KCRDESIGN
PLANS TO INSPIRE

Specification and Structural Calculations
Address removed to protect client confidentiality
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SPECIFICATION AS APPLICABLE

This specification to be read in conjunction with the architectural drawings and any structural calculations.
Any and all notes on the drawings are specific to the particular build and are to supersede this specification.
Do not scale from the drawings. Scale for planning purposes only. The contractor is responsible for checking all dimensions on site prior to commencement of the works with any errors being reported as soon as possible.
The contractor shall be entirely responsible for the security, strength and stability of the building during the course of the works.
All building work to be carried out to the satisfaction of the local authority building control officer and in accordance with the current building regulations and as such additional unforeseen building works may be required on site.
The exact location, type, condition and invert level of all existing drainage to be ascertained on site, with any defects being reported.
The contractor shall inspect all adjoining properties which may be affected by the works prior to commencement of works and record and report to the owner any defects.

Finished room dimensions may vary from those stated on the drawings.
Items in this specification, the drawing notes, and parts of the drawings, may not form part of the contract to be carried out by KCR Design.

Party Wall act

The owner, should they need to do so under the requirements of the Party Wall Act 1996, has a duty to serve a Party Structure Notice on any adjoining owner if the building work involves works on or to an existing Party Wall including:

- Support of beam
- Insertion of DPC through wall
- Raising a wall or cutting off projections
- Demolition and rebuilding
- Underpinning
- Insertion of lead flashings
- Excavations within 3 meters of an existing structure where the new foundations will go deeper than adjoining foundations, or within 6 meters of an existing structure where the new foundations are within a 45 degree line of the adjoining foundations.

A Party wall agreement is to be in place prior to start of works on site.

Southern Water

If submission has been made to building control, they will inform Southern Water of the application. It is the responsibility of the homeowner to ensure the requirements (if applicable) of Southern Water are adhered to. They can be contacted on 0330 303 0119

CDM Regulations

The owner, should they need to do so, must abide by the Construction Design and Management regulations 1994 which relate to any building works involving more than 500 man hours or longer than 30 days duration. It is the client's responsibility to appoint a Planning Supervisor on all projects that require compliance with the CDM regulations.

AS APPLICABLE

1. Site preparation
2. Foundations and drainage
3. Ground floor
4. External walls
5. Roofs
6. Windows and doors
7. Internal walls
8. Plumbing and electrical
9. Structural
10. Ventilation
11. Fire prevention and means of escape

1. SITE PREPARATION

Ground to be prepared for new works by removing all unsuitable material, vegetable matter and tree or shrub roots to a suitable depth to prevent future growth. Seal up, cap off, disconnect and remove existing redundant services as necessary. Reasonable precautions must also be taken to avoid danger to health and safety caused by contaminants and ground gases e.g. landfill gases, radon, vapours etc on or in the ground covered, or to be covered by the building.

2. FOUNDATIONS AND DRAINAGE

TRENCH FOUNDATION
750mm x 600mm trench fill foundations grade of ST2. All foundations to be a minimum of 1000mm below ground level, exact depth agreed on site with the Building Control Officer to suit site conditions. All constructed in accordance with 2004 Building Regulations A1/2 and BS 8004:1986 Code of Practice for Foundations. Ensure foundations are constructed below invert level of any adjacent drains. Base of foundations supporting internal walls to be min 600mm below ground level. Sulphate resistant cement to be used if required. Please note that should any adverse soil conditions or difference in soil type be found, or if there are any major tree roots in the excavations, the Building Control Officer is to be contacted. Exact depth of foundation is dependent on site sub soil conditions. Stepped foundations should overlap by twice the height of the step, or 1m whichever is the greater. The height of the step should not be greater than the thickness of the foundation.

WALLS BELOW GROUND
All new walls to have Class A blockwork below ground level or alternatively semi engineering brickwork in 1:4 masonry cement or equal approved specification. Cavities below ground level to be filled with lean mix concrete min 225mm below damp proof course. Or provide lean mix backfill at base of cavity wall (150mm below damp course) laid to fall to weepholes.

PIPEWORK THROUGH WALLS
Where new pipework passes through external walls form rocker joints either side wall face of max length 600mm with flexible joints with short length of pipe bedded in wall.
Alternatively provide 75mm deep pre-cast concrete plank lintels over drain to form opening in wall to give 50mm space all round pipe: mask opening both sides with rigid sheet material and compressible sealant to prevent entry of fill or vermin.

UNDERGROUND FOUL DRAINAGE
Underground drainage to consist of 110mm diameter UPVC proprietary pipe work to give a 1:40 fall. Surround pipes in 400mm pea shingle (900mm under drives). Shallow pipes to be covered with 100mm reinforced concrete slab over compressible material. Provide rodding access at all changes of direction and junctions. All below ground drainage to comply with BS7158 and BS801.

RAINWATER DRAINAGE
New rainwater goods to be new 110mm UPVC half round gutters taken and connected into 68mm dia UPVC downpipes. Rainwater taken to new soakaway, situated a min distance of 5.0m away from any building, via 110mm dia UPVC pipes surrounded in 150mm granular fill. Soakaway to be

min of 1 cubic metre capacity (or to depth to Local Authorities approval) with suitable granular fill with geotextile surround to prevent migration of fines. If necessary carry out a porosity test to determine design and depth of soakaway.

3. GROUND FLOOR AND INTERMEDIATE FLOORS

SUSPENDED BLOCK AND BEAM FLOOR
Remove top soil & vegetation, apply weed killer –
The underside of beams not less than 150mm above the top of the ground. PCC beams to be supplied and fixed to beam manufacturer's plan, layout and details (details and calculations to be sent to Building Control and approved before works commence). Minimum bearing 100mm onto DPC course and load bearing walls. Provide concrete blocks to BS6073 pt.1, wet and grout all joints with 1:4 cement/sand mix. Provide double beams below non-load bearing partitions. Lay 1200g DPM/radon barrier, with 300mm laps double welted and taped at joints and service entry points using radon gas proof tape, over beam & block floor. Lay floor insulation over DPM, 80mm Celotex GA4000 applied as a rigid material. Place 500g separating layer over insulation and provide 75mm sand/cement screed over and prepare for floor finishes as required. The top surface of the ground cover under the building shall be above the finished level of the adjoining ground.
Ventilation - Provide cross-ventilation of the under floor to outside air by ventilators in at least 2 opposite external walls of the building. Ventilation openings having an opening area of 1500mm² per metre run of perimeter wall or 500mm² per square metre of floor area, whichever is the greater.

4. EXTERNAL WALLS

MOVEMENT JOINTS
Movement joints are to be provided at 12 meter intervals to brickwork

EXTERNAL BRICKWORK CAVITY WALLS TO EXTENSION
To achieve minimum U Value of 0.28W/m²K
New cavity wall to comprise of 105mm facing brick to match existing. Full fill the cavity with 100mm Rockwool Cavity insulation as manufacturer's details. Inner leaf to be 100mm block K value 0.16 lightweight block (Aircrete, Celcon solar, Topblock toplite standard). Internal finish to be 12.5 mm plasterboard on dabs. Walls to be built with 1:1:6 cement mortar.

DPC
Provide horizontal strip polymer (hyload) damp proof course to both leafs minimum 150mm above external ground level. New DPC to be made continuous with existing DPC’s and with floor DPM. Vertical DPC to be installed at all reveals where cavity is closed.

WALL TIES
All walls constructed with stainless steel vertical twist type retaining wall ties built in at 750mm ctrs horizontally, 450mm vertically and 225mm cts at reveals and corners in staggered rows. Wall ties to be suitable for cavity width and in accordance with BS 1243.

CAVITIES
Provide cavity trays over openings. All cavities to be closed at eaves and around openings using Thermabate or similar non combustible insulated cavity closers. Provide vertical DPCs around openings and abutments. All cavity trays must have 150mm upstands and suitable cavity weep holes (min 2) at max 900mm centres.

EXISTING TO NEW WALL
Cavities in new wall to be made continuous with existing where possible to ensure continuous weather break. If a continuous cavity cannot be achieved, where new walls abuts the existing walls provide a movement joint with vertical DPC. All tied into existing construction with suitable proprietary stainless steel profiles.

5. ROOFS

PITCHED ROOF INSULATION AT CEILING LEVEL
To achieve U value of 0.16 W/m²K
Timber roof structures to be fixed in accordance with BS Codes of Practice no CP3 and CP112. Roofing tiles to match existing on 25 x 38mm tanalised sw treated battens on breathable membrane, supported on (see structural notes) rafters at max 400mm centres. Rafters supported on min 100 x 50mm sw wall plates. Insulation at ceiling level to be 150mm FR4000 Celotex between ceiling joists with a further 25mm over joists.
Construct ceiling using sw joists at 400mm centres, finished internally with 12.5mm plasterboard and min 3mm thistle multi-finish plaster. Provide polythene vapour barrier between insulation and plasterboard. Restraint strapping - 100mm x 50mm wall plate strapped down to walls. Ceiling joists and rafters to be strapped to walls and gable walls, straps built into cavity, across at least 3 timbers with noggins. All straps to be 1000 x 30 x 5mm galvanized straps or other approved to BSEN 845-1 at 2m centres, in accordance with CP111 Part 2.

STRAPPING FOR PITCHED ROOF
Gable walls should be strapped to roofs at 2m centres. All external walls running parallel to roof rafters to be restrained at roof level using 1000mm x 30mm x 5mm galvanised mild steel horizontal straps or other approved to BSEN 845-1 built into walls at max 2000mm centres and to be taken across minimum 3 rafters and screw fixed. Provide solid noggins between rafters at strap positions. All wall plates to be 100 x 50mm fixed to inner skin of cavity wall using 30mm x 5mm x 1000mm galvanized metal straps or other approved to BSEN 845-1 at maximum 2m centres.

LEAD WORK AND FLASHINGS
All lead flashings, any valleys or soakers to be Code 5 lead and laid according to Lead Development Association. Flashings to be provided to all jambs and below window openings with welded upstands. Joints to be lapped min 150mm and lead to be dressed 200mm under tiles, etc. All work to be undertaken in accordance with the Lead Development Association recommendations.

6. WINDOWS AND DOORS

NEW AND REPLACEMENT WINDOWS
New and replacement windows to be double glazed with 16mm argon gap and soft coat low-E glass. Window Energy Rating to be Band C or better and to achieve U-value of 1.6 W/m²K. The door and window openings should be limited to 25% of the extension floor area plus the area of any existing openings covered by the extension.

SAFETY GLAZING
All glazing in critical locations to be toughened or laminated safety glass to BS 6206 and Part N of the current building regulations. i.e. within 1500mm above floor level in doors and side panels within 300mm of door opening and within 800mm above floor level in windows.

ESCAPE WINDOWS
Provide emergency egress windows to any newly created first floor habitable rooms and ground floor inner rooms. Windows to have an unobstructed openable area of 450mm high x 450mm wide, minimum 0.33m sq, the bottom of the openable area should be not more than 1100mm above the floor. The window should enable the person to reach a place free from danger from fire.

NEW AND REPLACEMENT DOORS
New and replacement doors to achieve a U-Value of 1.80W/m²K. Glazed areas to be double glazed with 16mm argon gap and soft low-E glass. Glass to be toughened or laminated safety glass to BS 6206 and Part N of the current Building Regulations.

7. INTERNAL WALLS

INTERNAL STUD PARTITIONS
100mm x 50mm softwood treated timbers studs at 400mm cts with 50 x 100mm head and sole plates and solid intermediate horizontal noggins at 1/3 height or 450mm. Provide min 10kg/m³ density acoustic soundproof quilt tightly packed (eg. 100mm Rockwool or Isowool mineral fibre sound insulation) in all voids the full depth of the stud. Partitions built off doubled up joists where partitions run parallel or provide noggins where at right angles, or built off DPC on thickened concrete slab if solid ground floor. Walls faced throughout with 12.5mm plaster board with skim plaster finish. Taped and jointed complete with beads and stops.

8. PLUMBING AND ELECTRICAL

ELECTRICAL
All lighting, power and switch points are to be to clients requirements and installed to I.E.E. Code of Practice and B.S. 7671 by an N.I.C.I.E.C. approved Contractor. All electrical work is required to meet further requirements of Part P (Electrical Safety) and must be designed, installed, inspected and tested by a person competent to do so. Prior to completion the local Authority needs to be satisfied that Part P has been complied with. This will require an appropriate electrical installation certificate B.S. 7671 to be issued for the work by a person competent to do so. Run all electric cables in the first floor void above mineral wool and all cables in stud walls filled with mineral wall to be run in conduit. Where recessed light fittings are installed perforating the plasterboard, a fire

resisting enclosure should be built around the light fitting to maintain an imperforate floor. The light fitting should then be of a type that is ventilated downwards through the ceiling.

ENERGY EFFICIENT LIGHTING
Install low energy light fittings that only take lamps having a luminous efficiency greater than 45 lumens per circuit watt and a total output greater than 400 lamp lumens. Not less than three energy efficient light fittings per four of all the light fittings in the main dwelling spaces to comply with Part L of the current Building Regulations.

ABOVE GROUND DRAINAGE
Above ground drainage to comply with BS.5572.1978. for sanitary pipework. All drainage in accordance with part H of the Building Regulations. Wastes to have 75mm deep anti vac bottle traps and rodding eyes at changes of direction. All plumbing to be to BS 5572.
Size of wastes pipes and max length of branch connections (if max length is exceeded then anti vacuum traps to be used)
Sinks - 3m for 40mm pipe 4m for 50mm pipe
Washing machine and dishwasher - stand pipe 50mm
Wash basin - 1.7m for 32mm pipe 4m for 40mm pipe
Bath/shower - 3m for 40mm pipe 4m for 50mm pipe
W/c - 100mm for 6m for single wc
All branch pipes to connect to 110mm soil and vent pipe. Waste pipes not to connect within 200mm of the wc connection.
Supply hot and cold water to all fittings as appropriate.

HEATING
Extend all heating and hot water services from existing and provide new TVRs to radiators. Heating system to be designed, installed, tested and fully certified by a GAS SAFE registered specialist. All work to be in accordance with the Local Water Authorities bye laws, Gas safety requirements and IEEE regulations.

9.STRUCTURAL

EXISTING STRUCTURE
Existing structure including foundations, beams, walls and lintels carrying new and altered loads are to be exposed and checked for adequacy prior to commencement of work and as required by the Building Control Officer.

BEAMS
Supply and install new structural elements such as new beams, roof structure, floor structure, bearings, and padstones in accordance with the Structural Engineer's calculations and details. New steel beams to be encased in 12.5mm Gyproc fireline board with staggered joints nailed to timber cradles or painted in Nullifire S or similar intumescent paint to provide 1/2 hour fire resistance.

LINTELS
Lintel widths are to be equal to wall thickness. All lintels over 750mm sized internal door openings to be 65mm deep pre-stressed concrete plank lintels. 150mm deep lintels are to be used for

900mm sized internal door openings. Lintels to have a minimum bearing of 150mm on each end. Any existing lintels carrying additional loads are to be exposed for inspection at commencement of work on site. All pre-stressed concrete lintels to be designed and manufactured in accordance with BS 8110, with a concrete strength of 50 or 40 N/mm² and incorporating steel strands to BS 5896 to support loadings assessed to BS 5977 Part 1.
For other structural openings provide proprietary insulated steel lintels suitable for spans and loadings in compliance with Approved Document A and lintel manufacture standard tables. Stop ends, DPC trays and weep holes to be provided above all externally located lintels.

OPENINGS AND RETURNS
An opening or recess greater than 0.1m² shall be at least 550mm from the supported wall (measured internally).

10.VENTILATION

BACKGROUND AND PURGE VENTILATION
Background ventilation - Controllable background ventilation via trickle vents to BS EN 13141-3 within the window frame to be provided to new habitable rooms at a rate of min 5000mm²; and to kitchens, bathrooms, WCs and utility rooms at a rate of 2500mm²
Purge ventilation - New Windows/rooflights to have openable area in excess of 1/20th of their floor area, if the window opens more than 30° or 1/10th of their floor area if the window opens less than 30°
Internal doors should be provided with a 10mm gap below the door to aid air circulation. Ventilation provision in accordance with the Domestic ventilation compliance guide.

EXTRACT TO UTILITY ROOM
Utility room to have mechanical ventilation ducted to external air with an extract rating of 30l/s operated via the light switch, to have a 15min overrun if no window in room. Internal doors should be provided with a 10mm gap below the door to aid air circulation. Ventilation provision in accordance with the Domestic ventilation compliance guide. Intermittent extract fans to BS EN 13141-4. All fixed mechanical ventilation systems, where they can be tested and adjusted, shall be commissioned and a commissioning notice given to the Building Control Body.

11.FIRE PREVENTION AND MEANS OF ESCAPE

SMOKE DETECTION
Mains operated linked smoke alarm detection system to BS 5446 - 1:2000 and BS5839-6:2004 to at least a Grade D category LD3 standard and to be mains powered with battery back up. Smoke alarms should be sited so that there is a smoke alarm in the circulation space on all levels/ storeys and within 7.5m of the door to every habitable room. If ceiling mounted they should be 300mm from the walls and light fittings. Where the kitchen area is not separated from the stairway or circulation space by a door, there should be an interlinked heat detector in the kitchen.

MEANS OF ESCAPE - 2 exits at ground floor
The first and second storeys should be served by a protected stairway, the structure forming this enclosure must have 30 minute fire resistance including floors and ceilings above and below rooms. The doors must be FD20 rated fire doors to BS 476-22:1987 (fitted with intumescent strips

rebated around sides & top of door or frame if required by BCO). The enclosure should lead to at least two alternative escape routes at ground level, which should be separated from each other by fire-resisting construction and fire doors. Where applicable, any glazing in walls or doors enclosing the protected stairs is to have 30 minutes fire resistance. (no inner rooms allowed)

MEANS OF ESCAPE – Exit at first floor level.
An MOE window having an opening area of at least 0.33M2 and with minimum width or height of at least 450mm. The bottom of such opening should be located at a height of minimum 800mm and maximum 1100mm above the floor level.

BEAMS
Supply and install new structural elements such as new beams, roof structure, floor structure, bearings, and padstones in accordance with the Structural Engineer's calculations and details. New steel beams to be encased in 12.5mm Gyproc fireline board with staggered joints nailed to timber cradles or painted in Nullifire S or similar intumescent paint to provide 1/2 hour fire resistance.

Beam: **Beam A** **Span: 2.9 m.**

	Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*
U D	o.w.	0.2	0		L	0.29	0.29
U D	BLOCKWORK PARTITION	1.50*2.40	0		L	5.22	5.22
U D	TIMBER FLOOR	2.00*1.80	0		L	5.22	5.22
U D	TIMBER FLOOR	2.00*1.40	0		L	4.06	4.06
				Unfactored reactions (kN) Total:		**14.79**	**14.79**
					Dead:	*14.79*	*14.79*
					Live:	*0.00*	*0.00*
Total load: 29.58/41.41 kN *Unfactored/Factored*					**Factored reactions:**	**20.71**	**20.71**

Load types: U:UDL D: Dead; L: Live (positions in m. from R1)

Maximum B.M. (factored) = 15.0 kNm at 1.45 m. from R1

Maximum S.F. (factored) = 20.7 kN at R1

Live load deflection = 0.00 x 10^8/EI at R2 *(E in N/mm^2, I in cm^4)*

Total deflection = 9.39 x 10^8/EI at 1.45 m. from R1

Beam calculation to BS5950-1:2000 using S275 steel

SECTION SIZE : **178 x 102 x 19 UB S275 (compact)**

D=177.8 mm B=101.2 mm t=4.8 mm T=7.9 mm I_x=1,360 cm^4 r_y=2.37 cm S_x=171 cm^3

Shear capacity = 0.6 p_y.t.D = 0.6 x 275 x 4.8 x 177.8/1000 = 141 kN (>=20.7) OK

Maximum moment = 15.01 kNm at 1.45 m. from R1

Moment capacity, M_c = p_y.S_x = 275 x 171/1000 = 47.02 kNm OK

Beam is laterally restrained at supports only: effective length = 1.0L

Effective length (L_F) = 2.90m
Buckling parameter (u) = 0.886
β_w = 1.000 (Class 1/2 compact)
Bending strength, p_b = 150.6 N/mm^2

Slenderness, λ (L_F/r_v) = 2.90 x 100/2.37 = 122.4
Slenderness factor (v) = 0.798 (x = 22.6; λ/x = 5.41)
Equivalent slenderness (λ_{LT}) = u.v.λ.$\sqrt{\beta_w}$ = 86.52

Maximum moment within segment, M_x = 15.01 kNm
Equivalent uniform moment factor, $m_{l\,T}$ = 0.925 (M_2=11.3, M_3=15.0, M_4=11.3)
Equivalent uniform moment = 0.925 x 15.01 = 13.89 kNm
Buckling resistance moment, M_b = p_b.S_x = 150.6 x 171/1000 = 25.76 kNm OK

Check unstiffened web capacity with load of 20.71 kN
C1 = 40.9 kN; C2 = 1.32 kN/mm; C4 = 129; K = min{0.5+(a_e/1.4d),1.0}; p_{vw} = 275N/mm^2
(for derivation of C factors see Steelwork Design Guide to BS5950-1:2000 6th ed.)
Bearing capacity, P_w = C1+b_1C2 (b_e taken as zero) Buckling capacity, P_x = K$\sqrt{}$(C4.P_w)
With b_1=0, unstiffened web buckling capacity, P_x = 36.4 kN: no minimum stiff bearing length required

LL deflection = 0.000 x 1e8/205,000 x 1360.000 = 0.0 mm OK
TL deflection = 9.393 x 1e8/205,000 x 1360 = 3.4 mm (L/861)

Bearing details

178x102x19 UB stiff bearing length, b_1 = t + 1.6r + 2T = 32.8 mm

Local design strength of masonry (factored) = 0.700 N/mm^2 (User-entered value)

R1: 300 x 100 mm bearing plate

Factored reaction = 14.79 x 1.4 + 0.00 x 1.6 = 20.71 kN

15 mm m.s. bearing plate, size 300 x 100 mm
Bearing plate projection beyond stiff bearing length = (300-32.8)/2 = 133.6mm
Factored stress under plate = 20.71 x 1000/300 x 100 = 0.69 N/mm^2
Required plate thickness = $\sqrt{}$(3x0.69x134x134/275) = 11.6 mm: use 15mm
Factored bending stress in plate = 0.69x134x(134/2)/(15x15/6) = 164.3 N/mm^2 (p_y=275 N/mm^2)

R2 as R1

Encase beam to provide half-hour fire resistance as per specification.

Beam: **Beam B** **Span: 1.2 m.**

		Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*
U	T	o.w.	0.15	0		L	0.09	0.09
U	T	PITCHED ROOF	1.60*5.00	0		L	4.80	4.80
U	T	ROOF SPACE	0.55*4.00	0		L	1.32	1.32
U	T	BRICKWORK PARTITION	2.70*2.40	0		L	3.89	3.89
U	T	TIMBER FLOOR	2.00*2.00	0		L	2.40	2.40
							12.50	12.50

Total load: 25.00 kN

Load types: U:UDL T: Total (positions in m. from R1)

Maximum B.M. = 3.75 kNm at 0.60 m. from R1

Maximum S.F. = 12.5 kN at R1

Total deflection = 0.562 x 10^8/EI at 0.60 m. from R1 *(E in N/mm^2, I in cm^4)*

Timber beam calculation to BS5268 Part 2: 2002 using C16 timber

Use 50 x 147 C16 + 10 x 122 flitch plate *12.3 kg/m approx*

z = 180.1 cm^3 I = 1,324 cm^4 Flitch plate z = 24.8 cm^3 I = 151 cm^4

Timber grade: C16 2 members acting together: K_8 = 1.1

K_3 (loading duration factor) = 1.00 K_7 (depth factor) = 1.082 K_8 (load sharing factor) = 1.1

Loading will be carried by the timber members and flitch plate in proportion to their EI values. Checks are made using the mean and minimum E-values for timber to produce worst case stresses on timber and steel members respectively. See TRADA guidance document GD9, 2008, for more information.

EI_{steel} = 205,000 x 151 x 10^4 = 310 x 10^9 Nmm^2

Calculate K_{8A} *(modified K8 as per TRADA GD9)*

Using E_{mean}, EI_{timber} = 8,800 x 1,324 x 10^4 = 116 x 10^9 Nmm^2

Timber carries 116/(116+310) = 0.273 of total load (in worst case)

K_{8A} = 1.04 (EI_{steel} >= 0.2EI_{total} and EI_{steel} <= 0.8EI_{total})

Calculate effect of bolt holes

M10 bolts, centres offset 0 mm from beam centre line: assume 11 mm holes
To allow for holes factor bending stresses by 1.0 (timber) and 1.0 (steel)

Bending

Permissible bending stress, $\sigma_{m,adm} = \sigma_{m,g}.K_3.K_7.K_{8A}$ = 5.3 x 1.00 x 1.082 x 1.04 = 5.96 N/mm^2

Applied bending stress, $\sigma_{m,a}$ = 0.273 x 3.75 x 1.000 x 1000/180.1 = 5.68 N/mm^2 OK

Shear

Permissible shear stress, τ_{adm} = 0.67 x 1.04 = 0.70 N/mm^2

Applied shear stress, τ_a = 0.273 x 12.498 x 1000 x 3/(2 x 50 x 147) = 0.70 N/mm^2 OK

Bearings

Grade compression stress perpendicular to grain = 2.20 x 1.00 = 2.20 N/mm^2

Minimum bearing lengths: R1: 12.5 x 1000/(2.20 x 50) = 114mm
(subject to adequate support under bearing) R2: 12.5 x 1000/(2.20 x 1.00 x 50) = 114mm

Deflection:

Using E_{min} x K_9 (2 members) Timber EI = 5,800 x 1.14 x 1,324 x 10^4 = 87 x 10^9 Nmm^2

Timber carries 87/(87+310) = 0.220 of total load (average case)

Bending deflection = 0.220 x 0.562 x 10^8/(6,611 x 1,324) = 1.41 mm

Mid-span shear deflection = 0.220 x 1.2 x 3.75 x 10^6/(E/16) x 50 x 147 = 0.33 mm

Total deflection = 1.41 + 0.33 = 1.74 mm (0.0014 L) OK

Mid-span creep deflection:

Note that this calculation simplifies the Annex K calculation by taking all live loads as the leading live load rather than just the primary one if more than one

Service class 1 (dry) assumed: k_{def} = 0.6 ψ_2 = 0.3 (domestic) $Defl_{dead}$ = 0.14 $Defl_{live}$ = 0.42

Loads are assumed to be 25.0% dead; 75.0% live

$E_{fin} = E_{inst} \times (Defl_{dead} + Defl_{live})/(Defl_{dead} (1+ k_{def}) + Defl_{live} (1 + \psi_2.k_{def})) = E_{inst} \times 0.778$

$E_{min,fin}$ = 5,800 x 1.14 x 0.778 = 5,146 N/mm^2

Timber $E_{min,fin}$ I = 5,146 x 1,324 x 10^4 = 68 x 10^9 Nmm^2

Long term/instantaneous deflection = (87 + 310) / (68 + 310) = 1.05

Final deflection = 1.74 x 1.05 = 1.83 mm (0.0014 L) OK

Check flitch plate:

Using $E_{min,fin}$ for timber, flitch plate carries 310/(68 + 310) = 0.820 of total load

Per TRADA GD9 factor load by 1.10 to allow for slip and shear deflection in plate

Flitch plate f_{bc} = 0.820 x 3.75 x 1.10 x 1.000 x 1000/24.8 = 136.3 N/mm^2 OK

Bolting:

Use M10 4.6 bolts. Bolt numbers are calculated assuming worst case load on flitch plate

Load capacity per bolt in double shear = 2.62kN (BS5268 eq. G.7 - limiting value)

(G.7: 2.62kN; G.8: 25.0kN; G.9: 3.00kN; G.10: 4.24kN)

F_d=1350; $M_{y,d}$=48,000Nmm; p_k=310kg/m^3; K_{90}=1.50; $f_{h,0,d}$=10.60; $f_{h,1,d}$=7.068; B and K_a taken as 1.0

Bearings: R1 (12.5kN): Required number of bolts = 0.802 x 12.5/2.62 = 3.83 i.e. 4 bolts min.
R2 (12.5kN): Required number of bolts = 0.802 x 12.5/2.62 = 3.83 i.e. 4 bolts min.

For load transference a minimum of 8 bolts are also required across the span

Encase beam to provide half-hour fire resistance as per specification.
Use 2No. beams, one for each skin