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BBA BRITISH BOARD OF AGRÉMENT
TECHNICAL APPROVALS FOR CONSTRUCTION

Designated by Government to issue European Technical Approvals

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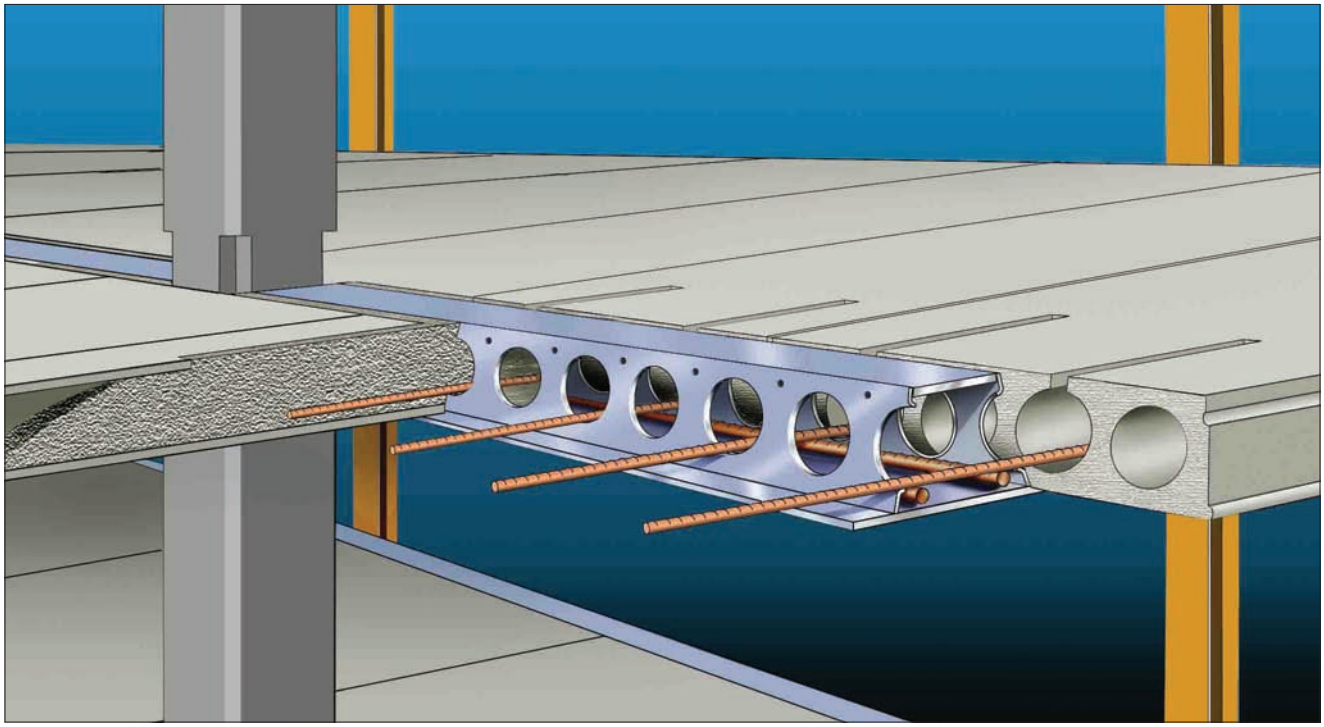
Agrément Certificate No 05/4204

*Certificate amended 12 January 2009**

DELTABEAM

Poutre composé
Verbundträger

Product



- *THIS CERTIFICATE REPLACES CERTIFICATE No 03/3989 AND RELATES TO DELTABEAM, A RANGE OF STEEL BEAMS FILLED WITH IN-SITU CONCRETE AND USED TO SUPPORT FLOOR SLABS.*
- *Deltabeams are fabricated from steel plates welded to form a trapezoidal box section with ledges on either side of the bottom flange.*
- *Deltabeams are fabricated by Teräspeikko Oy Deltatek, P O Box 104, FIN-15101, Lahti, Finland. Tel: 00 358 3 812316, Fax: 00 358 3 7330152.*

Regulations

1 The Building Regulations 2000 (as amended) (England and Wales)

The Secretary of State has agreed with the British Board of Agrément the aspects of performance to be used by the BBA in assessing the compliance of beams with the Building Regulations. In the opinion of the BBA, Deltabeam, if used in accordance with the provisions of this Certificate, will meet or contribute to meeting the relevant requirements.

Requirement:	A1	Loading
Comment:		The beams will have adequate strength and stiffness. See sections 7.4 and 7.5 and 8.1 to 8.5 of this Certificate.
Requirement:	A3	Disproportionate collapse
Comment:		Individually designed installations incorporating the beams will contribute to enabling a structure to meet this Requirement. See section 7.7 of this Certificate.
Requirement:	B3(1)	Internal fire spread (structure)
Comment:		Floors incorporating the beams can be designed to have a fire resistance of between 30 minutes and 120 minutes. See sections 9.1 and 9.2 of this Certificate.
Requirement:	Regulation 7	Materials and workmanship
Comment:		The product is acceptable. See section 12.1 of this Certificate.

2 The Building Standards (Scotland) Regulations 1990 (as amended)

In the opinion of the BBA, Deltabeam, if used in accordance with the provisions of this Certificate, will satisfy or contribute to satisfying the various Regulations and related Technical Standards as listed below.

Regulation:	**10**	Fitness of materials and workmanship
Standard:	B2.1	Selection and use of materials, fittings, and components, and workmanship
Comment:		The product can contribute to a construction meeting this Standard. See the *Installation* part of this Certificate.
Standard:	B2.2	Selection and use of materials, fittings, and components, and workmanship
Comment:		The product is an acceptable material. See section 12.1 of this Certificate.
Regulation:	**11**	Structure
Standard:	C2.1	Structure — Stability
Comment:		The beams will have adequate strength and stiffness. See sections 7.4 and 7.5 and 8.1 to 8.5 of this Certificate.
Standard:	C3.1	Disproportionate collapse — Disproportionate collapse
Comment:		Individually designed installations incorporating the beams will contribute to enabling a structure to satisfy this Standard. See section 7.7 of this Certificate.
Regulation:	**12**	Structural fire precautions
Standards:	D2.1 and D2.2	Structural protection — Principles
Standard:	D2.3	Structural protection — Non-combustible materials
Comment:		Floors incorporating the beams can be designed to have a fire resistance of between 30 minutes and 120 minutes. See sections 9.1 and 9.2 of this Certificate.

3 The Building Regulations (Northern Ireland) 2000

In the opinion of the BBA, Deltabeam, if used in accordance with the provisions of this Certificate, will satisfy or contribute to satisfying the various Building Regulations as listed below.

Regulation:	**B2**	Fitness of materials and workmanship
Comment:		The product is acceptable. See section 12.1 of this Certificate.
Regulation:	**D1**	Stability
Comment:		The beams will have adequate strength and stiffness. See sections 7.4 and 7.5 and 8.1 to 8.5 of this Certificate.
Regulation:	**D2**	Disproportionate collapse
Comment:		Individually designed installations incorporating the beams will contribute to enabling a structure to satisfy this Regulation. See section 7.7 of this Certificate.
Regulation:	**E4**	Internal fire spread — Structure
Comment:		Floors incorporating the beams can be designed to have a fire resistance of between 30 minutes and 120 minutes. See sections 9.1 and 9.2 of this Certificate.

4 Construction (Design and Management) Regulations 1994 (as amended)

Construction (Design and Management) Regulations (Northern Ireland) 1995 (as amended)

Information in this Certificate may assist the client, planning supervisor, designer and contractors to address their obligations under these Regulations.

See sections:	10 *Practicability of installation* (10.1), 13 *General* (13.1) and 14 *Procedure* of this Certificate (14.2).

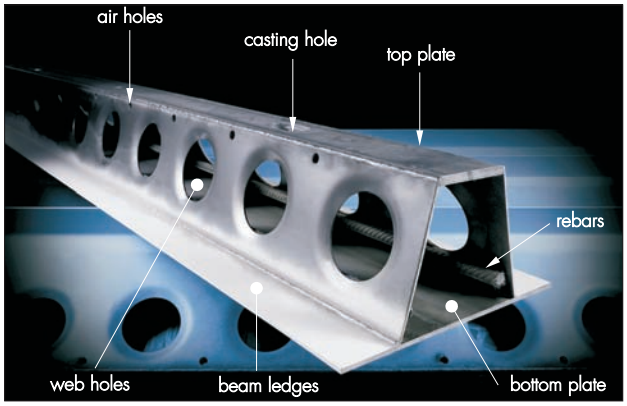
Technical Specification

5 Description

5.1 Deltabeam is fabricated from steel plates welded[1] to form a top-hat boxed-steel section (see Figure 1). Welding is continuous and undertaken in the factory.

(1) Quality requirements for welding according to EN 729-2 : 1994. Weld in accordance with BS EN ISO 5817 : 2003, quality level C.

Figure 1 Deltabeam profile



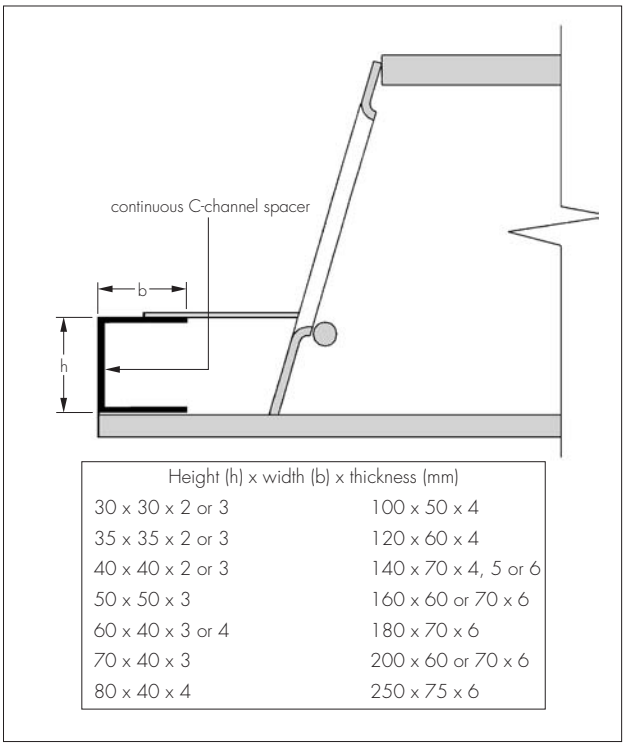
5.2 The beam elements are of steel grade S355J2G3 to BS EN 10025 : 1993 and comprise:

- top flange plate — in thicknesses of 8 mm, 10 mm, 12 mm and 15 mm and in increments of 5 mm from 15 mm to 30 mm
- bottom flange plate — in thicknesses of 5 mm, 6 mm, 8 mm, 10 mm, 12 mm, 15 mm and 20 mm
- web plates — 5 mm, 6 mm and 8 mm thick punched with 80 mm or 150 mm diameter holes at 300 mm centres to allow transverse reinforcement to be threaded. A row of 20 mm diameter air holes are provided at the top to check fill level during concrete pour. The steel web plates are cut out to a predetermined camber and welded continuously to the bottom and top flanges
- shear reinforcement on top flange — shear elements placed as required to provide composite action with the structural concrete topping, if present and used in the composite design of the Deltabeam.

5.3 Other items used with the beams are:

- longitudinal steel reinforcing bars — 20 mm, 25 mm and 32 mm diameter
- transverse steel reinforcing bars — 12 mm to 20 mm diameter at 600 mm centres
- infill concrete — minimum grade C35 to BS 8500-1 : 2002, maximum aggregate size 10 mm
- C-channels — in various sizes (see Figure 2) for use with Deltabeam and positioned on the beam ledge
- threaded bars
- nuts/washers
- connecting consoles and connectors — for connection to steel stanchions or concrete columns.

Figure 2 Detail of C-channel spacer



Height (h) x width (b) x thickness (mm)	
30 x 30 x 2 or 3	100 x 50 x 4
35 x 35 x 2 or 3	120 x 60 x 4
40 x 40 x 2 or 3	140 x 70 x 4, 5 or 6
50 x 50 x 3	160 x 60 or 70 x 6
60 x 40 x 3 or 4	180 x 70 x 6
70 x 40 x 3	200 x 60 or 70 x 6
80 x 40 x 4	250 x 75 x 6

5.4 There are ten standard profiles each with various flange plate combinations. The tolerances on each component are given in Table 1.

Table 1 Acceptance criteria

Property	Tolerance
Overall length (mm)	±5
Overall height (mm)	±3
Bottom flange width (mm)	±5
Total ledge width (mm)	±5
Plate thicknesses from 5 mm to 40 mm	to BS EN 10029, Class A and to BS EN 10051
Pre-camber[1]	±L/650
Location of cut holes (mm)	±5
Location of inserts and fittings (mm)	±5

(1) L = Length of Deltabeam.

6 Delivery and site storage

6.1 The beams must be handled in accordance with the manufacturer's instructions and the requirements of this Certificate.

6.2 The beams should be protected from adverse weather during transportation and storage.

6.3 The beams may be stacked with timber spacers on firm level ground. They should be stacked in a square pattern, ie two high by two wide, three high by three wide.

6.4 Each beam bears the BBA identification mark incorporating the number of this Certificate.

Design Data

7 General

7.1 Deltabeams are individually designed and are reference marked on a layout drawing for each scheme by the Technical Department of the Certificate holder or the UK marketing company. Each contract involving Deltabeams includes a Method Statement to identify the sequence of the concrete infill operation to achieve composite action.

7.2 The Method Statement is reproduced on each member location plan to the site and is to be strictly observed. To achieve composite action, each box section is infilled with concrete and, if necessary to meet the design capacity, the whole floor is laid with a structural in-situ concrete screed.

7.3 The infilling of the box section of the beams and the laying of the structural concrete screed is to be carried out either in one operation (for in-situ concrete slab or pre-stressed plank floor construction) or as two separate operations (for hollow-core concrete slab floor construction). In the latter case, the concrete in the box section is allowed to harden (composite action phase 1) before the structural concrete screed is laid (composite action phase 2). In the former case, the Deltabeam is designed to support the entire design dead and construction loads.

7.4 One of the standard profiles listed in Table 2 is selected and the capacity of a beam due to the combined actions of phase 1 is used in the calculations. A detailed analysis is carried out to include both ultimate and serviceability limit states in compliance with the requirements of BS 5950-3.1 : 1990, BS 8110-1 : 1997, DD ENV 1993-1.1 : 1992, DD ENV 1994-1.1 : 1994 and DD ENV 1995-1.2 : 2000.

7.5 Design procedures include calculations for the adequacy of reinforcement provided for fire resistance in accordance with BS 8110-1 : 1997, BS 5950-3.1 : 1990, DD ENV 1993-1.1 : 1992, DD ENV 1994-1.1 : 1994 and DD ENV 1995-1.2 : 2000 and allow for construction loads during the 'temporary steel beam' stage.

7.6 If a structural screed is used in the design, shear elements welded to the top flange at the designed spacing, are required to ensure composite action.

7.7 If a structure is required to meet national Building Regulations requirements for disproportionate collapse, the technical departments of the Certificate holder and the UK marketing company should be notified to enable them to include additional steel reinforcement in the beams and to specify conventional steel tie beams.

7.8 The beams are designed and manufactured with a predetermined upward camber to allow for dead load deflection.

8 Structural performance

8.1 As a guide, the structural characteristics of the beam for all the standard profiles and flange plate thicknesses at normal temperatures are given in Table 2. The infill concrete used should be minimum grade C35 to BS 8500-1 : 2002.

8.2 The figures derived in Table 2 assume that a structural concrete screed is not applied and that there is no contribution from the effects of T-beam action of the supported concrete floor slabs. Each beam is assumed to incorporate:

- hollow-core floor with 35 Nmm^{-2} strength concrete
- unless designed otherwise, two longitudinal T25 reinforcing bars are present in the box section
- unless designed otherwise, transverse T16 reinforcing bars are inserted through at least alternate holes (ie at 600 mm centres maximum) in the web plates, along the entire length of the beam
- unless designed otherwise, each transverse bar should project at least 685 mm on either side of the web plates to ensure adequate bonding with the supported floor slabs.

8.3 For higher design loads either one or a combination of the following design enhancements may be used:

- a structural concrete screed of minimum concrete grade C35 to BS 8500-1 : 2002 is specified. In this instance, the beam is fabricated with shear elements on the top flange; the location and number used in accordance with the design calculations
- a deeper beam section incorporating continuous C-channel spacer sections (see Figure 2) welded to each ledge and strapped back to the web at 300 mm centres
- additional transverse bars are used to tie the concrete slabs to the beam. This is to provide resistance to torsion, particularly when supported slabs are unevenly loaded on either side of the beam.

8.4 The maximum effective width in compression can be taken as L/8 on each side of the beam (where L is the span of the beam or the distance between zero bending on the bending moment diagram). Normally compression flanges are utilised only in the stiffness calculations. If the compression flanges are to be utilised in the ultimate limit state calculations, then adequate mechanical fixings are required:

- for hollow-core floors with adequate mechanical fixings in the top flange of a beam, the thickness of the concrete screed above the beam can be included in the ultimate limit state design calculations of the neutral axis of the composite section

Table 2 Deltabeam basic values at normal temperatures[1]

Deltabeam type	Flange thickness (mm)		Bending stiffness[2] (MNm²)			Bending resistance (kNm)			Composite beam shear resistance (kN)
	Top	Bottom	Steel member $(EI)_a$	Composite short-term $(EI)_{r1}$	Composite long-term $(EI)_{rc1}$	Steel $M_{ael\ Rd}$	Sagging $M_{ppl.Rd}$	Hogging $M_{ppl.Rd}$	$V_{Rd.nosp}$
D20–300	12	6	12.042	19.369	16.098	157.38	229.40	179.91	409 0
	15	6	13.187	19.706	16.775	184.52	248.28	204.66	402.5
	15	8	14.972	23.153	19.328	188.71	272.08	225.97	402.5
	15	10	16.398	26.236	21.535	191.66	288.86	241.02	402.5
	20	8	16.833	23.735	20.469	231.60	303.28	266.19	391.6
	20	10	18.632	26.948	22.903	235.77	326.87	285.22	391.6
	20	12	20.236	30.030	25.187	239.90	342.31	297.57	391.6
	25	10	20.326	27.522	23.991	275.35	356.86	324.27	380.7
	25	12	22.238	30.713	26.465	280.81	381.28	341.10	380.7
	25	15	24.644	35.029	29.726	286.97	395.77	355.67	380.7
	30	10	21.653	28.022	24.894	311.20	384.46	361.52	369.9
	30	12	23.790	31.268	27.493	317.32	410.66	379.64	369.9
	30	15	26.561	35.728	30.994	325.13	440.05	401.76	369.9
	30	20	30.487	42.492	36.177	336.23	456.96	418.61	369.9
D20–400	12	6	16.589	24.128	20.694	228.17	309.89	241.89	354.1
	15	6	18.155	24.681	21.703	270.30	333.65	278.95	348.4
	15	8	20.834	29.223	25.218	276.21	372.83	309.19	460.1
	15	10	22.979	33.254	28.235	280.32	403.35	335.54	459.9
	20	8	23.364	30.181	26.910	342.40	414.80	371.11	460.1
	20	10	26.080	34.442	30.298	348.54	453.60	401.22	459.9
	20	12	28.506	38.504	33.458	354.66	485.27	423.35	459.6
	25	10	28.356	35.376	31.889	409.19	494.34	461.42	459.9
	25	12	31.243	39.630	35.357	417.53	533.92	488.98	459.6
	25	15	34.895	45.358	39.914	426.81	572.36	512.25	459.2
	30	10	30.086	36.164	33.168	419.38	503.68	509.17	459.9
	30	12	33.304	40.525	36.841	473.06	573.51	547.66	459.6
	30	15	37.502	46.501	41.780	485.15	629.51	579.98	459.2
	30	20	43.473	55.532	49.076	502.12	662.73	607.43	458.6
D26–300	12	6	19.958	35.638	29.060	188.94	314.98	215.57	474 0
	15	6	21.871	36.055	30.052	220.35	336.01	245.35	468.4
	15	8	24.554	42.146	34.384	224.28	365.34	266.85	468.4
	15	10	26.694	47.706	38.184	227.04	384.44	274.68	468.4
	20	8	27.743	42.901	36.121	274.77	400.54	314.63	459 0
	20	10	30.519	48.711	40.319	279.22	429.49	332.24	459 0
	20	12	32.740	53.860	43.916	282.00	440.84	336.89	459 0
	25	10	33.580	49.578	42.125	327.75	465.48	381.53	449.6
	25	12	36.273	54.872	45.997	331.46	490.40	393.85	449.6
	25	15	39.695	62.188	51.204	336.16	502.29	400.51	449.6
	30	10	35.972	50.223	43.555	371.54	497.57	428.11	440.3
	30	12	39.162	55.744	47.766	377.31	527.99	444.45	440.3
	30	15	43.168	63.264	53.337	383.31	549.75	457.18	440.3
	30	20	48.610	74.549	61.422	392.13	569.08	468.29	440.3
D26–400	12	6	28.033	44.215	37.283	282.05	425.44	300.96	610.3
	15	6	30.760	44.988	38.869	333.88	443.93	349.56	610.3
	15	8	34.976	53.065	44.905	339.76	503.96	377.84	610 0
	15	10	38.352	60.373	50.156	343.77	542.63	397.56	609.7
	20	8	39.483	54.463	47.659	422.66	548.83	458.39	610 0
	20	10	43.890	62.216	53.586	429.66	604.01	488.10	609.7
	20	12	47.447	69.061	58.656	433.91	640.05	499.80	609.4
	25	10	48.158	63.763	56.391	508.92	653.12	567.43	609.7
	25	12	52.474	70.892	61.939	514.87	701.86	591.26	609.4
	25	15	57.995	80.703	69.379	522.35	740.66	603.44	609 0
	30	10	51.370	64.916	58.550	568.82	671.04	643.17	609.7
	30	12	56.457	72.434	64.652	589.30	754.16	670.74	609.4
	30	15	62.908	82.632	72.716	599.20	817.79	696.70	609 0
	30	20	71.742	97.863	84.380	613.51	847.74	713.15	608.4
D32–300	12	6	26.082	55.150	43.232	188.25	380.17	228.97	428.9
	15	6	28.691	55.544	44.395	216.85	398.84	256.65	424.7
	15	8	31.555	63.891	50.006	220.98	429.87	278.20	424.7
	15	10	33.819	71.527	54.948	223.92	447.96	287.90	424.7
	20	8	35.992	64.801	52.222	268.25	463.61	323.82	417.7
	20	10	38.860	72.593	57.495	272.00	490.50	340.54	417.7
	20	12	41.261	79.760	62.203	275.13	501.60	344.84	417.7
	25	10	43.072	73.393	59.623	317.11	525.86	388.65	410.8
	25	12	45.972	80.696	64.620	320.97	543.34	397.24	410.8
	25	15	49.680	90.984	71.458	326.22	558.62	403.73	410.8
	30	10	46.714	74.259	61.628	360.35	558.32	432.47	403.8
	30	12	50.096	81.681	66.888	365.02	583.16	447.83	403.8
	30	15	54.354	91.959	73.947	370.58	598.65	455.73	403.8
	30	20	60.068	107.219	84.089	378.70	619.24	465.99	403.8

continued

Table 2 Deltabeam basic values at normal temperatures[1] (continued)

Deltabeam type	Flange thickness (mm)		Bending stiffness[2] (MNm²)			Bending resistance (kNm)			Composite beam shear resistance (kN)
	Top	Bottom	Steel member $(EI)_a$	Composite short-term $(EI)_{r1}$	Composite long-term $(EI)_{rc1}$	Steel $M_{ael\ Rd}$	Sagging $M_{ppl.Rd}$	Hogging $M_{ppl.Rd}$	$V_{Rd.nosp}$
D32–400	12	6	38.842	68.135	55.879	303.83	526.89	336.81	738.7
	15	6	42.946	69.113	58.053	358.50	558.35	388.06	738.7
	15	8	47.981	80.405	66.152	364.74	610.19	419.10	738.3
	15	10	51.989	90.657	73.233	369.18	653.04	440.85	738.0
	20	8	54.885	82.447	70.176	454.66	672.56	506.57	738.3
	20	10	60.067	93.093	77.952	460.76	719.74	536.88	738.0
	20	12	64.415	102.837	84.865	465.72	756.90	548.55	737.7
	25	10	66.476	95.003	81.796	545.92	779.62	622.37	738.0
	25	12	71.778	105.086	89.303	552.43	825.95	646.56	737.7
	25	15	78.615	119.228	99.538	561.53	863.97	657.82	737.3
	30	10	71.782	96.862	85.235	626.84	829.84	705.87	738.0
	30	12	77.970	107.255	93.287	635.17	886.97	733.45	737.7
	30	15	85.859	121.585	104.074	645.05	946.53	756.18	737.3
	30	20	96.517	142.801	119.536	659.21	976.16	771.60	736.6
D37–400	12	6	48.708	94.278	75.595	315.76	617.31	369.86	815.7
	15	6	54.051	95.442	78.267	370.30	650.07	421.84	808.9
	15	8	59.776	110.174	88.523	377.64	707.05	453.19	808.9
	15	10	64.437	123.801	97.694	383.29	757.22	477.61	808.9
	20	8	68.740	112.496	93.395	467.73	768.69	542.62	797.5
	20	10	74.714	126.496	103.294	475.04	822.17	573.90	797.5
	20	12	79.586	139.232	112.006	480.26	864.14	584.81	797.5
	25	10	83.155	128.648	108.000	561.43	881.99	661.21	786.1
	25	12	89.107	141.673	117.317	568.06	933.01	684.20	786.1
	25	15	96.970	160.396	130.381	578.20	973.59	694.68	786.1
	30	10	90.361	130.846	112.350	644.62	940.49	747.96	774.7
	30	12	97.340	144.217	122.288	652.84	995.07	773.74	774.7
	30	15	106.409	163.00	135.885	663.63	1053.37	794.14	774.7
	30	20	118.209	190.355	154.935	677.45	1091.26	808.41	774.7
D37–500	12	8	70.790	125.330	102.109	455.79	838.38	527.34	854.5
	15	8	62.839	121.586	96.752	383.25	783.01	461.79	808.9
	15	10	67.499	137.035	106.968	388.72	843.06	484.74	808.9
	15	12	71.194	150.973	115.833	392.56	869.33	488.84	808.9
	20	8	72.563	123.706	101.630	474.11	841.79	551.67	797.5
	20	10	78.576	139.479	112.564	481.14	905.29	585.49	797.5
	20	12	83.418	153.802	122.147	486.11	952.60	592.09	797.5
	25	10	87.797	141.383	117.291	568.39	962.57	675.07	786.1
	25	12	93.749	155.941	127.462	574.68	1022.01	693.24	786.1
	25	15	101.562	176.863	141.701	584.43	1061.97	702.21	786.1
	30	10	95.754	143.431	121.743	652.60	1019.10	762.92	774.7
	30	12	102.777	158.306	132.538	660.37	1082.00	791.81	774.7
	30	15	111.827	179.151	147.246	670.68	1140.92	802.31	774.7
	30	20	123.452	209.479	167.763	683.90	1179.82	816.55	774.7
D40–400	12	6	57.376	113.090	90.418	344.20	689.38	411.47	884.1
	15	6	63.757	114.631	93.691	403.59	722.44	468.09	877.2
	15	8	70.368	131.972	105.762	412.13	789.98	502.30	877.2
	15	10	75.840	148.142	116.639	418.90	846.03	530.26	877.2
	20	8	80.747	134.193	111.066	508.08	852.94	599.05	865.8
	20	10	87.853	151.114	123.040	517.83	913.92	629.69	865.8
	20	12	93.510	166.013	133.211	523.86	967.04	646.55	865.8
	25	10	97.936	153.792	128.694	612.49	979.23	727.44	854.4
	25	12	104.830	169.076	139.593	620.02	1035.80	751.83	854.4
	25	15	113.748	190.542	154.516	630.00	1091.38	765.38	854.4
	30	10	106.241	155.840	133.381	700.90	1035.98	821.06	843.0
	30	12	114.504	171.847	145.268	711.86	1100.59	848.98	843.0
	30	15	124.996	193.838	161.160	723.90	1176.54	873.49	843.0
	30	20	138.654	226.015	183.494	738.19	1217.51	887.69	843.0
D40–500	12	8	83.132	149.692	121.640	495.74	932.68	582.19	919.2
	15	8	73.922	145.667	115.668	418.29	875.31	510.87	877.2
	15	10	79.410	164.049	127.830	424.83	942.24	538.04	877.2
	15	12	83.740	180.518	138.320	429.33	983.99	543.15	877.2
	20	8	85.163	147.544	120.887	515.12	934.84	608.73	865.8
	20	10	92.339	166.687	134.181	524.53	1007.65	644.90	865.8
	20	12	97.975	183.512	145.424	530.28	1069.51	654.76	865.8
	25	10	103.321	169.089	139.852	620.12	1069.56	741.56	854.4
	25	12	110.232	186.254	151.816	627.27	1136.24	764.09	854.4
	25	15	119.101	210.311	168.131	636.83	1192.89	773.03	854.4
	30	10	112.478	170.846	144.563	709.68	1126.42	836.91	843.0
	30	12	120.820	188.759	157.559	720.12	1198.57	869.88	843.0
	30	15	131.311	213.280	174.833	731.62	1279.01	882.39	843.0
	30	20	144.784	249.067	198.975	745.24	1320.21	896.11	843.0

continued

Table 2 Deltabeam basic values at normal temperatures[1] (continued)

Deltabeam type	Flange thickness (mm)		Bending stiffness[2] (MNm²)			Bending resistance (kNm)			Composite beam shear resistance (kN)
	Top	Bottom	Steel member $(EI)_a$	Composite short-term $(EI)_{r1}$	Composite long-term $(EI)_{rc1}$	Steel $M_{ael\,Rd}$	Sagging $M_{ppl.Rd}$	Hogging $M_{ppl.Rd}$	$V_{Rd.nosp}$
D50–500	15	8	133.980	248.387	201.226	647.84	1254.68	799.76	1148.8
	15	10	144.600	278.630	222.075	659.74	1371.52	838.39	1148.5
	15	12	153.491	307.021	241.061	669.03	1462.22	863.45	1148.2
	20	8	154.060	253.074	211.531	802.63	1328.62	952.11	1148.8
	20	10	167.480	284.146	233.941	817.57	1457.30	1001.98	1148.5
	20	12	178.830	313.259	254.331	829.21	1564.99	1036.59	1148.2
	25	10	186.720	289.159	244.491	969.57	1533.97	1157.54	1148.5
	25	12	200.790	319.837	266.903	986.06	1661.42	1200.03	1148.2
	25	15	218.150	360.882	295.977	1002.66	1804.96	1228.54	1147.8
	30	10	203.390	294.466	254.487	1118.22	1603.95	1306.18	1148.5
	30	12	219.350	325.022	277.545	1135.23	1739.46	1359.81	1148.2
	30	15	239.700	367.008	308.394	1155.09	1906.04	1395.86	1147.8
	30	20	267.170	430.078	353.062	1180.28	2079.67	1424.28	1147.2
D50–600	15	10	183.440	317.017	260.436	884.43	1624.20	1062.07	1148.5
	20	10	212.170	325.036	276.280	1111.03	1730.87	1287.90	1148.5
	20	12	228.000	359.714	301.666	1125.97	1882.48	1337.09	1148.2
	25	10	235.570	332.191	290.034	1328.38	1818.71	1498.14	1148.5
	25	12	255.200	368.941	318.153	1350.60	1992.45	1567.49	1148.2
	25	15	279.600	418.259	354.808	1372.36	2210.81	1618.36	1147.8
	30	10	255.290	339.433	302.701	1537.06	1883.58	1691.67	1148.5
	30	12	277.510	376.294	331.893	1563.20	2080.42	1781.94	1148.2
	30	15	306.099	427.057	371.094	1589.92	2324.89	1853.20	1147.8
	30	20	345.050	503.422	428.026	1623.62	2625.36	1900.81	1147.2

(1) Examples of typical plate combinations — other variations are available.

(2) Sectional modulus of composite beams relates to Deltabeam box sections infilled with concrete (minimum grade C35). It should be noted that where transverse steel bars are placed in broken-out hollow cores of floor units, concrete of the same grade is used as the infill.

- for solid slabs with adequate mechanical fixings in the top flange of a beam or through the web holes, the thickness of the concrete can be included in the ultimate limit state design calculations of the neutral axis of the composite T-section.

8.5 Mechanical fixings into the structural concrete screed must be utilised before it can be used as part of the composite section.

9 Behaviour in relation to fire

9.1 A floor incorporating the beams will have fire resistance of between 30 minutes and 2 hours (Classes R, E and I) (loadbearing and separating capacity) when both the longitudinal and transverse steel reinforcement are designed accordingly. In all cases, each beam should have transverse reinforcement of a minimum of one T16 bar through every alternate hole of the web and bonded over a minimum length of 650 mm inside the adjacent slab units, although each project will be designed individually and additional transverse bars may be provided if required.

9.2 In fire design calculations, the connections between the beams and concrete columns or steel stanchions will be assumed to be pinned, unless moment connections are used and the design principles are agreed with the client's Engineer.

10 Practicability of installation

10.1 The beams can be handled in a similar manner to that used with traditional steelwork.

10.2 Bearings and bolted connections are comparable to those found in steel structures.

10.3 The beams may be lifted by chains through the web holes. There are no specific points of lifting and purpose made lifting beams are not necessary.

10.4 Provided eccentric loading is not present or torsion is taken into account in the connection design, propping of Deltabeams is not normally required during construction.

11 Habitability

The beams have not been assessed for national Building Regulations requirements for resistance to transmission of sound or conservation of fuel and power. However, the following points are relevant:

- the mass of a composite flooring system is relied upon to provide airborne and impact sound insulation
- thermal insulation can be added to the composite flooring system and a non-structural concrete screed can be laid on top to protect it
- service entries through the beam and the composite flooring system should be incorporated at the design stage.

12 Durability

12.1 The durability of the Deltabeam floor construction is comparable to that of composite steel structures.

12.2 The mix design of infill concrete should be in accordance with BS 8500-1 : 2002. Grouting of precast, hollow-core concrete slabs should conform to the specifications of the concrete slab manufacturer.

12.3 The underside of the beams and any exposed faces should be protected by a suitable corrosion protection system.

Installation

13 General

13.1 Installation should be carried out in accordance with the instructions given in the Technical Manual issued by the Certificate holder.

13.2 The manufacturer's proprietary connecting console and connection details are used to fix the beams to concrete columns, and the beams to steel columns.

13.3 The relevant detail specified by the manufacturer should be used for splicing the beams together.

13.4 Prior to fixing a beam, the steel fixer should check that the connecting console connections are at the correct level. If an error has occurred, any alteration to the beam should be agreed with the Technical Department of the UK marketing company.

14 Procedure

14.1 The end connection should be designed to take into account any eccentric loading applied, eg due to floor slab units being erected only on one side of a beam, otherwise props will be required. These should be located at both ends of the beam and be fitted tight against the end plates, positioned centrally under the junction of the web plate to the bottom flange and under the loaded side of the beam. Deltabeams fixed ready to receive the floor slabs are shown in Figure 3.

14.2 Floor slabs should bear directly on to the ledge over a distance of 80 mm, ie with a gap of 20 mm between the slab end and the web plate at the bottom (see Figure 4). Precast, hollow-core slab units should not be propped, but other types of floor units may require propping in accordance with the manufacturer's instructions.

14.3 The beams are cleaned thoroughly before infilling with concrete. Reference should be made to the Method Statement for each contract prepared by the Technical Department of the Certificate holder or the fabricator to identify the sequence of the concrete infill operation to achieve composite action.

Figure 3 Deltabeams ready to receive floor slabs

Figure 4 Floor slabs craned into position

14.4 If hollow-core concrete slabs are used, the method and procedure of concreting will be stated on each project. Normally, the Deltabeam and joints are concreted before pouring the concrete screed or structural topping.

14.5 For in-situ concrete slabs and those supported by steel decking or pre-stressed planks, both operations of infilling and casting of the floor slab are carried out simultaneously.

14.6 The concrete should be poured into the box section of a beam from one side and be vibrated

until completely filled with concrete. Weepholes on the opposite side should be used to detect when the beam is full of concrete (see Figure 5).

Figure 5 Placing concrete

14.7 Special design details specified by the Technical Department of the UK marketing company should be adhered to in buildings required to resist against disproportionate collapse. This entails additional steel reinforcement at the connections of the beams with both columns and with specially-designed conventional steel tie beams.

Technical Investigations

The following is a summary of the technical investigations carried out on Deltabeam.

15 Investigations

15.1 An examination was made of test data and reports from VTT Building Technology, Finland, and research documents published by the University of Oulu, Finland.

15.2 An assessment was made of the philosophy of design and the suitability of calculations for UK conditions, eg as required in such Standards as BS 8110-1 : 1997 and BS 5950-3.1 : 1990, and the suitability for UK certification.

15.3 An assessment was made of the suitability of available test data for covering the full product range. Test data, computer design and manual calculations were compared and, where information did not cover the full product range, necessary safeguards were incorporated into the Certificate holder's recommended design procedures.

15.4 The necessary amendments to the design philosophy of the computer design program and in detailing of steel reinforcement to meet the UK certification requirements have been incorporated by the Certificate holder.

Bibliography

BS 5950-3.1 : 1990 *Structural use of steelwork in building — Design in composite construction — Code of practice for design of simple and continuous composite beams*

BS 8110-1 : 1997 *Structural use of concrete — Code of practice for design and construction*

BS 8500-1 : 2002 *Concrete — Complementary British Standard to BS EN 206-1 — Method of specifying and guidance for the Specifier*

BS EN 206-1 : 2000 *Concrete — Specification, performance, production and conformity*

BS EN 10025 : 1993 *Hot rolled products of non-alloy structural steels. Technical delivery conditions*

BS EN 10029 : 1991 *Specification for tolerances on dimensions, shape and mass for hot rolled steel plates 3 mm thick or above*

BS EN 10051: 1992 *Specification for continuously hot-rolled uncoated plate, sheet and strip of non-alloy and alloy steels— Tolerances on dimensions and shape*

BS EN ISO 5817 : 2003 *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections*

DD ENV 1993-1.1 : 1992 *Eurocode 3. Design of steel structures — General rules and rules for buildings (together with United Kingdom National Application Document)*

DD ENV 1994-1.1 : 1994 *Eurocode 4. Design of composite steel and concrete structures — General rules and rules for buildings (together with United Kingdom National Application Document)*

DD ENV 1995-1.2 : 2000 *Eurocode 5. Design of timber structures — General rules — Structural fire design*

EN 729-2 : 1994 *Quality requirements for welding — Fusion welding of metallic materials — Comprehensive quality requirements*

Conditions of Certification

16 Conditions

16.1 This Certificate:

(a) relates only to the product that is named, described, installed, used and maintained as set out in this Certificate;

(b) is granted only to the company, firm or person identified on the front cover — no other company, firm or person may hold or claim any entitlement to this Certificate;

(c) is valid only within the UK;

(d) has to be read, considered and used as a whole document — it may be misleading and will be incomplete to be selective;

(e) is copyright of the BBA;

(f) is subject to English law.

16.2 References in this Certificate to any Act of Parliament, Regulation made thereunder, Directive or Regulation of the European Union, Statutory Instrument, Code of Practice, British Standard, manufacturers' instructions or similar publication, are references to such publication in the form in which it was current at the date of this Certificate.

16.3 This Certificate will remain valid for an unlimited period provided that the product and the manufacture and/or fabrication including all related and relevant processes thereof:

(a) are maintained at or above the levels which have been assessed and found to be satisfactory by the BBA;

(b) continue to be checked as and when deemed appropriate by the BBA under arrangements that it will determine; and

(c) are reviewed by the BBA as and when it considers appropriate.

16.4 In granting this Certificate, the BBA is not responsible for:

(a) the presence or absence of any patent, intellectual property or similar rights subsisting in the product or any other product;

(b) the right of the Certificate holder to market, supply, install or maintain the product; and

(c) the actual works in which the product is installed, used and maintained, including the nature, design, methods and workmanship of such works.

16.5 Any recommendations relating to the use or installation of this product which are contained or referred to in this Certificate are the minimum standards required to be met when the product is used. They do not purport in any way to restate the requirements of the Health & Safety at Work etc Act 1974, or of any other statutory, common law or other duty which may exist at the date of this Certificate or in the future; nor is conformity with such recommendations to be taken as satisfying the requirements of the 1974 Act or of any present or future statutory, common law or other duty of care. In granting this Certificate, the BBA does not accept responsibility to any person or body for any loss or damage, including personal injury, arising as a direct or indirect result of the installation and use of this product.

BBA BRITISH BOARD OF AGRÉMENT
TECHNICAL APPROVALS FOR CONSTRUCTION

In the opinion of the British Board of Agrément, Deltabeam is fit for its intended use provided it is installed, used and maintained as set out in this Certificate. Certificate No 05/4204 is accordingly awarded to Teräspeikko Oy Deltatek.

On behalf of the British Board of Agrément

Date of issue: 3rd March 2005

Chief Executive

**Certificate amended 12 January 2009, to incorporate the Certificate holder's new name, address and contact details.*

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For information about the Agrément Certificate, including validity and scope, tel: Hotline 01923 665400, or check the BBA website.