressive strength	p_{unit} = **7.3** N/mm^2
Characteristic compressive strength (Table 2c)	f_{kc} = **3.20** N/mm^2
Characteristic compressive strength (Table 2d)	f_{kd} = **6.40** N/mm^2
Height of solid block	h_{unit} = **215.0** mm
Least horizontal dimension	l_{unit} = **100.0** mm

Block ratio — ratio = h_{unit} / l_{unit} = **2.2**

Ratio between 0.6 and 4.5 - OK

Characteristic compressive strength — f_k = **6.40** N/mm^2

Loading details

Characteristic concentrated dead load — G_k = **25** kN

Characteristic concentrated imposed load — Q_k = **25** kN

Design concentrated load — F = ($G_k \times 1.4$) + ($Q_k \times 1.6$) = **75.0** kN

Characteristic distributed dead load — g_k = **5.0** kN/m

Characteristic distributed imposed load — q_k = **5.0** kN/m

Design distributed load — f = ($g_k \times 1.4$) + ($q_k \times 1.6$) = **15.0** kN/m

Masonry bearing type

Bearing type — **Type 2**

Bearing safety factor — γ_{bear} = **1.50**

Check design bearing without a spreader

Design bearing stress — f_{ca} = F / (B $\times$ l_b) + f / t = **5.789** N/mm^2

Allowable bearing stress — f_{cp} = $\gamma_{bear} \times f_k / \gamma_m$ = **2.743** N/mm^2

FAIL - Design bearing stress exceeds allowable bearing stress, use a spreader

Spreader details

Length of spreader — l_s = **440** mm

Depth of spreader — h_s = **215** mm

Edge distance — s_{edge} = max(0 mm, x_{edge} – (l_s - B) / 2) = **0** mm

Spreader bearing type

Bearing type — **Type 3**

Bearing safety factor — γ_{bear} = **2.00**

Check design bearing with a spreader

Loading acts eccentrically within middle third – triangular stress distribution

Eccentricity of load — e = ((l_s – B) / 2) – x_{edge} = **53** mm

Maximum bearing stress — f_{ca} = F $\times$ (1 + (6 $\times$ e / l_s)) / ($l_s \times$ t) + f / t = **3.098** N/mm^2

Allowable bearing stress — f_{cp} = $\gamma_{bear} \times f_k / \gamma_m$ = **3.657** N/mm^2

PASS - Allowable bearing stress exceeds design bearing stress

Check design bearing at 0.4 × h below the bearing level

Slenderness ratio — h_{ef} / t_{ef} = **18.05**

Eccentricity at top of wall — e_x = **0.0** mm

From BS5628:1 Table 7

Capacity reduction factor — β = **0.83**

Length of bearing distributed at 0.4 × h — l_d = **1193** mm

Maximum bearing stress — f_{ca} = F / ($l_d \times$ t) + f / t = **0.779** N/mm^2

Allowable bearing stress — f_{cp} = $\beta \times f_k / \gamma_m$ = **1.526** N/mm^2

PASS - Allowable bearing stress at 0.4 × h below bearing level exceeds design bearing stress