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Derbyshire County Council
Improving life for local people

CORPORATE RESOURCES DEPARTMENT
CORPORATE PROPERTY

STRUCTURAL CALCULATIONS
FOR
CANTILEVERED FIRST FLOOR JOIST SUPPORTS

AT

77 LONGMOOR LANE
LONG EATON
DE72 3BB

ID No: 826440

Calcs By: Angela Holmes

Checked By: John Lawrence

Date: 20 September 2016

Rev. 0

Jeremy Goacher
Director of Property
Chatsworth Hall
Chesterfield Road
MATLOCK
DE4 3FW

INTRODUCTION TO CALCULATIONS

The calculations have been carried out to the following Codes of Practice:-

BS EN 1990:Eurocode – Basis of Structural Design (31 July 2010 edition)
UK National Annex to BS EN 1990:Eurocode – Basis of Structural Design (30 June 2009 edition)

BS EN 1991-1-1: Eurocode 1: Actions on structures: Densities, self-weight and imposed loads (28 February 2010 edition)
UK National Annex to BS EN 1991-1-1 (December 2005 edition)

BS EN 1995-1-1:Eurocode 5: Design of timber structures – Part 1-1: General – Common rules and rules for buildings (31 January 2009 edition)
UK National Annex to BS EN 1995-1-1 (31 October 2012 edition)

PD 6693-1 UK Non-Contradictory Complementary Information to Design of timber structures – Part 1-1: General – Common rules and rules for buildings (October 2012)

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1) Brief

An existing wall between the kitchen and store room is to be removed to create space in the kitchen area.

A survey of the wall to be removed was carried out on the 12 September 2016 to determine whether or not it was loadbearing.

During this inspection a section of the ceiling was removed in the ground floor store room. This revealed 3 No. joists which cantilevered from the kitchen wall to be removed.

As a result of this inspection the wall was deemed loadbearing and supporting the ends of the existing cantilevered joists at the stairs has been proposed in these calculations.

2) First floor joist check – existing cantilevered conditions

The survey revealed that 3 No. joists 200mm deep x 50mm wide at 300mm centres were present above the store room spanning from the kitchen party wall to the stairs. The joist ends were unsupported at the stairs therefore they are cantilevering off the wall to be removed. The span of the joists was 1.95m wall to wall with a 0.9m cantilevered section. The ends of the cantilevered section are taking the stud wall of the bedroom above.

A single joist has been checked taking a 300mm (c/c) strip of load.

Variable UDL for domestic loading = 1.5kN/m^2 x 0.3 = 0.45kN/m^2

Permanent UDL for laminate first floor = 0.6kN/m^2 x 0.3 = 0.18kN/m^2

Stud wall 1.2kN/m including plaster finishings = 1.2 x 0.3 = 0.36kN PL acting at 50mm from support A.

Assume at least 75mm end bearing will have been achieved.

See calculation pages 6-8 which prove that the existing cantilevered joists were adequate.

3) First floor joists – wall removal and end support

Once the wall has been removed the existing joists are spanning 2.85m wall to wall.

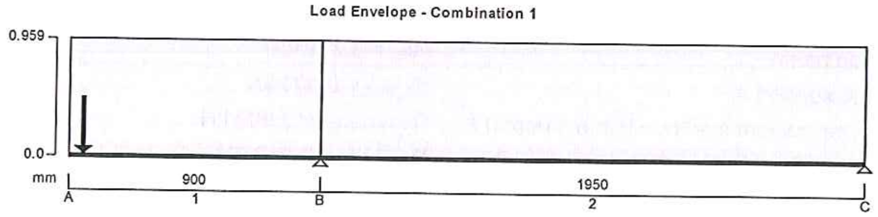
See calculation pages 9-11which prove that the existing joists are adequate when the kitchen wall is removed providing both ends of the joists and the bedroom stud wall are supported.

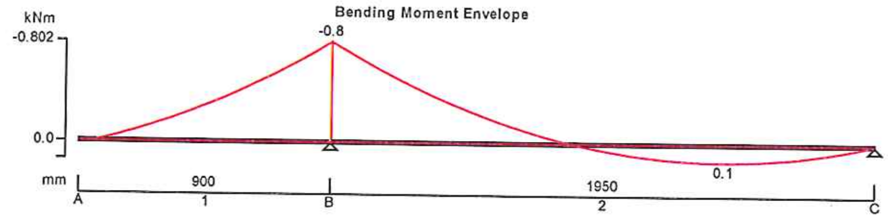
Derbyshire County Council, Chatsworth Hall, Matlock, DE4 3FW	Project: 77 Longmoor Lane Breaston DE72 3BB			Job no.: 826440	
	Calcs for: Cantilevered first floor joists			Start page no./Revision: 6	
	Calcs by: AJH	Calcs date: 19/09/2016	Checked by	Checked date	Approved by	Approved date

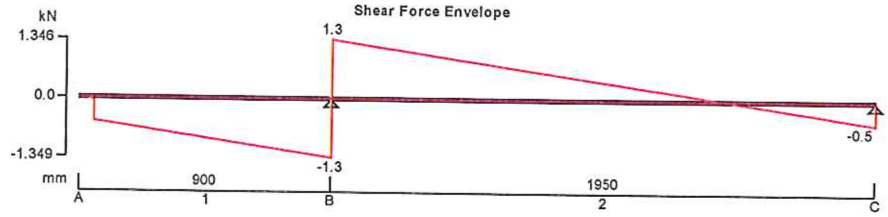
TIMBER BEAM ANALYSIS & DESIGN TO EN1995-1-1:2004

In accordance with EN1995-1-1:2004 + A1:2008 and Corrigendum No.1 and the UK National Annex incorporating National Amendment No.1

Tedds calculation version 1.5.11







Applied loading

Beam loads

Permanent point load 0.360 kN at 50 mm

Permanent full UDL 0.180 kN/m

Variable full UDL 0.450 kN/m

Permanent self weight of beam × 1

Load combinations

Load combination 1

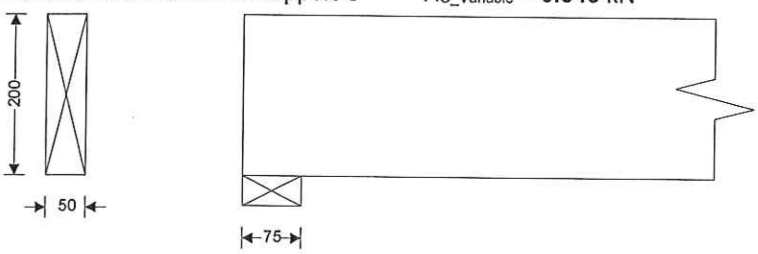
Support A	Permanent × 1.35
	Variable × 1.50
Span 1	Permanent × 1.35
	Variable × 1.50
Support B	Permanent × 1.35
	Variable × 1.50
Span 2	Permanent × 1.35
	Variable × 1.50
Support C	Permanent × 1.35

DERBYSHIRE County Council Improving life for local people Derbyshire County Council Chatsworth Hall Matlock DE4 3FW	Project 77 Longmoor Lane Breaston DE72 3BB			Job no. 826440	
	Calcs for Cantilevered first floor joists			Start page no./Revision 7	
	Calcs by AJH	Calcs date 19/09/2016	Checked by	Checked date	Approved by	Approved date

Variable × 1.50

Analysis results

Maximum moment	M_{max} = **0.143** kNm	M_{min} = **-0.802** kNm
Design moment	M = max(abs(M_{max}),abs(M_{min})) = **0.802** kNm	
Maximum shear	F_{max} = **1.346** kN	F_{min} = **-1.349** kN
Design shear	F = max(abs(F_{max}),abs(F_{min})) = **1.349** kN	
Total load on beam	W_{tot} = **3.219** kN	
Reactions at support A	R_{A_max} = **0.000** kN	R_{A_min} = **0.000** kN
Unfactored permanent load reaction at support A	$R_{A\_Permanent}$ = **0.000** kN	
Unfactored variable load reaction at support A	$R_{A\_Variable}$ = **0.000** kN	
Reactions at support B	R_{B_max} = **2.695** kN	R_{B_min} = **2.695** kN
Unfactored permanent load reaction at support B	$R_{B\_Permanent}$ = **0.955** kN	
Unfactored variable load reaction at support B	$R_{B\_Variable}$ = **0.937** kN	
Reactions at support C	R_{C_max} = **0.524** kN	R_{C_min} = **0.524** kN
Unfactored permanent load reaction at support C	$R_{C\_Permanent}$ = **0.005** kN	
Unfactored variable load reaction at support C	$R_{C\_Variable}$ = **0.345** kN	



Timber section details

Breadth of timber sections	b = **50** mm
Depth of timber sections	h = **200** mm
Number of timber sections in member	N = **1**
Overall breadth of timber member	b_b = N × b = **50** mm
Timber strength class - EN 338:2009 Table 1	**C16**

Member details

Load duration - cl.2.3.1.2	**Long-term**
Service class of timber - cl.2.3.1.3	**1**
Length of bearing	L_b = **75** mm

Section properties

Cross sectional area of member	A = N × b × h = **10000** mm²
Section modulus	W_y = N × b × h² / 6 = **333333** mm³
	W_z = h × (N × b)² / 6 = **83333** mm³
Second moment of area	I_y = N × b × h³ / 12 = **33333333** mm⁴
	I_z = h × (N × b)³ / 12 = **2083333** mm⁴
Radius of gyration	r_y = √(I_y / A) = **57.7** mm
	r_z = √(I_z / A) = **14.4** mm

Partial factor for material properties and resistances

Partial factor for material properties - Table 2.3	γ_M = **1.300**

Modification factors

Modification factor for load duration and moisture content - Table 3.1

k_{mod} = **0.700**

Deformation factor for service classes - Table 3.2 k_{def} = **0.600**

Depth factor for bending - exp.3.1 $k_{h.m}$ = **1.000**

Depth factor for tension - exp.3.1 $k_{h.t}$ = **1.000**

Bending stress re-distribution factor - cl.6.1.6(2) k_m = **0.700**

Crack factor for shear resistance - cl.6.1.7(2) k_{cr} = **0.670**

Load configuration factor - exp.6.4 $k_{c.90}$ = **1.000**

System strength factor - cl.6.6 k_{sys} = **1.000**

Lateral buckling factor - cl.6.3.3(5) k_{crit} = **1.000**

Compression perpendicular to the grain - cl.6.1.5

Design compressive stress $\sigma_{c.90.d} = R_{B\_max} / (N \times b \times L_b)$ = **0.719** N/mm²

Design compressive strength $f_{c.90.d} = k_{mod} \times k_{sys} \times k_{c.90} \times f_{c.90.k} / \gamma_M$ = **1.185** N/mm²

$\sigma_{c.90.d} / f_{c.90.d}$ = **0.607**

PASS - Design compressive strength exceeds design compressive stress at bearing

Bending - cl 6.1.6

Design bending stress $\sigma_{m.d} = M / W_y$ = **2.405** N/mm²

Design bending strength $f_{m.d} = k_{h.m} \times k_{mod} \times k_{sys} \times k_{crit} \times f_{m.k} / \gamma_M$ = **8.615** N/mm²

$\sigma_{m.d} / f_{m.d}$ = **0.279**

PASS - Design bending strength exceeds design bending stress

Shear - cl.6.1.7

Applied shear stress $\tau_d = 3 \times F / (2 \times k_{cr} \times A)$ = **0.302** N/mm²

Permissible shear stress $f_{v.d} = k_{mod} \times k_{sys} \times f_{v.k} / \gamma_M$ = **1.723** N/mm²

$\tau_d / f_{v.d}$ = **0.175**

PASS - Design shear strength exceeds design shear stress

Deflection - cl.7.2

Deflection limit $\delta_{lim} = \min(14\text{ mm}, 0.004 \times L_{s1})$ = **3.600** mm

Instantaneous deflection due to permanent load δ_{instG} = **1.004** mm

Final deflection due to permanent load $\delta_{finG} = \delta_{instG} \times (1 + k_{def})$ = **1.607** mm

Instantaneous deflection due to variable load δ_{instQ} = **0.064** mm

Factor for quasi-permanent variable action ψ_2 = **0.3**

Final deflection due to variable load $\delta_{finQ} = \delta_{instQ} \times (1 + \psi_2 \times k_{def})$ = **0.076** mm

Total final deflection $\delta_{fin} = \delta_{finG} + \delta_{finQ}$ = **1.683** mm

$\delta_{fin} / \delta_{lim}$ = **0.467**

PASS - Total final deflection is less than the deflection limit

DERBYSHIRE County Council Derbyshire County Council Chatsworth Hall Matlock DE4 3FW	Project 77 Longmoor Lane Breaston Derby DE72 3BB			Job no. 826440	
	Calcs for First floor Joist check - wall removed and ends supported			Start page no./Revision 9	
	Calcs by AJH	Calcs date 19/09/2016	Checked by	Checked date	Approved by	Approved date

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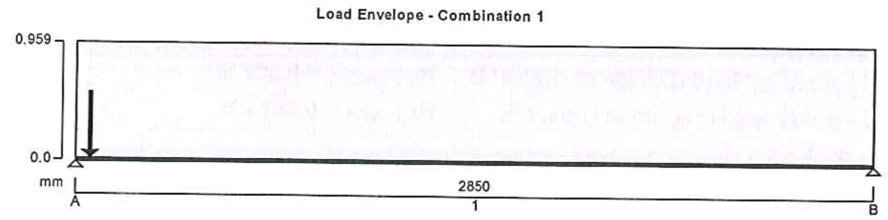
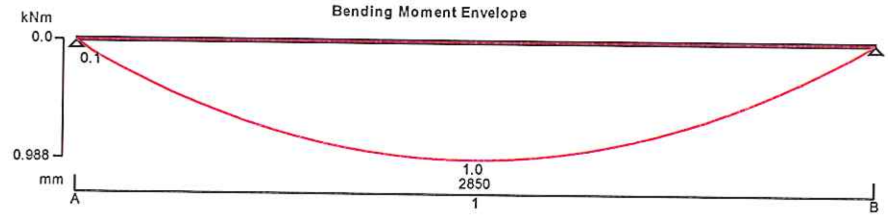
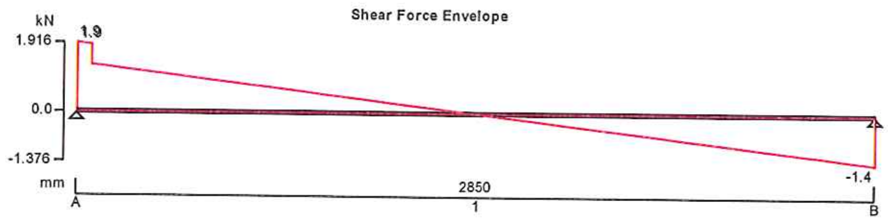
Tedds calculation version 1.5.11







Applied loading

Beam loads

Permanent point load 0.414 kN at 50 mm

Variable full UDL 0.450 kN/m

Permanent full UDL 0.180 kN/m

Permanent self weight of beam × 1

Load combinations

Load combination 1

Support A	Permanent × 1.35
	Variable × 1.50
Span 1	Permanent × 1.35
	Variable × 1.50
Support B	Permanent × 1.35
	Variable × 1.50

Analysis results

Maximum moment — M_{max} = **0.988** kNm — M_{min} = **0.000** kNm

Design moment — M = max(abs(M_{max}),abs(M_{min})) = **0.988** kNm

Maximum shear — F_{max} = **1.916** kN — F_{min} = **-1.376** kN

Design shear — F = max(abs(F_{max}),abs(F_{min})) = **1.916** kN

Total load on beam — W_{tot} = **3.292** kN

Reactions at support A — R_{A_max} = **1.916** kN — R_{A_min} = **1.916** kN

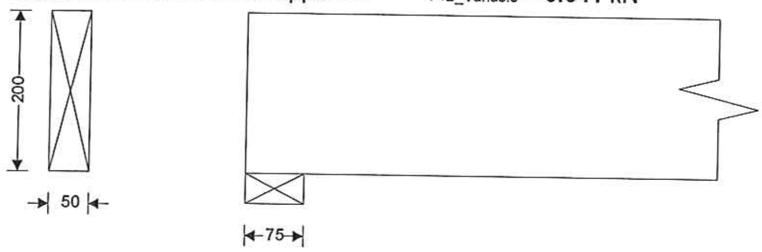
Unfactored permanent load reaction at support A — $R_{A\_Permanent}$ = **0.707** kN

Unfactored variable load reaction at support A — $R_{A\_Variable}$ = **0.641** kN

Reactions at support B — R_{B_max} = **1.376** kN — R_{B_min} = **1.376** kN

Unfactored permanent load reaction at support B — $R_{B\_Permanent}$ = **0.307** kN

Unfactored variable load reaction at support B — $R_{B\_Variable}$ = **0.641** kN



Timber section details

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Depth of timber sections — h = **200** mm

Number of timber sections in member — N = **1**

Overall breadth of timber member — b_b = N × b = **50** mm

Timber strength class - EN 338:2009 Table 1 — **C16**

Member details

Load duration - cl.2.3.1.2 — **Long-term**

Service class of timber - cl.2.3.1.3 — **1**

Length of bearing — L_b = **75** mm

Section properties

Cross sectional area of member — A = N × b × h = **10000** mm²

Section modulus — $W_y = N \times b \times h^2 / 6$ = **333333** mm³

$W_z = h \times (N \times b)^2 / 6$ = **83333** mm³

Second moment of area — $I_y = N \times b \times h^3 / 12$ = **33333333** mm⁴

$I_z = h \times (N \times b)^3 / 12$ = **2083333** mm⁴

Radius of gyration — $r_y = \sqrt{(I_y / A)}$ = **57.7** mm

$r_z = \sqrt{(I_z / A)}$ = **14.4** mm

Partial factor for material properties and resistances

Partial factor for material properties - Table 2.3 — γ_M = **1.300**

Modification factors

Modification factor for load duration and moisture content - Table 3.1

k_{mod} = **0.700**

Deformation factor for service classes - Table 3.2 — k_{def} = **0.600**

Depth factor for bending - exp.3.1 — $k_{h.m}$ = **1.000**

Depth factor for tension - exp.3.1 — $k_{h.t}$ = **1.000**

Bending stress re-distribution factor - cl.6.1.6(2) — k_m = **0.700**

Crack factor for shear resistance - cl.6.1.7(2) — k_{cr} = **0.670**

Load configuration factor - exp.6.4 — $k_{c.90}$ = **1.000**

System strength factor - cl.6.6 k_{sys} = **1.000**

Lateral buckling factor - cl.6.3.3(5) k_{crit} = **1.000**

Compression perpendicular to the grain - cl.6.1.5

Design compressive stress $\sigma_{c.90.d} = R_{A\_max} / (N \times b \times L_b)$ = **0.511** N/mm^2

Design compressive strength $f_{c.90.d} = k_{mod} \times k_{sys} \times k_{c.90} \times f_{c.90.k} / \gamma_M$ = **1.185** N/mm^2

$\sigma_{c.90.d} / f_{c.90.d}$ = **0.431**

PASS - Design compressive strength exceeds design compressive stress at bearing

Bending - cl 6.1.6

Design bending stress $\sigma_{m.d} = M / W_y$ = **2.963** N/mm^2

Design bending strength $f_{m.d} = k_{h.m} \times k_{mod} \times k_{sys} \times k_{crit} \times f_{m.k} / \gamma_M$ = **8.615** N/mm^2

$\sigma_{m.d} / f_{m.d}$ = **0.344**

PASS - Design bending strength exceeds design bending stress

Shear - cl.6.1.7

Applied shear stress $\tau_d = 3 \times F / (2 \times k_{cr} \times A)$ = **0.429** N/mm^2

Permissible shear stress $f_{v.d} = k_{mod} \times k_{sys} \times f_{v.k} / \gamma_M$ = **1.723** N/mm^2

$\tau_d / f_{v.d}$ = **0.249**

PASS - Design shear strength exceeds design shear stress

Deflection - cl.7.2

Deflection limit δ_{lim} = min(14 mm, 0.004 × L_{s1}) = **11.400** mm

Instantaneous deflection due to permanent load δ_{instG} = **0.771** mm

Final deflection due to permanent load $\delta_{finG} = \delta_{instG} \times (1 + k_{def})$ = **1.234** mm

Instantaneous deflection due to variable load δ_{instQ} = **1.559** mm

Factor for quasi-permanent variable action ψ_2 = **0.3**

Final deflection due to variable load $\delta_{finQ} = \delta_{instQ} \times (1 + \psi_2 \times k_{def})$ = **1.840** mm

Total final deflection $\delta_{fin} = \delta_{finG} + \delta_{finQ}$ = **3.074** mm

$\delta_{fin} / \delta_{lim}$ = **0.270**

PASS - Total final deflection is less than the deflection limit