BUSCK
PRESTRESSED CONCRETE LTD

Double Tee

Product Brochure

ECAAS ISO 9001 CERTIFIED QUALITY MANAGEMENT

concretenz PRECAST CERTIFIED PLANT

Busck's operations are ISO9001 certified as well as being Certified Plants meeting the high standards set by Concrete NZ.

Busck Prestressed Concrete Ltd supplies Double Tees throughout the North Island. Busck Double Tees are manufactured to a standard width of 3.0m, providing an immediate working platform, saving valuable crane time and labour to place the units. Double Tees do not usually require propping.

They are made on a long steel bed and are accelerated cured to allow units to be made in any achievable length, shape and thickness on a daily production cycle.

Architects

General

Busck Prestressed Concrete has grown to the extent that it is now not only one of the largest precasting operation in New Zealand, we also influence the industry delivering performance and high quality standards throughout New Zealand from our plants in Whangarei and Ashburton. Busck precast work ranges from small, niche architectural housing to large, technically challenging commercial and infrastructure projects.

Busck's Double Tee flooring system incorporates prestressed concrete tee section 3m wide, 200mm to 650mm deep designed in-house allows for easy and fast placement by crane to provide an instant working platform, with the addition of an in situ concrete topping, gives a suspended floor with 200mm wide, steel formed, legs spaced at 1500mm centres.

Double Tees work incomposite with an in-situ concrete topping slab to form the perfect floor system in medium to long span commercial and car park buildings. Spans typically 6m to 19m not usually requiring temporary propping during construction, saving time and money.

Double Tees provide architects with the convenient space between legs to conceal services.

Acoustic Rating

A major benefit of concrete floors are that they are quiet because they do not creak under load or with changes in temperature.

Double Tee plus a minimum 75mm depth of topping concrete, will provide a Sound Transmission Class (STC) rating of 53dB. If a suspended ceiling using 9.5mm gypsum plasterboard is framed to the underside a STC rating of 59dB is achieved providing any gaps, eg. recessed lighting, is insulated and limited to one every 5m.

Double tee topping Acoustic Rating		
Topping thickness (mm)	STC rating (dB)	STC with ceiling (dB)
75mm	53	59
100mm	54	60

Fire Rating

Three elements define the fire rating of concrete units in accordance with section 4 of NZS3101:2006.

1) Insulation – thickness of concrete and other materials that separate occupancies in the building.

2) Integrity – the criteria of integrity are considered satisfied if the precast element meets the criteria of both insulation and structural adequacy for that period.

3) Structural adequacy – section geometry of the concrete element, distance from the surface to the centre of the reinforcement and/or strand called "axis distance" and continuity at the supports.

Specified in the form eg. 60/60/60 for a 60 minute fire rating. Seek advice from fire protection suppliers in regards to their tested products when detailing fire rated penetrations through precast elements.

Standard Double Tees achieve 90 minute fire rating. By increasing Double Tee depth and cover to strand higher fire ratings are possible. Contact Busck for solutions.

Surface Finishes

NZS3114:1987 prescribes the descriptions and tolerances for formed finishes "F1" to "F6" and manual finishes "U1" to "U11"eg. "U5" for broomed rough top surface quality. Concrete surfaces are influenced by quality of vibration, trowelling and mould material used in production. Cost increases as the expectations of the quality of the surface improves.

Double Tees generally achieve, at worst, "F5" soffit finish off a steel mould and "U5" broomed top roughened to 5mm amplitude to provide good bond with the topping concrete. Contractors should allow for bagging the underside to receive an exposed painted finish.

Thermal Rating

Estimated thermal resistance ratings for Double Tees with 75mm concrete topping = 0.06m^2.°C/w plus associated materials are:

Thermal ratings	
Material	R rating/100mm thick (m^2.°C/w)
Concrete	0.045
Expanded poly.(type2)	2.77
Gypsum plasterboard	0.62

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Consulting Engineers

Load-Span Tables

Load-Span tables provide the maximum recommended uniformly distributed unfactored superimposed live load for the corresponding span, allowing for maximum number of strand and the floor is temporarily propped. Double Tees floor systems are well suited for superimposed loadings typically used in commercial and car park buildings. Self-weight of the floor system plus superimposed dead load of 0.5kPa is applied along with load factors of 1.2G and 1.5Q as per AS/NZS1170.0 in the design analysis, noting serviceability limits usually govern. For serviceability:

- Partial prestress design is applied with limits of up to 0.3mm crack width and steel stress range of up to 200MPa (internal environment classification A1).
- Short term live load factor, $\Psi s = 0.7$.
- Deflection limit is lesser of span/500 or 10mm sag long term.
- Vibration limit meet domestic/office use with a damping ratio of 0.05 (full height partitions).

For more vibration sensitive type uses in-service with few partitions, damping ratio=0.025, then we suggest a span/depth ratio of 28 is adopted. Because we adopt partial prestress design for Double Tees, construction loads including the weight of wet topping on bare units tend to govern, therefore lower span depth ratios are best achieved by specifying deeper tees rather than thicker topping slabs.

All specified unfactored loads should be clearly stated on the Consultant's drawings. We recommend significant point & line loads should be checked by a Busck Engineer during the design phase of your project. High dead loads induce higher creep deflection values so if this is the case, please contact Busck's technical people for further advice. Concentrated loads as per cl 3.4.2(a) AS/NZS 1170.1 2002 have not been allowed for.

Seating

In accordance with cl18.7.4.3 NZS 3101:2006 amendment 3 Double Tee flooring systems require a minimum of 75mm end seating after tolerances on support structures. A construction tolerance of 10mm is recommended to be added to these figures.

Clause 18.7.4.3. also provides guidance for more seismically ductile supporting structures to allow for elongation, spalling, shrinkage and temperature effects that may result in longer seating length being required.

All units are to bear on low friction bearing pads or strips with a maximum in-service coefficient of friction of 0.7.

Cast in steel cazaly hangers can be designed by Busck in-house engineers to provide the benefits of flange supported Double Tees. There are also options to partial leg or leg support the tees.

Topping Concrete

Topping concrete is typically specified with a minimum compressive strength of 25MPa after 28 days standard curing. Reinforcement is designed and detailed by the projects design engineer. Changes in topping thickness and in-situ strips formed on-site needs to be accounted for as additional gravity load, as well as the potential benefit of added stiffness, allowed for in the design.

Design Self Weight including topping concrete

Double Tee floor system self weight with 75mm concrete topping.

Double tee + topping Weights		
Tee depth (mm)	75 topping (kPa)	100 topping (kPa)
200	3.8	4.4
250	4.0	4.6
300	4.1	4.8
350	4.3	4.9
400	4.5	5.1
450	4.6	5.3
500	4.8	5.4
550	5.0	5.6
600	5.1	5.8
650	5.3	5.9

Durability

Busck's precast concrete products are typically manufactured with the strength and cover to reinforcement to achieve 50 year design life in exposure classifications A1, A2, B1 & B2 prescribed in section 3 of the New Zealand standard NZS3101:Part 1:2006. Longer design life and/or precast concrete elements in environmentally more extreme environments, such as bridges in coastal marine areas, are achievable.

Busck Technical Support

Our own National Technical and Design Manager has a wealth of precast industry experience working with design consultants to provide the most economical solution to a bespoke design specifically for the needs of your project. A Chartered Professional Engineer with Engineering NZ who leads our **ISO9001** certificated quality system process of signing off every shop drawing and provides a Producer Statement for the design (PS1) for every product Busck designs. Experience and capability flows to our factory operations leaders who are proud to maintain **Concrete NZ Plant Certification** for Busck who also provide Producer Statements for the Manufacture (PS3) & by arrangement Manufacture Monitoring (PS4).

Contractors

Temporary Propping

Busck's Double Tees do not usually require propping. On the rare occasion propping is required it is to be designed by a suitably qualified engineer employed by the contractor.

Topping Concrete

Care needs to be taken to not mound up the concrete in one place while pouring concrete as this can exceed normal construction loads.

Shorter spans can be poured level. For spans longer than 8m, topping concrete thickness should generally remain parallel with the camber of the Busck Double Tee, unless instructed otherwise.

Cambers

Due to the nature of prestressing, Busck Double Tees may arrive at site with a slight camber. In most cases this is unavoidable. The amount of camber depends on a number of factors including; unit length, practicality of stacking, level of prestress, the days since units were manufactured, the heat of sun & environment to name a few variables. Our designers generally predict the Double Tee floor system will be near flat long term. Please contact the Busck Technical people if you have any queries.

Drilling Penetrations and Installing Fixings

Busck strongly recommends, before any holes are drilled through the suspended floors, contractors read and follow the process described in Information Bulletin IB95 "Drilling, Cutting or Forming Holes in Suspended Concrete Floor Slabs", published by Concrete NZ. This document is available on the Busck website.

Busck Double Tees can have penetrations core drilled through the unit and fixings installed in specific locations. Coordinate by referring to unit cross-sections on our shop drawings, avoiding strand that will reduce the floor system's capacity if cut. To maintain durability a zone of 20mm cover to the side of the strand must remain. A benefit of the Busck Double Tee system is the ample space between the legs to locate penetrations.

If an unintended strand is cut on-site, immediately place a temporary prop either side of the penetration, then contact Busck to obtain a design check confirmation to declare the unit is still structurally sound.

Holes for fixings can be drilled using a hammer drill or "dyna-drill' into Busck Double Tee, ensuring you maintain minimum edge distances, spacings as well as avoiding the strands to achieve the required embedment. If in doubt seek advice from the fixing manufacturer as to the suitability and the load carrying capacity of their products in Busck Double Tee.

Early coordination will allow for the most efficient unit layout maintaining standard widths and avoiding potentially unstable single tees. Be aware varying unit widths effectively alters the section that induces varying cambers between the Double Tee units.

Handling and Storage

Busck Double Tees are cast with "Swift-lift" anchors or lifting eyes made from strand offcuts, usually located 600mm from each end.

Specifically designed lifting chains and hooks are to be used to lift the units. These lifting points should be used without substitution. All lifting gear needs to be certified and regularly checked for any wear or damage as concrete elements can be abrasive.

Busck Double Tees, if stored on-site, needs to be dunnaged near the lifting points and dunnage blocks need to be aligned directly on top of each other so as to not induce large point loads on the units below. Care needs to be taken as to the bearing capacity of the ground the units are stored on.

Handling weights of Busck Double Tees:

Double tee unit Weights	
Tee depth (mm)	Self weight (kg/m)
200	591
250	642
300	693
350	744
400	795
450	846
500	897
550	948
600	999
650	1050

Double Tee Tables

Busck's Double Tee flooring system incorporates a pre-stressed concrete tee element with an in-situ concrete topping slab to give a cost effective, thin, composite suspended floor. Temporary propping is normally required.

They are made and accelerated cured on a long steel bed to allow units to be made in any achievable length, shape and thickness on a daily production cycle.

Busck's Double tees typically are placed at 3000mm module and come in 50mm depth increments from 200mm to 650mm deep.

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Double tee Flooring **Product Data Sheet**

Temporary propping is usually not required for Busck Double tees.
On your drawings call up Busck Double tee as eg. "**Busck 250 Double tee with 75mm concrete topping**".
Spans beyond the heavy **black line** exceed span/depth<31, not recommended for simply supported end conditions.
Values to the left of the **green line** (Span/depth<28) meet vibration limits for residential and office occupancies where the damping ratio is 0.025.
Partial prestress applied; max stress range = 200MPa, max crack width = 0.3mm. Valid for environment class. A1 for 50 year design life.

Double tee Load/Span Tables (indicative only).

3.0m wide Double tee with 75mm topping concrete (25MPa).

Unfactored maximum superimposed live load (Q_b) in kilopascals (kPa), allowing for superimposed dead load **SDL = 0.5kPa**.

Tee	Self wt	Simply supported span (m)																
depth (mm)	(kPa)	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	20.5
200	3.8	13.0	8.6	5.7	3.8													
250	4.0	20.6	13.8	10.5	8.6	5.1	3.4											
300	4.1	23.8	15.5	12.9	10.4	7.9	5.7	3.7										
350	4.3		20.0	15.8	13.0	10.7	8.7	6.6	4.7	3.0								
400	4.5				15.5	12.4	10.4	8.7	7.2	5.6	4.3	3.0						
450	4.6					15.5	12.5	10.5	8.9	7.4	6.0	4.6	3.4					
500	4.8							13.4	10.8	9.0	7.5	6.2	4.9	3.7	**2.6**			
550	5.0								12.3	10.0	8.4	7.2	6.0	4.9	3.8	**2.9**		
600	5.1									11.7	9.5	8.0	6.8	5.7	4.6	3.6	**2.7**	
650	5.3										12.3	10.1	8.6	7.4	6.3	5.2	4.2	**3.3**

3.0m wide Double tee with 100mm topping concrete (25MPa).

Unfactored maximum superimposed live load (Q_b) in kilopascals (kPa), allowing for superimposed dead load **SDL = 0.5kPa**.

Tee	Self wt	Simply supported span (m)																
depth (mm)	(kPa)	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	20.5
200	4.4	15.8	10.3	6.6	**4.2**	**2.5**												
250	4.6	22.6	15.3	11.6	9.6	5.9	**4.0**											
300	4.8	25.3	16.5	13.6	11.0	8.4	6.0	**3.9**	**2.5**									
350	4.9		23.4	18.4	15.0	12.3	9.8	7.3	5.0	**3.0**	**2.5**							
400	5.1				17.6	14.0	11.6	9.7	7.9	6.1	4.5	**3.0**						
450	5.3					16.5	13.3	11.1	9.4	7.8	6.2	4.7	**3.4**	**2.6**				
500	5.4							14.0	11.2	9.4	7.8	6.5	5.1	3.8	**2.7**			
550	5.6								12.8	10.4	8.7	7.4	6.2	5.0	**3.9**	**2.9**		
600	5.8									11.8	9.6	8.1	6.8	5.7	4.6	**3.6**	**2.7**	**2.5**
650	5.9										12.4	10.2	8.6	7.4	6.3	5.1	**4.1**	**3.7**

Span/Maximum live loads in bold blue require propping at mid-span to support construction loads.
Additonal capacity can be achieved through cropping flanges to a minimum unit width of 2.0m
Spans to the left of the heavy black line meet vibration limits where damping ratio = 0.05 (full height partitions).
Spans to the left of the heavy green line meet vibration limits where damping ratio = 0.025 (open floor plans).
Contact Busck's technical department to check specific requirements that may fall outside the table.

Double tee Section Properties

Section properties are based on 3.0m wide Double tee with legs spaced at 1500crs, plus **75mm topping concrete, uncracked.**

			Bare unit				Composite unit			
Tee depth (mm)	Tee weight (kg)	Overall depth (mm)	A $x10^3mm^2$	Y_b mm	I $x10^9mm^4$	Z_b $x10^9mm^3$	A' $x10^3mm^2$	Y_b' mm	I' $x10^9mm^4$	Z_b' $x10^9mm^3$
200	591	275	239	143	0.63	4.4	464	182	1.56	8.6
250	642	325	260	179	1.22	6.8	485	222	2.46	11.1
300	693	375	279	214	2.02	9.4	504	260	3.58	13.8
350	744	425	300	246	3.24	13.2	525	296	5.29	17.9
400	795	475	317	280	4.59	16.4	542	335	7.32	21.8
450	846	525	337	311	6.42	20.6	562	370	9.89	26.7
500	897	575	369	335	9.30	27.8	594	398	13.53	34.0
550	948	625	377	372	11.30	30.4	602	439	16.63	37.9
600	795	675	408	394	15.35	39.0	633	467	21.99	47.1
650	1050	725	432	419	19.61	46.8	657	495	27.14	54.8

Specifications

Drawing call-up

To specify the Busck Double Tee system on your drawings, we suggest you use the following designation:

Busck depth Double Tee with topping thickness

For example if the project is to be made from 300mm deep Busck Double Tee with a 75mm topping, then the specification would read:

Busck 300 Double Tee with 75mm topping

Written specification clauses

Busck Double Tee products in general comply with the following standards:

(i) NZS 3101:2006 'Concrete Structures Standard Part 1 & 2' Amendment 3.

(ii) NZS 3109:1997 'Concrete Construction'

(iii) AS/NZS 4671:2001 'Steel Reinforcing Materials'

(iv) BS 5896:1980 'Specification for High Tensile Steel Wire and Standard for the Prestressing of Concrete'

Materials

(i) Concrete shall be specifically mixed depending on environmental conditions and should have a 28 day cylinder strength of 45MPa as a minimum.

(ii) All concrete shall show signs of thorough compaction otherwise rejected if repair cannot be undertaken to bring the unit back to the original specification.

(iii) An air entraining agent complying with BS EN 934-2-2001 may be included in the concrete mix to improve workability.

(iv) The strand reinforcement used in Busck Double Tee shall be 9.6mm or 12.7mm diameter complying with the requirements of AS/NZS 4671:2001.

(v) Prestressing strand shall be clean and free from deleterious substances. Superficial rust is acceptable, however strand with corrosion that has caused surface pitting shall be rejected for the main longitudinal reinforcement of the unit.

Design

(i) The design of Busck Double Tee shall be in accordance with the requirements and recommendations of NZS 3101:2006 'Concrete Structures Standard Part 1 & 2' and/or any recognised international Standard or part thereof, for example BS 8110:2007 'The Structural Use of Concrete'.

(ii) The prestress strand pattern in the Busck Double Tee shall be designed to sustain the loadings shown on the Consulting Engineer's drawings and allowance will be made for self weight of the unit and topping concrete.

(iii) The Busck Double Tee shall be designed for exposure classification A1/A2/B1/B2 as per table 3.6 in NZS 3101:2006.

(iv) The Busck Double Tee unit shall have a FRR (Fire Resisting Rating) of 60/60/60. Penetrations through the flooring system shall be reinstated to the required FRR by an approved fire protection system.

(v) Busck Double Tee shall be designed to have a maximum crack width of 0.3mm under full live load conditions.

(vi) The acoustic STC (Sound Transmission Class) and IIC rating of the floor system shall meet or exceed 53dB measured in 'on-site conditions'. These ratings apply to the finished floor system, including any carpeting and suspended ceiling systems.

(vii) The Busck Double Tee units shall have a minimum of 75mm end seating or L/180 per clause 18.7.4.3 in NZS 3101:2006 A3 plus tolerance of 10mm if seated on an unarmoured concrete beam.

Manufacture

(i) Materials, execution of stressing prestress strand and workmanship of the Busck Double Tee units shall conform with Busck Prestressed Concrete ISO 9001 Quality Assurance Operating Procedures.

(ii) Busck Double Tee units shall be nominally 3000mm wide and made in the following nominal depths 200mm-650mm in 50mm increments.

(iii) The top surface of the Busck Double Tee unit shall have a nominal roughness of 5mm free of laitance as stipulated in NZS3101:2006 clause 18.5.4.1(a).

(iv) The tolerance for length of the Busck Double Tee units shall be in accordance with NZS 3109 Table 5.1 (usually +/- 10mm).

Temporary Propping

(i) Design of temporary propping, back propping, bracing systems and ground conditions to support prop loads shall be carried out by a suitably qualified Engineer.

(ii) Propping shall not be removed until the topping concrete has reached at least 15MPa.

(iii) It is the Contractor's responsibility to ensure the propping system used on site meets the criteria as detailed in the aforementioned design and any additional requirements shown on the Busck Engineered Concrete drawings.

(iv) All proposed systems with supporting calculations shall be submitted to the Specifying Engineer prior to erection on site for approval.

Topping Concrete

(i) The top surface of the Double Tee units shall be clean and free of all dust, oil or any deleterious substances which may adversely affect the wet topping bond to the Double Tee units.

(ii) Pre-wet precast concrete surfaces prior to placing the topping concrete.

(iii) Free water shall be broomed away before the topping is applied.

(iv) Topping reinforcement shall be laid and supported to the Specifying Engineer's requirements and shall be supported to prevent displacement during concreting.

(v) Topping concrete shall have a maximum aggregate size of _____ (normally 13mm) and a 28 day strength of _____ (minimum of 25MPa) and be well compacted with mechanical vibrators.

(vi) Topping concrete shall be poured to a true surface so that the specified thickness of _____ (minimum of 75mm) is achieved at the centre of the span.

(vii) In-situ concrete shall be cured by the application of an approved curing membrane or by being kept continuously wet for not less than seven days.

Fixing & Penetrations

(i) Fixing to the Double Tee units shall be in accordance with the approved details only and shall not impair or reduce the strength of the unit in any way.

(ii) Documentation of tested fixings proposed for the project shall be submitted to the Specifying Engineer prior to installation.

(iii) Penetrations, setdowns or chases to the Double Tee unit or topping concrete shall be in accordance with the details agreed by the Specifying Engineer and the Double Tee manufacturer prior to any work being undertaken on site.

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