Cairngorm Funicular Railway

Schedule of Suppliers

Name / Address	Supplier of	Contact Name	Tel / Fax Numbers
Aberdeen Window and Door Systems 83 - 87 Causewayend Aberdeen Window and Door Systems AB25 3TQ	Windows and doors	Personal Data Redacted	
Acorn Signs Unit 42 Harbour Road Inverness	Signage		
Asset International Ltd Netherton Street Wishaw Lanarkshire ML2 0ED	Armcopanel		
BRC 14 Newhouse Ind Est ML1 5SE	Reinforcment		
Caledonian Quarry Products Dores Road Inverness	Pre cast concrete Blocks and lintols Ready mix concrete		
Creagh Concrete Newbridge Ind est Newbridge Edinburgh EH28 8PJ	Pre cast concrete (Funicular)		
John Davidson Pipes 22 Seafield Road Inverness	Cast Iron Drainage Upvc Pipe Blue Alkathene		
Encon Insulation Ltd Block 9 Myrekirk Road Wester Gourdie Ind Est Dundee DD2 4SH	Insulation Metal stud partition		
Fyfe Douglas Ltd 15a Harbour Road Inverness IV1 1MX	Ironmongery		
Edinburgh Tile Distributers Shore Street Inverness IV1 1NT	Wall Tiles		
Grays Timber Products Ltd 58 Seafiled Road Inverness IV1 1SG	All - non Glulam Timbers Plasterboard MDF Plywood		
Halfen Ltd Humphrys Road Woodside Estate Dunstable LU5 4TP	Halfen Channel		

Highland Industrial Supplies 36 Seafield Road Inverness IV1 1SG	Nails / Screws	Personal Data Redacted
Ischebeck Titan Ltd John Dean House Wellington Road Burton on Trent DE14 2TG	Anchors / Couplers (Funicular)	
Keyline Ltd 25 Harbour Road Inverness IV1 1MX	Flexcell Lotrak 10/7 Common Brick Cement Engineering Brick Reinforcing Mesh	
Lam Art Ltd 122 Liff Road Dundee DD2 2TP	Sales counter Vanity units / Toilet cubicles	
Normanby Industries Ltd Mannaberg Way Scunthorpe North Lincolnshire DN15 8QS	Macalloy bars / fittings (Funicular)	
Pasquill Roof trusses 16 Dalcross Ind Est Inverness IV2 7XB	(Timber) roof trusses	
A Ross and Son Ltd Mid Lairgs Quarry Daviot Inverness IV2 2XH	Building Sand Pipe Surround	
Stanton Plc 2 Grampian Court Beveridge Square Livingston EH54 6Q	Cast Iron Drainage	
Rigby Taylor Newbridge Industrial Estate Newbridge Midlothian EH28 8LE	Seed Aide Grass Seed Agricultural Emerald Microcal 10.15.10	
Travis Perkins Shore Street Inverness IV1 1TD	Fair faced lintols Porphory paving slabs camparta red mix Code 4 lead	
Turkington Precast James Park Mahon Road Portadown Road Northern Ireland	Precast concrete column sections (Funicular)	
Bio Forest Consultancy "Cuilalunn" Kinchurdy Road Boat of Garten	Deer posts	

City Electrical Factors 5 Seafield Road Inverness	Armoured cable	Personal Data	sonal Data Redacted
Fountain Forestry Bogallan North Kessock Inverness - shire IV31 3XE	Chespale (snow) fencing		
Ancon CCI Ltd President Way President Park Sheffield S47 7UR	Bearings (Funicular)		
J Gordon & Co Ltd Station Road Carrbridge Sawmill Invernes - shire	Fencing		

MORRISON

CAIRNGORM FUNICULAR

4.2 PRODUCT INFORMATION

The suppliers and manufacturers product information is provided in this section. Certain products have maintenance procedures included in their information packages.

1 LAM ART : COUNTER AND TOILET CUBICLES

2 CALEDONIAN QUARRY PRODUCTS

3 ISCHEBECK : ROCK BOLTS

4 ANCON CCL

5 CLANCO

6 RICHARD LEES

7 BSB : FIRE DAMPERS

8 NOR-DAN

9 FYFE DOUGLAS : IRONMONGERY

10 RD : FIRE PROTECTION

11 RIGBY TAYLOR.

12

13

14

15

16

17

18

19

20

Lam-Art (Dundee) Ltd
122 Liff Road • Dundee DD2 2TP • Tel: 01382 612222 • Fax: 01382 612233

JOB SPECIFICATIONS

Laminated Toilet Cubicle

The dividers and doors are constructed from 18mm thick chipboard. Pilasters are post formed 28mm thick, headrail 15mm thick.

All surfaces are bonded with high pressure laminate in a wide selection of plain colours or pattern effects. Jumbo or large sheet sizes are used to minimise joints. For maximum protection all edge lippings are applied prior to bonding the facing surfaces. Pilasters, head rail inserts where post formed are edged last.

Ironmongery is supplied in polyester powder coated aluminium to our standard colour range.

Solid Grade Cubicle

The dividers, door panels and pilasters are constructed from 13mm thick solid grade laminate in a choice of manufacturers plain or pattern effects. There is no edge lippings applied and the black core is polished and arrises are eased to provide a finished edge. Ironmongery is supplied in polyester powder coated aluminium to our standard colour range.

MFC Cubicle

The dividers, door panels and pilasters are constructed from 18mm melamine faced moisture resistant chipboard. For maximum protection all edge lippings are 3mm thick P.V.C. solid colour from our standard range of 6 colours.

Ironmongery is supplied in polyester powder coated aluminium to our standard colour range.

Duct and Wall Panelling

Panels for ducting systems can be constructed from a wide range of core materials such as M.R. chipboard, M.D.F., M.R.M.F.C. or W.B.P. plywood. All faced with high pressure laminate and suitably balanced to ensure stability. Panels can have square or post formed edges with edging in laminate or 3mm thick P.V.C. in a choice of standard colours Duct panels can be supplied complete with backing frames for fitting between a dressed softwood structural framework. The frames are manufactured from 25mm thick W.B.P. plywood complete with supports for sanitary ware. The panelling for concealing the plumbing services can be divided horizontally and vertically by shadow gaps faced in matching laminate.

Vanity Fitments

Vanity fitments can be constructed from a wide selection of core materials to meet the demands of particular needs, cores can be in chipboard, M.D.F. or plywood and are faced with high pressure decorative laminate with balancing veneer on the reverse face to ensure stability of the composite construction. An extensive choice of laminates is available to match or to compliment the colours of cubicle systems and decorative themes.

Unit tops and front aprons can be manufactured in continuous form, limited only by the sheet size of the chosen laminate. Front access panels can be square edged or post formed along the vertical or horizontal edges and are supplied with secret fixing clips for accessibility. Solid surfacing materials such as Corian® or Surrell® can be utilised for vanity tops including integrated vanity basins.

Lam-Art (Dundee) Ltd
122 Liff Road • Dundee DD2 2TP • Tel: 01382 612222 • Fax: 01382 612233

REMOVING SPOTS

Remove with ➡ / Stains from	Household detergent	Spirits, Window cleaner	Petrol acetone perchlor-ethylene	Special solvents Grafitti-remover
Finger marks	■	■		
Grease, oil	■		■	
Shoe scuff marks	■		■	
Soot, nicotine	■			
Inks	■		■	
Coffee, tea	■			
Fruit juices	■			
Crayons, ball-point pens	■		■	
Marker pens		■	■	
Varnish, adhesive*		■	■	■
Lipstick, shoe polish, wax	■		■	
Nail varnish			■	■
Lime soap, calcium deposits**				
Rust***	■			

* Certain adhesives (particularly hardened 2- component adhesives) often cannot be removed from the surface once they have hardened.

Calcium deposits and lime soap, which may appear in shower areas, are to be removed with 10% acetic acid solution. So-called de-calcifying agents must be used with great caution, as they may contain strong etchants.

*** Use citric acid solution on stubborn stains.

REMOVING EXCESS ADHESIVE

Use clean, lukewarm water to remove any glue residues from the decorative surface before pressing. See that the glue is really removed, not just thinned out over a larger area of the surface. Remove dried PVAc adhesive with lukewarm water containing about 10% ethanol. Hardened urea adhesive is difficult to remove. Satisfactory results may sometimes be obtained by brushing with diluted hydrochloric acid, perhaps also scraping carefully with a wooden knife or the like.

Another possibility to remove urea adhesives is to place a damp cloth over the spot and run a warm iron over it.

Consult the adhesive manufacturer for further information regarding the removal of hardened glue residues.

REMOVING STAINS FROM PAINT, MARKER PENS ETC.

Use organic solvents such as methylated spirits, petrol, acetone, graffiti stain removers etc. Remove solvent residues with water and ordinary cleanser.

Do not use nitro cellulose thinner. Some solvents are inflammable or hazardous if inhaled.

Cleaning should therefore be done in a well ventilated area, away from any open flame.

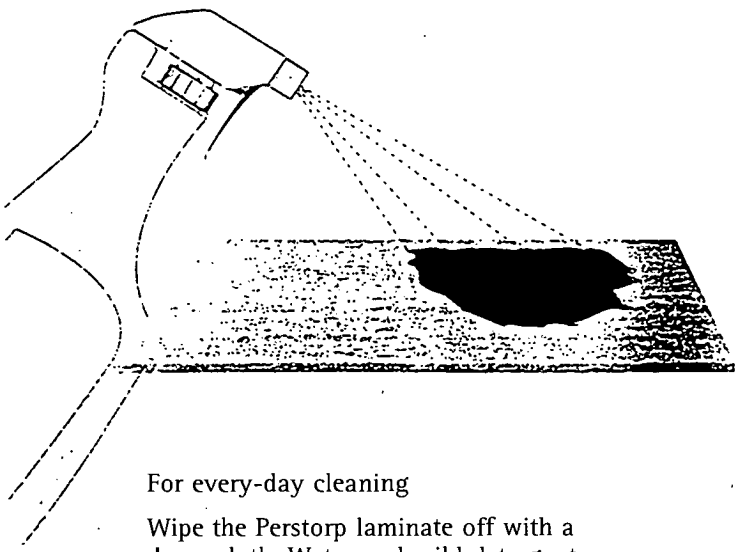
DO NOT FORGET...

Whenever removing stains, always wash the surface afterwards with plenty of water containing soap, cleanser, detergent etc. and wipe dry.

Lam-Art (Dundee) Ltd
122 Liff Road • Dundee DD2 2TP • Tel: 01382 612222 • Fax: 01382 612233

MAINTENANCE

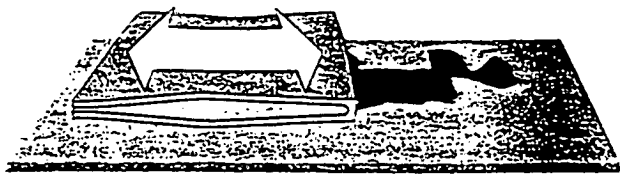
Perstorp laminate is highly durable and requires only general maintenance. For best results when removing stains, follow our recommendations.



For every-day cleaning

Wipe the Perstorp laminate off with a damp cloth. Water and mild detergent removes most stains.

Stubborn stains require concentrated cleanser. Wipe dry with a clean cloth.



SLIGHTLY SOILED SURFACES - DAILY CLEANING

1. Wet a clean cloth in water containing soap, cleanser or detergent
2. Wring out the cloth and wipe off the surface.
3. Wipe dry with a clean, dry cloth.

DIRTY SURFACES - THOROUGH CLEANING

1. Wipe off any loose dirt.
2. Wet a clean cloth in water containing cleanser and wring out.
3. Put cleanser on the damp cloth and wipe to loosen all dirt. For Interior and other surface textures with directional grain, wipe with the grain.
4. Wet a clean cloth in clean water, preferably with spirits or window cleaner added, and wipe.
5. Wipe dry with a clean cloth.

Note: For cleaning extremely soiled structured surface textures, use a soft nylon brush.

NEVER USE STEEL WOOL FOR CLEANING

Steel wool, scouring powder, abrasive creams, scouring pads (e.g. Scotch Brite) and other abrasives must not be used for cleaning, as they may scratch the surface of the laminate.

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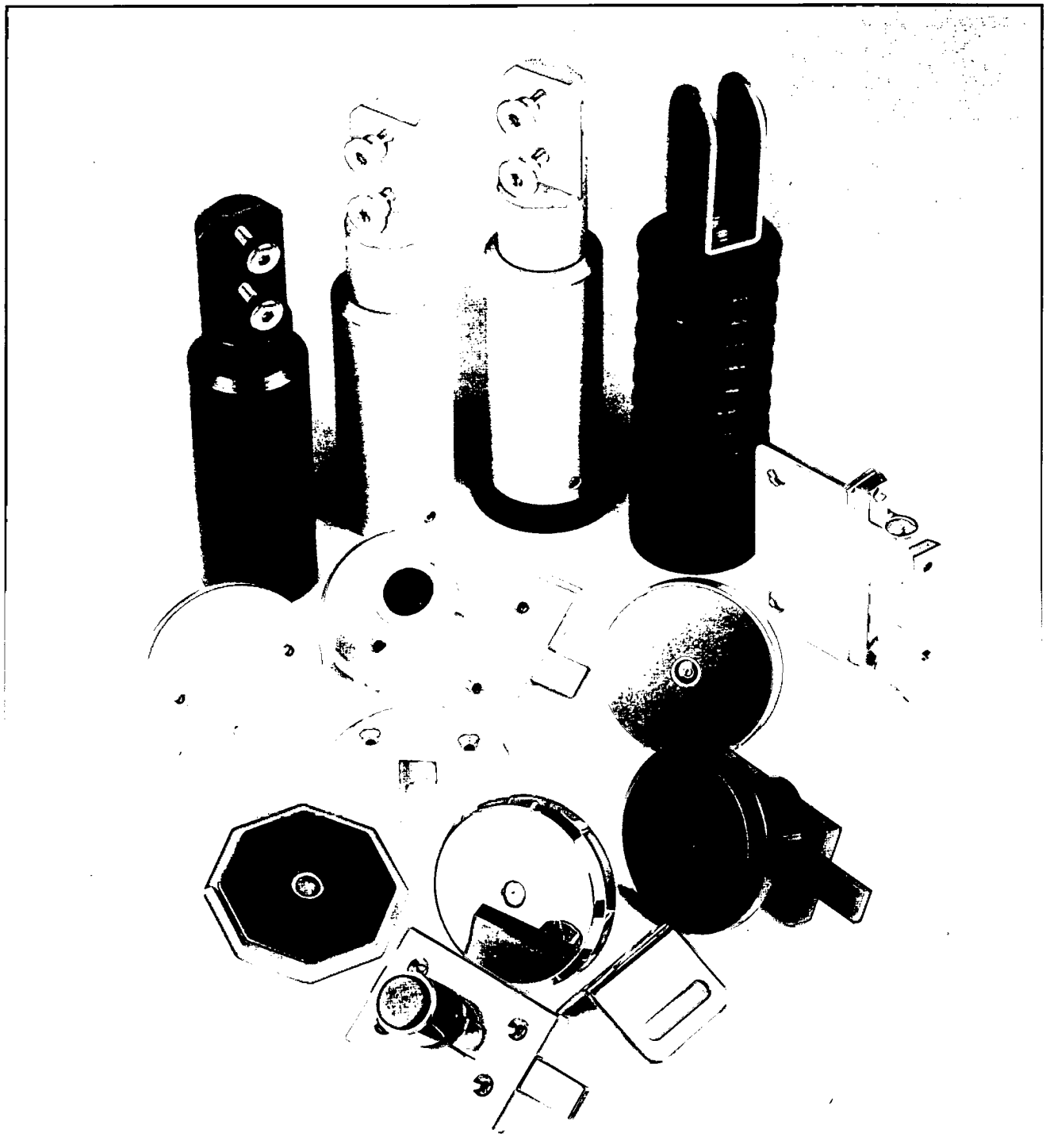
IRONMONGERY



SAFETY DATA SHEET

Code: Tarmac 16 - Issue: 2

Issue Date: August 2001 page 1 of 2

Tarmac

1 Identification of Substance & Company

READY-MIXED CONCRETE

Company

Tarmac Limited
Millfields Road
Ettingshall
Wolverhampton WV4 6JP
Telephone: 01902 353522
Fax: 01902 353920
Emergency Telephone: 01902 353522

2 Composition / Information on Ingredients

Ready-mixed concrete is a mixture of:

- A cementitious material. (This may be cement or a mixture of cement with pulverised fuel ash or ground granulated blastfurnace slag or silica fume).
- Fine and coarse aggregate.
- Water.
- Admixtures or additives may be added to improve the properties of the fresh or hardened concrete. Pigments may be added to colour the product.

The components vary in concentration according to the required properties of the product.

The resultant mixture is abrasive and alkaline.

3 Hazards Identification

Skin
Contact with wet cement mixes such as wet concrete can cause skin disease.

Irritant contact dermatitis is caused by the combination of the wetness, alkalinity and abrasiveness of the ready-mixed concrete.

Allergic contact dermatitis may be caused by individual sensitivity to chromium compounds which may occur in cement.

Cement burns, a form of skin ulceration, may result from contact with freshly mixed concrete.

Eyes
Wet material can cause irritation, inflammation or burns on contact with eyes.

Ingestion
The swallowing of small amounts of fresh concrete is unlikely to cause any significant reaction. Larger amounts can cause irritation of the stomach and intestines.

4 First Aid Measures

Summary of First Aid Procedures

In all cases of doubt, or where symptoms persist, medical advice should be obtained.

Inhalation
Not applicable.

Skin Contact
Where skin contact occurs with wet concrete , either directly or through saturated clothing, the concrete must be washed off immediately with soap and water.

Where concrete enters boots or gloves or saturates clothing, the article should be removed immediately and washed before further use.

Eye Contact
Immediately and thoroughly irrigate with water.

Ingestion
Wash out mouth and drink plenty of water. do not induce vomiting. Seek medical advice if a large amount is swallowed.

5 Fire Fighting Measures

Suitable Extinguishing Media
Not applicable.

Unsuitable Extinguishing Media
Not applicable.

Special Exposure Hazards in Fire
None.

Special Protective Equipment for Fire Fighters
None.

6 Accidental Release Measures

Personal Precautions
No special requirements.

Environmental Precautions
Entry into watercourses should be avoided.

Methods for Cleaning
No special requirements.

7 Handling and Storage

Handling
Skin contact should be avoided. The mixture is abrasive and highly alkaline.

Storage
The hardening process of ready-mixed concrete can be delayed by the addition of additives and or admixtures, extending the period during which the precautions given in this data sheet should continue to be taken and during which access by unauthorised persons should be prevented.

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8 Exposure Controls / Personal Protection

Take measures to Prevent
Direct skin contact with fresh concrete should be avoided. It is also improtant not to kneel or sit on the material as harmful contact can occur through saturated clothing.

The surface treatment and cutting of hardened concrete can create dust which may contain quartz. If inhaled in excessive quantities over an extended period, respirable dust containing quartz can constitute a long term health hazard.

Exposure Control Limits / Source

Total Dust:	O.E.S. 10mg/m³ 8 Hours T.W.A.
Respirable Dust:	O.E.S. 4mg/m³ 8 Hours T.W.A
Respirable Quartz: Crystalline Silica SiO_2	M.E.L. 0.3mg/m³ 8 Hours T.W.A.

O.E.S. = Occupational Exposure Standard
M.E.L. = Maximum Exposure Limited
T.W.A. = Time Weighted Average

Respiratory Protection
Suitable respiratory protective equipment.

Hand Protection
Impervious gloves

Skin Protection
Long sleeved clothing, full length trousers and impervious boots.

Eye Protection
Goggles may be required.

9 Physical and Chemical Properties

Appearance	Grey, granular paste
Odour	None
pH	Highly alkaline
Boiling Point / Range	Not determined
Melting point / Range	Not determined
Flash Point (°C)	Not applicable
Flammability	Not applicable
Auto Flammability	Not applicable
Explosive Properties	Not applicable
Oxidising Properties	Not applicable
Vapour Pressure	Not applicable
Relative Density	Above 2.0
Water Solubility	Dependent on rock type
Fat Solubility	Not determined

10 Stability and Reactivity

Conditions to Avoid
None.

Materials to Avoid
None.

Hazardous Decomposition Products
None.

11 Toxicological Information

Skin contact could result in dermatitis and skin burns or disease. Inhalation of respirable dust from the working of hardened concrete may cause permanent lung damage.

12 Ecological Information

Possible Effects
None.

Behaviour
Non Hazardous.

Environmental Assessment
When used and disposed of as intended, no adverse environmental effects are foreseen.

13 Disposal Consideration

Likely Residues / Waste Product
Alkaline slurry.

Inert hardened material.

Safe Handling of Residues / Waste Product
Aggregates are inert but should be disposed of in accordance with local and national legal requirements. See the Environmental Protection Act 1990 "Duty of Care" and other current legislation.

14 Transport Information

Special Carriage Requirements
None.

15 Regulatory Information

This product is NOT classified as dangerous for transport.

16 Other Information

Training Advice
Wear and use of PPE

Recommended Uses and Applications
Industrial and construction applications.

Further Information
The Safety, Health & Environmental Manager
Tarmac Limited
Telephone: (01902) 353522

Key Data Used to Compile Data Sheet
HSE Guidance Note EH40/2000
PPE Regulations 1992
COSHH Regulations 1999
Environmental Protection Act 1990
HSE Crystalline Silica EH59

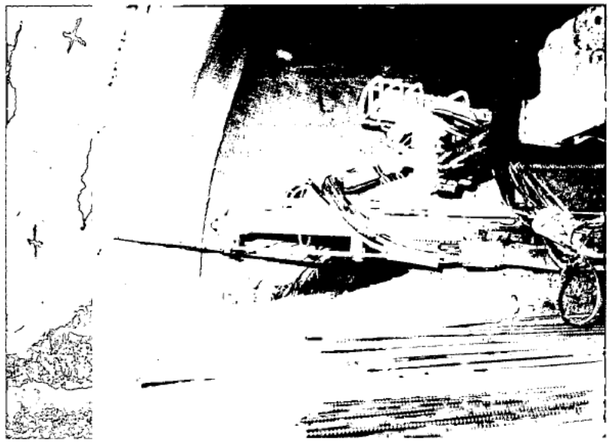
If you have purchased this product for supply to a third party for use at work, it is your duty to take all necessary steps to ensure that any person handling or using the product is provided with the information in this sheet.

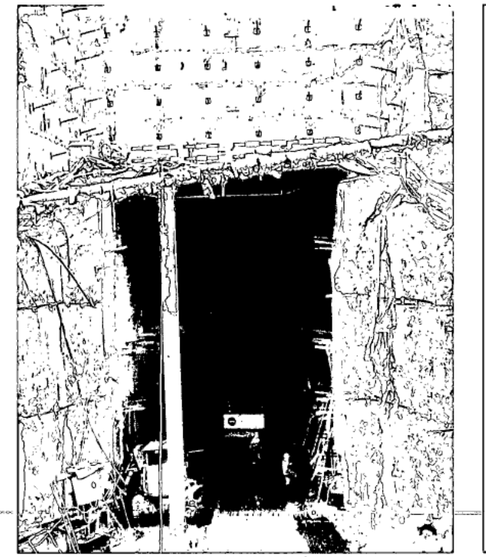
If you are an employer, it is your duty to tell your employees and others who may be affected of any hazards described in this sheet and any of the precautions which should be taken.

Further copies of this Safety Date Sheet may be obtained from Tarmac Limited.

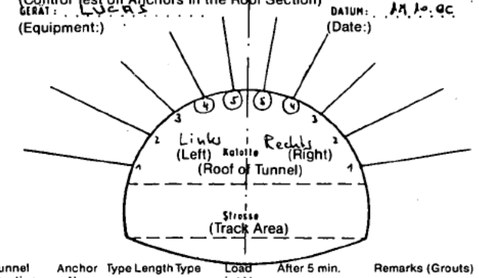
ISCHEBECK

TITAN Rock Bolts
for tunnel construction





ISCHEBECK ANKERVERSUCH ST. 2080 ÷ 2082,0 m
(Test on Ischebeck Anchors in Section of a Railway Tunnel in Germany)
ANKERKRAFTKONTROLLMESSUNGEN IN DER KALOTTE
(Control Test on Anchors in the Roof Section)
GERÄT: LUCAS (Equipment:) DATUM: 11.10.90 (Date:)



Tunnel Section Station	Anchor No. Anker-Nr.	Type Typ	Length Länge (m)	Type Ø (mm)	Load in kN Zugkraft in to o lb	After 5 min. Nach 5 Min. positiv	After 5 min. Nach 5 Min. negativ	Remarks (Grouts) Bemerkungen
2080,5	L 5	Titan	8,0	30/11	300	+		PZ 45+4% Tricosal
2081,5	L 4	"	8,0	30/11	300	+		PZ 45+4% Tricosal
2080,5	R 5	"	8,0	30/11	300	+		PZ 35+4% Tricosal
2081,5	R 4	"	8,0	30/11	300	+		PZ 35+4% Tricosal

(26 ft) (66.000 lbs)

BAUÜBERWACHUNG (Supervisor) [redacted] FIRMA (Contractor) [redacted]

Conversions: 1 m ~ 40" 1" ~ 25,4 mm 1 cm² ~ 0,155 in² 1 kN ~ 225 lbs - 1 N/mm² ~ 145 lbs/in² - 1 Bar ~ 14,5 psi - 1 kN/m² ~ 20,49 lbs/ft² 1 kg ~ 2,25 lbs - 1 Nm ~ 0,72 lb ft
Imperial figures are rounded. Photos are illustrative only, products must be used in conformity with safe practices and applicable codes and regulations. Subject to technical changes.

ISCHEBECK ... technically advanced formwork, shoring, trenching and geotechnical systems

member of ADSC

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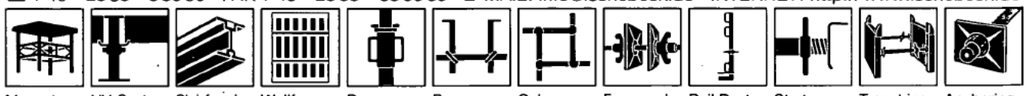
☎ + 49 – 23 33 – 8 30 50 · FAX + 49 – 23 33 – 83 05 55 · E-MAIL: info@ischebeck.de · INTERNET: http://www.ischebeck.de

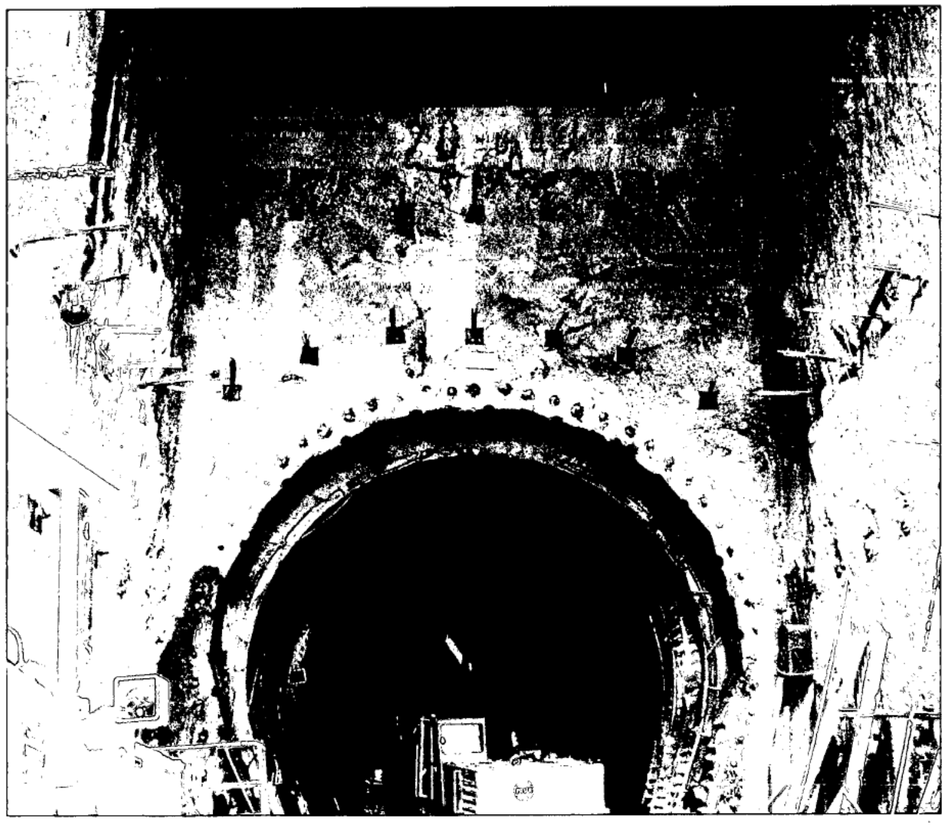


Megashore | HV-System | Slabforming Systems | Wallform | Props | Beam Forms | Column Forms | Formwork Ties | Rail Posts | Struts | Trenching Systems | Anchoring Systems

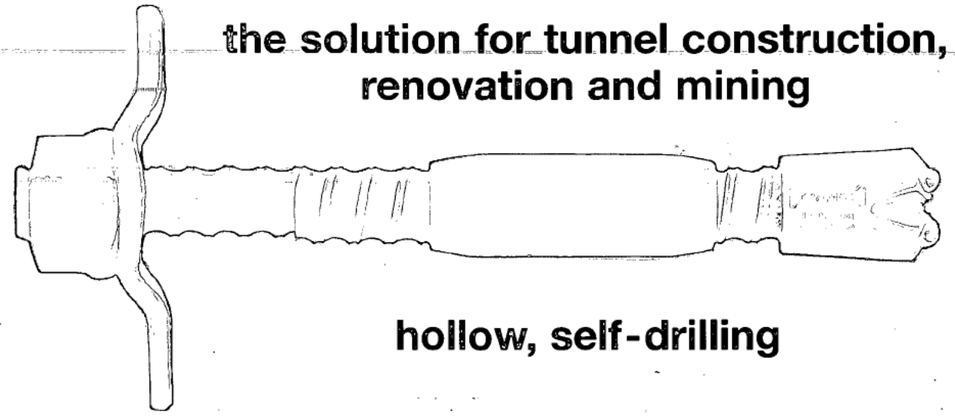
W 29.1/3.95/2.00/2 GB · Störring Satz + Druck GmbH, Ennepetal

Subject to technical changes.

Rock Bolts ISCHEBECK® TITAN



the solution for tunnel construction, renovation and mining

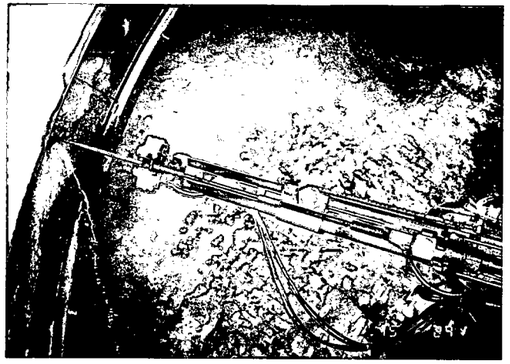


hollow, self-drilling

ISCHE-
BECK

TITAN Rock Bolts are used for:

- **the NEW Austrian Tunneling Method (NATM) for bolts longer than 3 m, for loose materials (glacial deposits, schist, coarse clay), for small overlay, and for fault zones**
- **horizontal spiling (fore-piling) by reinforced jet-grouting (up to 160 bar)**
- **fixing tunnel junctions (columns) against shear movements**
- **reinforcing of fault zones with polyutherane or organic mineral epoxies, for example for protecting TBM's**
- **the build-up of water-tight grout umbrellas with the Flex-Mix-method**
- **slope stabilization at the tunnel portal (tallus)**
- **final anchoring of large section tunnels with high side walls**

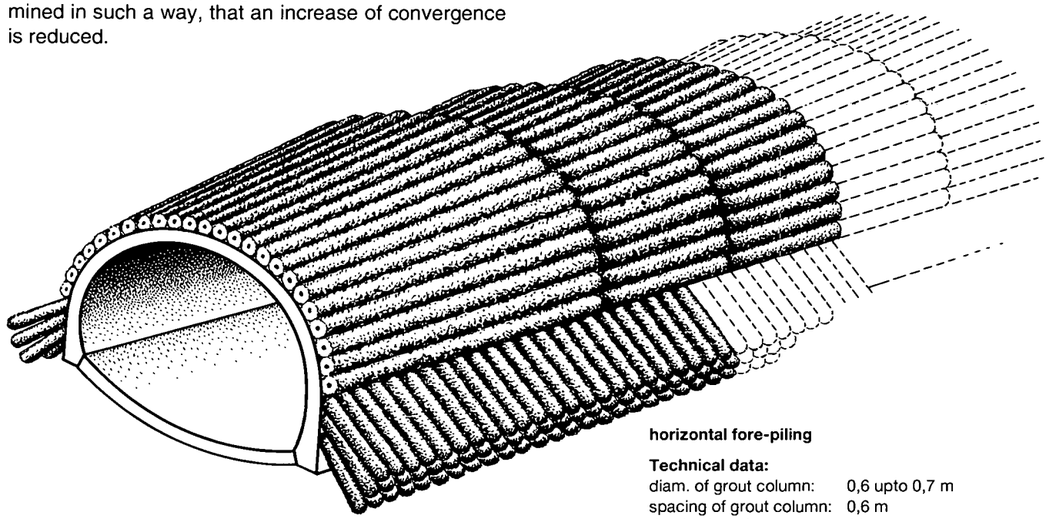


New Austrian Tunnelling Method (NATM)

The principle of the NATM is a temporary (flexible) distribution of the rock pressure around the tunnel excavation until stabilized by the final concrete tunnel lining.

Based on convergence monitoring, the thickness of shotcrete and the spacing between the bolts is determined in such a way, that an increase of convergence is reduced.

Characteristics for the NATM are:
an immediate sealing of the tunnel surface after excavation by support through shotcrete against further tension relief, as well as bolting the soil layers with anchors to create a shear resistant bearing ring for the rock.

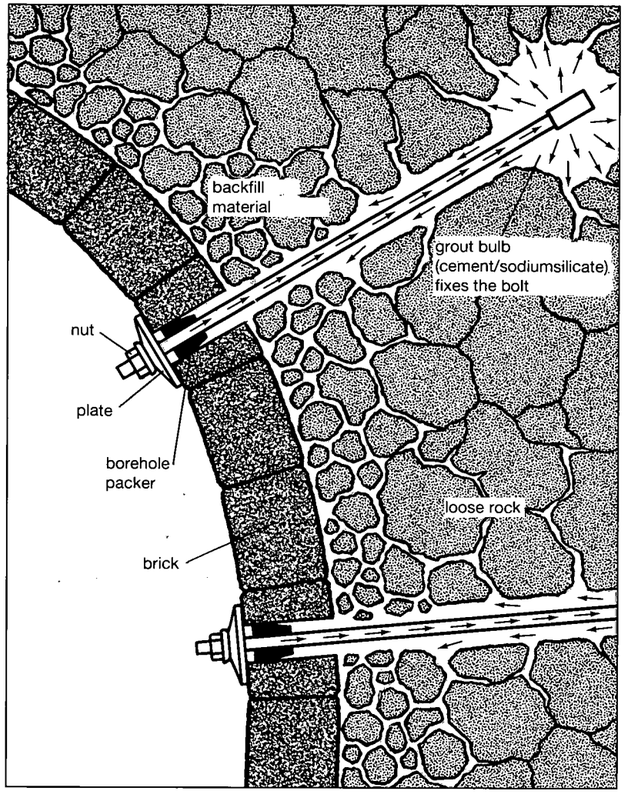


horizontal fore-piling

Technical data:

diam. of grout column:	0,6 upto 0,7 m
spacing of grout column:	0,6 m
depth of section:	11 m
for 15 m section	approx. 300 linear drilling metres in 2½ days

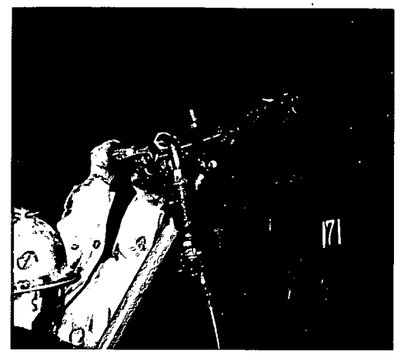
ISCHEBECK®
TITAN Rock Bolts
for tunnel construction

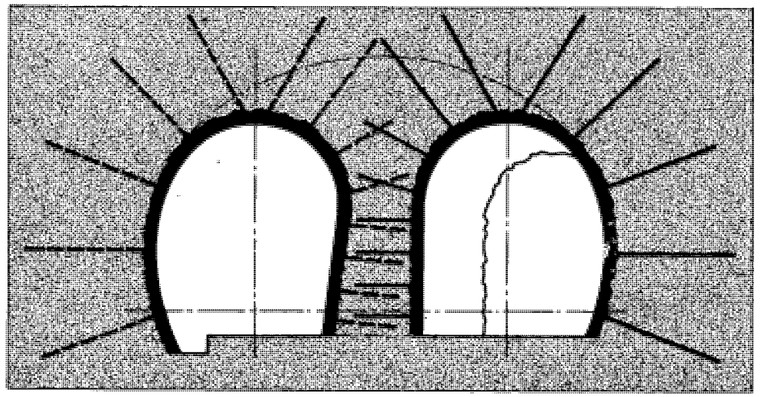


Renovation of Tunnels

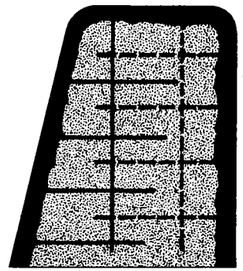
In old tunnels the backfill material has settled, or has been washed-off and consequently effected bulging of the brick-walls.

In such cases, like in the St. Gotthard Tunnel in Switzerland the TITAN rock bolts are ideal. Traffic interruptions were kept to an absolute minimum whilst backanchoring the existing brick wall and backfilling the hollow spaces.





bolting for column

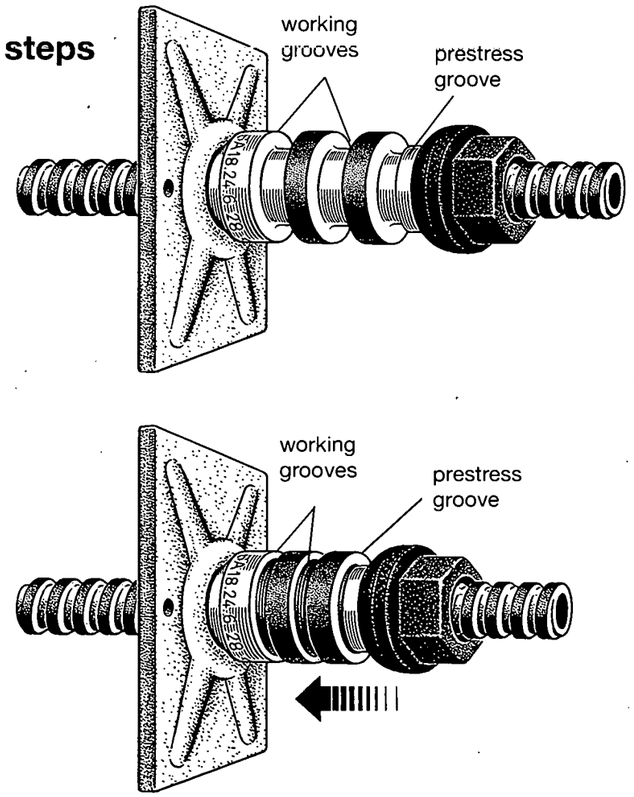


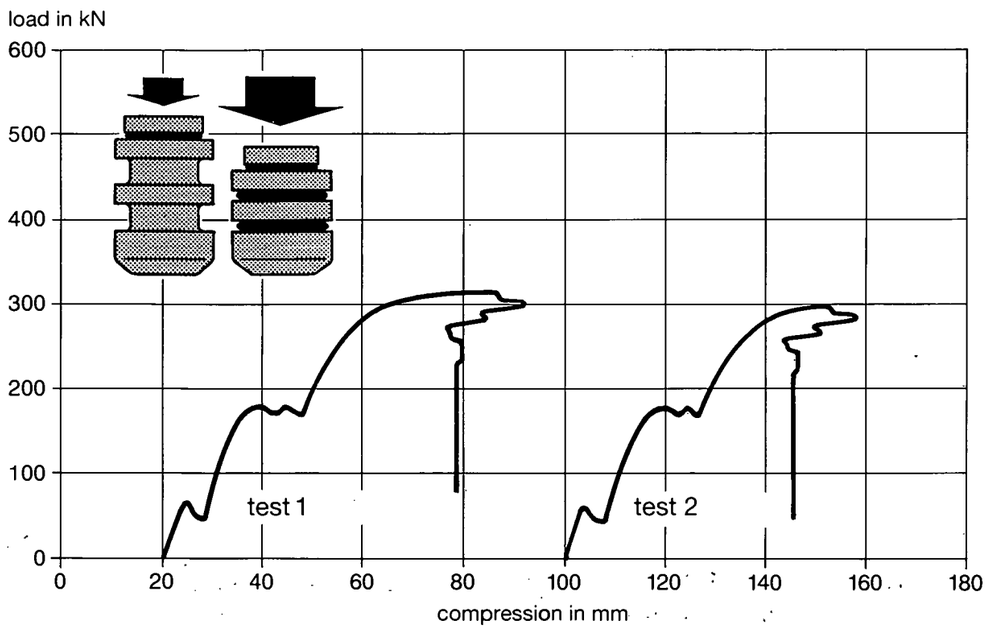
section

TITAN load indicator- 2 load steps

approved by LOBA (German Coal Board)
no. 18.24.6-28-4

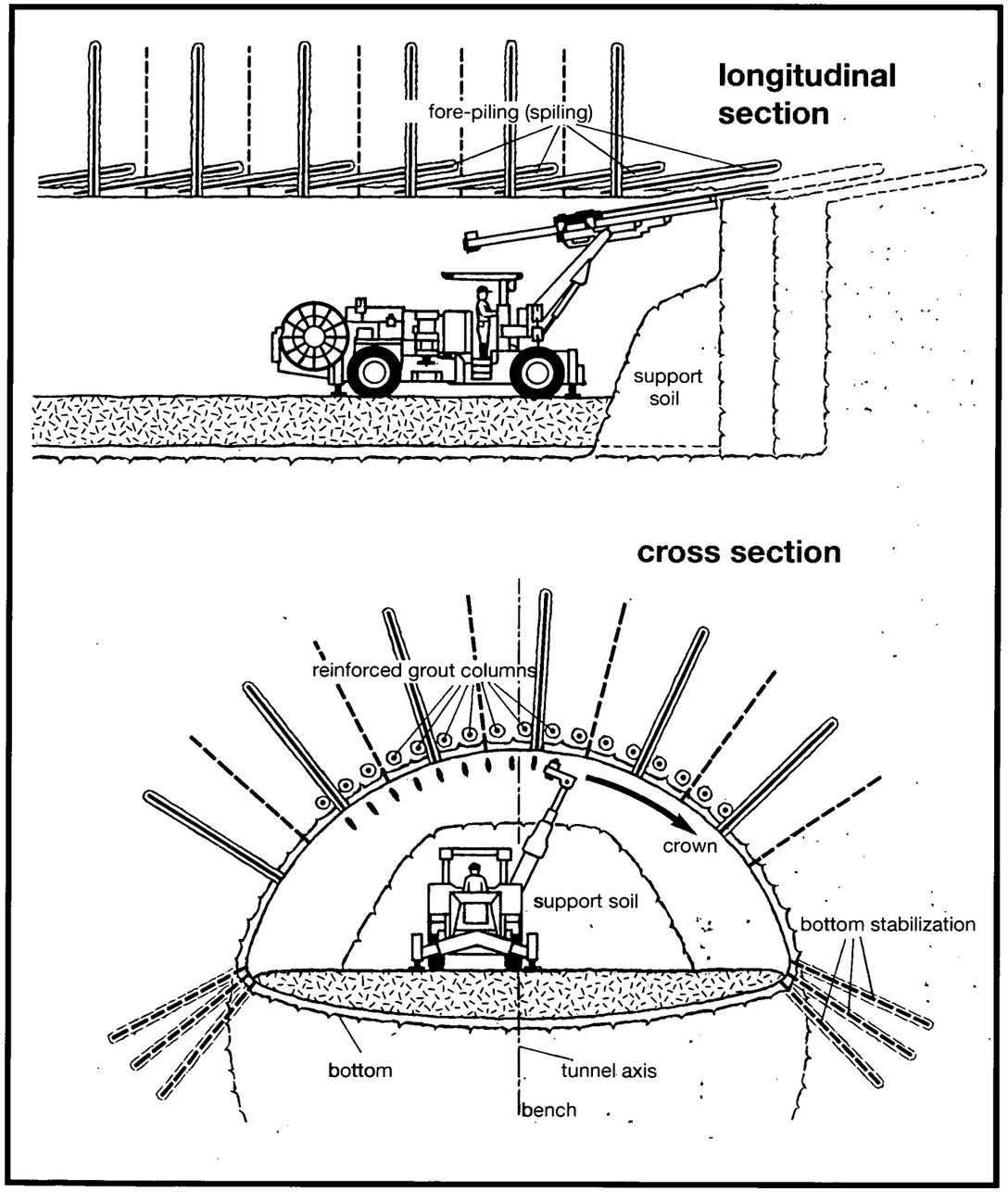
1. **prestressing range**
   with a pneumatic torque wrench at 2500 Nm the TITAN bolt is prestressed to 60 kN. The prestress groove closes. An easily visible sign that the bolt is fixed and can be loaded.
2. **working range**
   at 180 kN load both working grooves are closing one after one. The TITAN load indicator shrinks by 30 mm in length and consequently the bolts do not fail but the load stays constant.
3. **Advantages**
   - The stress situation of the bolt can be visually monitored at any time on the TITAN load indicator.
   - The closing of the grooves increases the physical load bearing ability of the rock bolt.
   - If convergences or shock loads occur, there is sufficient time to install further rock bolts.
   - Consistent indication
   - No danger through bursting nuts





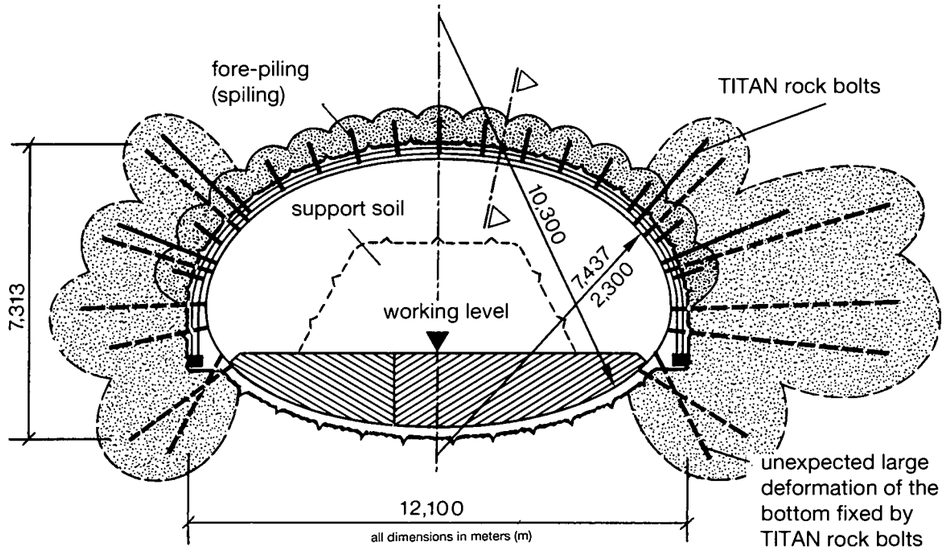
Self-drilling, hollow TITAN rock bolts, facilitate and extend the use of the NATM method to gravelly, shisty, sandy and even coarse clay soils because

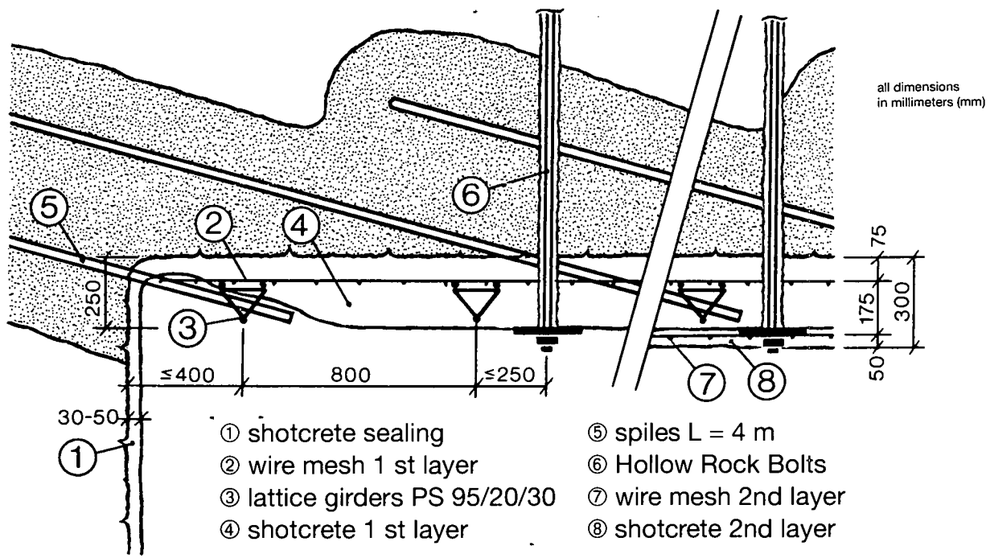
- the cohesion is increased by grout injection
- they are drilled, bolted and grouted without casing
- the same drilling equipment can install longer bolts



Conversions:
1 m ~ 40" 1" ~ 25,4 mm 1 cm² ~ 0,155 in² 1 kN ~ 225 lbs – 1 N/mm² ~ 145 lbs/in² – 1 Bar ~ 14,5 psi - 1 kN/m² ~ 20,49 lbs/ft² 1 kg ~ 2,25 lbs – 1 Nm ~ 0,72 lb ft

The application of the New Austrian Tunnelling Method





① shotcrete sealing
② wire mesh 1 st layer
③ lattice girders PS 95/20/30
④ shotcrete 1 st layer
⑤ spiles L = 4 m
⑥ Hollow Rock Bolts
⑦ wire mesh 2nd layer
⑧ shotcrete 2nd layer

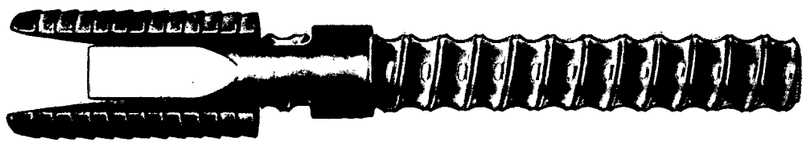
Bolt capacity: 50 to 250 kN/m²

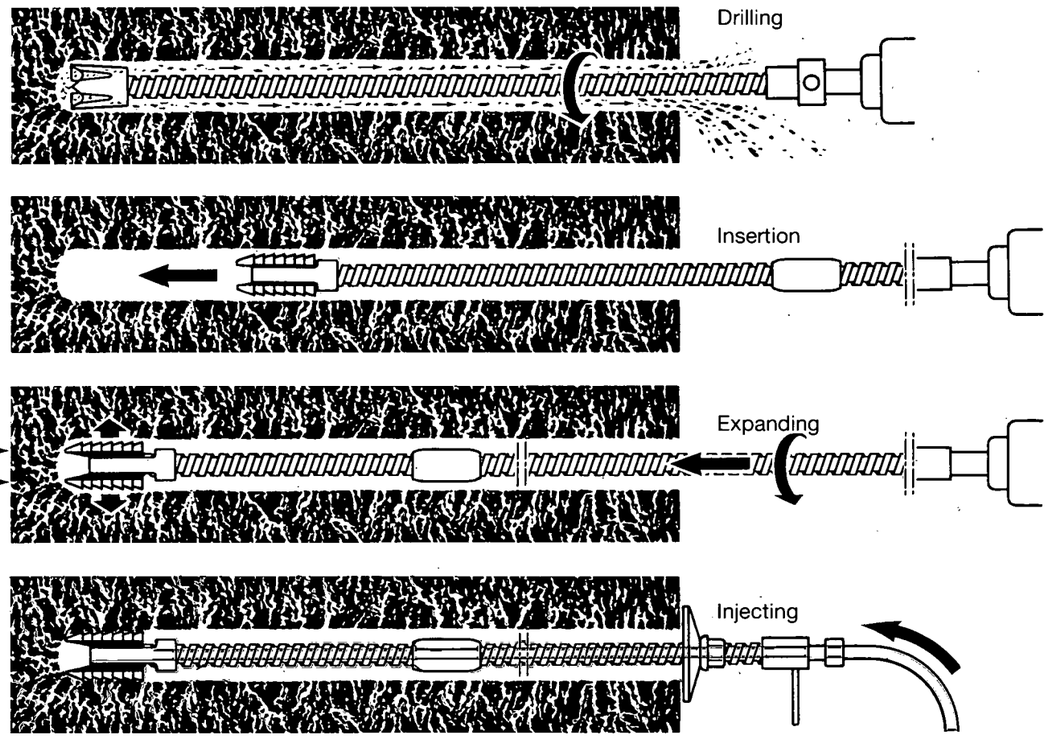
ISCHEBECK
TITAN Rock Bolts
for tunnel construction

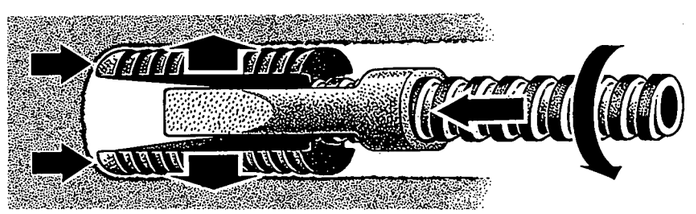
TITAN Rock Bolt with expansion shell

In certain situations with solid rock, or intrusion of water, it is necessary to load the TITAN Rock Bolts immediately. In such cases the expansion shell fixed onto the TITAN Rock Bolt is inserted into the hole and rotation effects a parallel expansion of the shells.

For corrosion protection and for sealing off the intruding water the hollow TITAN rock bolt is injected with grout.







Expansion shell for TITAN 30/11 and 30/16

area of contact 60 cm², 2x120°

permissible load 150 kN depending on type of rock e.g. rock with 35 MPA strength: 100 kN SWL

weight 0,8 kg

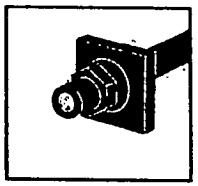
type 42
for drill hole Ø 42 upto 52 mm

type 46
for drill hole Ø 46 upto 56 mm

Conversions:
1 m ~ 40" 1" ~ 25,4 mm 1 cm² ~ 0,155 in² 1 kN ~ 225 lbs – 1 MPa/1 Bar/1 N/mm² ~ 142,3 lbs/in² – 1 kN/n² ~ 20,49 lb/ft² 1 kg ~ 2,25 lbs – 1 Nm ~ 0,72 lb ft

ISCHEBECK®
TITAN

Injection Anchors
Technical Data Sheet
for Rock Bolts, Soil Nails, Piles + Anchors



January 01

Anchor /Pile type	TITAN 30/16	TITAN 30/14	TITAN 30/11	TITAN 40/20	TITAN 40/16	TITAN 52/26	TITAN 73/53	TITAN 73/56	TITAN 103/78	TITAN 103/51	NEW 130/60
Nominal outside diam.	30 mm	30 mm	30 mm	40 mm	40 mm	52 mm	73 mm	73 mm	103 mm	103 mm	130mm
Nominal Inside diam.	16 mm	14 mm	11 mm	20 mm	16 mm	26 mm	53 mm	56 mm	78 mm	51 mm	60mm
Ulitmade load	220 kN	260 kN	320 kN	539 kN	660 kN	929 kN	1160 kN	1194 kN	1950 kN	3460 kN	6,000kN
Yield	180 kN	220 kN	260 kN	430 kN	525 kN	730 kN	970 kN	785 kN	1570 kN	2750 kN	5250kN
Yield stress T 0,2	470 N/mm²	610 N/mm²	580 N/mm²	590 N/mm²	590 N/mm²	550 N/mm²	590 N/mm²	550 N/mm²	500 N/mm²	500 N/mm²	550N/mm2
Cross section (A)	382 mm²	395 mm²	446 mm²	726 mm²	879 mm²	1337 mm²	1631 mm²	1414 mm²	3146 mm²	5501 mm²	9540mm2
Weight	3,0 kg/m	3,1 kg/m	3,5 kg/m	5,6 kg/m	6,9 kg/m	10,5 kg/m	12,8 kg/m	11,1 kg/m	24,7 kg/m	43,4 kg/m	145kg/m
thread left hand/ right hand	left	left	left	left	left	right	right	right	right	right	right
lengths	3, 4 m	3, 4 m	2, 3, 4 m	3 m	3 m	3 m	3 m	6,25 m	3 m	3 m	3 m

DVS ZERT

The allowable shear force is determined by the formula:

$$Q_{allow.} = \frac{T_{0,2} * A}{1,75 * \sqrt{3}}$$

E. & O.E.
subject to change without notice

qualified to ISO 9001 standard

THE HIGHWAYS AGENCY

THE SCOTTISH OFFICE DEVELOPMENT DEPARTMENT

THE WELSH OFFICE
Y SWYDDFA GYMREIG

THE DEPARTMENT OF THE ENVIRONMENT FOR NORTHERN IRELAND

Use of Rock Bolts

Summary: This Advice Note covers the design, construction and testing of rock bolts. Some information provided is also applicable to similar ground support systems as rock dowels and cable bolts.

1. INTRODUCTION

Scope

1.1.1 This Advice Note covers the design, construction and testing of rock bolts. Some of the information provided is also applicable to similar ground support systems such as rock dowels and cable bolts. It is intended to give the reader an introduction to the potential uses and benefits of this technique for ground support. This document does not cover the design of structures supported by rock bolts.

1.1.2 The British Standard Code of Practice for ground anchorages (BS 8081: 1989) provides comprehensive information on the design, construction and testing of anchorage systems. BD 71 (DMRB 2.1.6) covers the use of ground anchorages for highway works. The range of application of each of these documents excludes rock bolts but they all state that some of the information they provide may be applicable to particular elements of the design, construction and testing of rock bolts. Indeed BS 8081: 1989 has sections that cover the design and use of rock bolts within the overall context of ground anchorage systems.

Equivalence

1.2.1 The construction of rock bolts will normally be carried out under contracts incorporating the Specification for Highway Works (MCHW Volume 1). In such cases, products conforming to equivalent standards of technical specifications of other member states of the European Economic Area, and tests undertaken in other states of the European Economic Area will be acceptable in accordance with the 104 and 105 series of clauses of that specification. Any contract not containing these clauses must contain suitable clauses of mutual recognition having the same effect regarding which advice should be sought.

Rock bolts

1.3.1 A rock bolt is a short, low capacity reinforcement comprising a bar (or tube) fixed into rock and tensioned to a predetermined load. Some of the components of a rock bolt are defined in Figure 1.1. Rock bolts are usually less than 6m long and rarely longer than 10m. Their working load is typically between 150 and 200kN and they would normally be formed from high yield steel bars with diameters up to 32mm. However, but unusually, working loads of up to 300kN may be specified; typically these would be formed from high yield steel bars having diameters up to 40mm.

1.3.2 The types of rock bolt commonly used for civil engineering works include:

(i) Mechanical bolts - typically these have a wedge shaped shell assembly which, when expanded, anchors them into the drillhole.
(ii) Cement grouted bolts - typically these are formed by inserting the bar into a drillhole filled with grout.
(iii) Two-speed resin bonded bolts - with these the bar is fixed (and then stressed) within a fast setting resin at the distal end and subsequently bonded along the remainder of its length by a slower setting resin.

Typical arrangements of these types are shown in Figures 1.2, 1.3 and 1.4 respectively.

1.3.3 Rock bolts are used widely to improve the stability and load bearing characteristics of a rock mass. Often they are used to stabilise relatively small blocks of rocks in cuttings, slopes and underground excavations such as tunnels, caverns and mines. They can be used on their own or in conjunction with other support systems such as ground anchorages.

1.3.4 The proximal end of the bar may be threaded so that a nut and faceplate can be attached; the plate may provide local support to the rock surface and allow the attachment of mesh reinforcement which may be required for a shotcrete finish.

Rock dowels

1.4.1 A rock dowel comprises a bar which is inserted in a drillhole and fixed along its entire length. Movement of the rock surrounding the drillhole is relied upon to induce tension in the dowel and thereby strengthen the mass as a whole.

Cable bolts

1.5.1 Cable bolts utilise bundles of steel wires or fibreglass rods to form a fixed anchorage at depth. The inherent flexibility of cable bolts allows long unjointed bolts to be installed where there are cramped working conditions or where access is difficult.

Durability

1.6.1 BD 71 (DMRB 2.1.6) specifies that permanent ground anchorages must be provided with a double corrosion protection system sufficient to provide a service life of 120 years; such a system requires the

provision of two physical barriers to protect the steel tendon from corrosion. Details of such systems are given in BD 71 (DMRB 2.1.6) and BS 8081: 1989. Rock bolts are not provided with a similar standard of protection as given to ground anchorages because;

(i) rock bolts are formed from high yield or mild steels rather than the high tensile prestressing grades of steel that are commonly used for ground anchorages; the latter are more susceptible to stress corrosion and hydrogen embrittlement,

(ii) rock bolts provide local support at a multitude of points, whereas ground anchorages support much higher loads at wider spacings, and thus the failure of a bolt is much less likely to lead to the catastrophic collapse of the supported structure.

1.6.2 Rock bolts in new permanent structures shall be designed for a service life of 120 years but in structural maintenance applications, slope stabilisation and temporary works the service life should be compatible with the needs of those works. Corrosion protection should take account of the aggressivity of the ground and groundwater, the required service life and the consequences of failure.

Definitions

1.7.1 The following definitions apply to common terms used in this Advice Note; other terms are defined as they arise or in the references quoted. Many of the component parts of a rock bolt are shown in Figures 1.1 to 1.4.

1.7.2 *Rock bolt* is a short, low capacity reinforcement comprising a bar fixed into rock and subsequently tensioned to a predetermined load.

1.7.3 The *Bolt head* usually comprises a faceplate, nut and washer: a cap to the nut may also be included. It transmits the load from the tendon to the rock face or structure requiring support.

1.7.4 *Distal* – the end situated furthest from the bolt head.

1.7.5 *Proximal* – the end situated nearest to the bolt head.

1.7.6 The *Tendon*, or *shank*, is that part of the rock bolt that transmits the tensile load from the anchor to the bolt head.

1.7.7 The *Design anchor length* is the length over which the tensile load is designed to be transmitted to the surrounding ground.

1.7.8 The *Free length* is the distance between the proximal end of the design anchor length and the bolt head.

1.7.9 The *Tendon bond length* is the length of tendon that transmits the applied tensile load to the surrounding grout.

1.7.10 The *Free tendon length* is the length of tendon that is decoupled from the surrounding grout.

1.7.11 *Primary grout* is a thin fluid mortar placed or injected prior to the stressing of the bolt.

1.7.12 *Secondary grout* is a thin fluid mortar injected following the stressing of the bolt.

1.7.13 *Debonding* is the breakdown of bond at an interface.

1.7.14 *Decoupling* is the separation of components to provide, ideally, a frictionless interface; for example the separation of the free tendon length from the secondary grout by a greased sheath.

1.7.15 The *Proof load* is the maximum pull out load to which a bolt is subjected during stressing.

1.7.16 The *In-service load* is that load specified to be carried by a bolt throughout its service life.

1.7.17 The *Faceplate* is usually a flat steel plate that distributes the load from the rock bolt to the rock face or structure requiring support.

1.7.18 A *Cable bolt* is a bolt comprising a number of steel wires or fibreglass rods formed into a strand or cable.

1.7.19 A *Rock dowel* is a short, low capacity reinforcement comprising a bar (usually of steel), which is bonded by grouting over its full length at installation; it is not tensioned to a predetermined load.

Implementation

1.8.1 This Advice Note should be used forthwith on all future schemes for the construction, improvement and maintenance of trunk roads, including motorways. It shall also apply to schemes currently in preparation provided that, in the opinion of the Overseeing Organisation, this would not result in significant additional expense or delay progress. Design Organisations shall confirm its application to particular schemes with the Overseeing Organisation.

3. TYPES OF ROCK BOLTS

Introduction

3.1.1 Because they are installed for similar purposes, there are inevitably similarities between rock bolts and other types of support devices, such as rock dowels, cable bolts and ground anchorages. Some of the information given in this chapter is relevant to dowels rather than bolts but has been included to provide a comprehensive coverage of the range of low capacity rock support methods.

3.1.2 Details of proprietary devices and materials are given in this Advice Note, but the presence or absence of information for a particular device or material should not be taken to imply that it is recommended or not recommended for use. Further details of the types and uses of rock bolts and similar devices have been provided by Hoek and Brown (1980), by Hobst and Zajic (1983) and by Stillborg (1994).

Types of anchor

3.2.1 Rock bolts and dowels can be divided into three broad categories, according to how they are anchored into the rock mass.

(i) Mechanical - where the load is transferred to the rock through some form of mechanical device. Typically this is achieved through the use of expanding wedge systems or deformable steel tubes placed in intimate contact with the sides of the drillhole.

(ii) Cement grouted - where a cementitious grout is used to anchor the bolt into the rock. Such grouts are usually pumpable, but systems based on the use of capsules have also been developed. Cementitious grouts are commonly used for secondary grouting works.

(iii) Resin bonded - typically these employ polyester resins to anchor the bolt into the rock, but epoxy resins have also been used. In most cases, for convenience, the grout is supplied in pre-packed sausage-like capsules which contain the resin and hardener in separate compartments (Exchem Mining & Construction Ltd). The action of rotating the tendon during installation ruptures the capsules and mixes their contents. Resinous grouts have been used in pumped or poured forms but these are less common.

3.2.2 Mechanical anchors

(i) Expansion shell anchor
With an expansion shell anchor a wedge attached to the shank is pulled into a conical shell forcing it to expand against the walls of the drillhole; a typical arrangement is shown in Figure 3.1.
This type of bolt can be tensioned immediately after installation and grouted at a later stage when short-term movements have ceased. The expansion shell anchor has a proven track record in competent rocks where relatively high bolt loads can be sustained but systems have been developed for use in soft rocks by increasing the surface area of contact through an increase in the length or diameter of the shells or by the use of coupled assemblies. A range of expansion shell systems is shown in Figure 3.2.
Often such bolts are used as a permanent support and in such cases secondary grouting would be employed to provide the tendon with some protection against corrosion. Various means have been developed to achieve this, but typically a rubber bung is inserted in the collar of the drillhole to centralise the bolt and act as a seal against grout leakage. Alternatively, a rapid set mortar can be used to seal the collar - and often in such cases the mortar is extended to bed down the faceplate. Grout can be injected into the drillhole by various arrangements. For upward facing holes, the grout is injected into the collar end and the return pipe is extended to the base of the hole; grout injection is stopped when all the air has been displaced and grout flows from the return tube. For downward facing holes, grout is pumped to its base through a full-length injection pipe and exits at its collar. The shank of the bolt can be formed from a tube, as in the 'Titan' injection anchor (Ischebeck Titan Ltd), which makes it far easier to inject the secondary grout. In upward facing drillholes the centre bore acts as the air bleed and grout relief vent, whereas in downwardly inclined holes it acts as the grout injection tube. Details of typical arrangements are shown in Figure 3.1.
Skilled workmanship and close supervision are required to install expansion shell systems correctly. It is essential that the size of the expansion shell anchor is suitable for the diameter of the drillhole.

2. USES OF ROCK BOLTS

Underground excavations

2.1.1 Rock bolts are installed:

(i) to support discrete wedges or blocks of rock that would otherwise be free to fall or slide;

(ii) to reinforce the crown or sidewalls of a tunnel:

(iii) in older designs rock bolts were used as part of temporary support, but more recently as part of the permanent support system

Typical support schemes are shown schematically in Figures 2.1 to 2.4 and in detail in Figure 2.5.

Rock excavations, slopes and faces

2.2.1 For highway works, rock bolts are predominantly used to stabilise relatively small instabilities. Rock bolts can give support to discrete unstable blocks bounded by discontinuities of various types. Where there is widespread instability a gridage of rock bolts has been used to improve the overall integrity and stability of the rock mass, sometimes in combination with netting, or where bolts/dowels (and cables) have been used to hold rock fall protection (ie at the crest and toe). Common situations are shown in Figure 2.6. Future usage could be envisaged in areas of maintenance and improvement schemes (ie rock slope protection)

A typical stabilisation scheme for a highway cutting is shown in Figure 2.7. As shown here an integrated approach is commonly used in such works combining ground anchorages and rock bolts with small-scale buttressing and dental concrete.

Other applications

2.3.1 Rock bolts have been used to restrain light structures, such as gantry signs, which are subject to overturning or tension forces.

2.3.2 Rock bolts have also been used to strengthen or repair earth retaining walls, see for example Figure 3.12.

e great advantages of resin-based systems are that y are simple to use and they set relatively quickly which maintains a rapid cycle time in a construction sequence where the cost of the material may be a relatively inexpensive part of the process. Depending upon the quality of the rock, this type of bolt can mobilise high lock-off loads. With appropriate setting times, a one-shot installation can produce a fully grouted and tensioned rock bolt, and such bolts are widely used for permanent works.

3.2.5 Cable bolts

Cable bolts have been formed from seven-wire steel prestressing strand and also from bundles of individual glass fibre rods. With the former, a single 12.7 or 15.2mm steel strand having a breaking load of between 200 and 300kN is commonly used. The individual wires ıe strand are unwound from around the king-wire u bushed ('bird-caged') over the load transfer length i... a series of nodes and antinodes, as shown in Figure 3.9. Fibreglass rods are typically 6mm in diameter and 6 to 12 of these are formed into a bundle: the bundle is usually fabricated on suitable spacers to form a node/ antinode configuration similar to that used for steel strands.
Cable bolts are usually fixed in place with cementitious grouts, but pumpable resinous grouts have also been used. The flexibility of these types of bolt allows them to be used in long unjointed lengths in areas of restricted access.

Types of tendon

3.3.1 Steel bars

Steel bars are by far the commonest form of tendon used f ɔck bolts. In principle any suitable steel may be ut ed but, because of the potential loss in section due to corrosion, it is uncommon for bars of less than 20mm in diameter to be used, particularly in permanent works. Details of the type, size and yield strengths of steels that have been used for rock bolts in the UK are presented in Table 3.1.

(i) High yield steel
Currently in the UK, tendons are most commonly formed from high yield steels (to BS 4449: 1997), which have a characteristic yield strength of 460N/mm². The characteristic rupture and yield strength for a range of Grade 460 bars are given in Table 3.2.
The bar must be threaded at the proximal end to allow tensioning of the bolt and for a nut and faceplate to be attached. The distal end may be threaded for attaching mechanical expansion shells or for coupling and extending the bars. Such threads are usually formed by machining the ribs off the end of the bar and machine-cutting the thread. This removes material and therefore reduces the allowable design strength of the bolt. Table 3.3 gives details of the characteristic rupture and yield strengths for a range of standard cut thread-forms used with Grade 460 bars. Alternatively, rolled threads can be provided which, because they do not remove material, retain the full strength of the bar. Such threads can be formed on a bar after machining off the ribs, however a coarse thread can be rolled directly onto a ribbed bar to provide a thread as strong as the parent bar. A common and convenient alternative to rolled or cut threads is to form a coarse continuous thread-like configuration onto the surface of the deformed bar during the rolling process. Such bars would have characteristic yield and ultimate strengths of 500N/mm² and 550 to 600N/mm² respectively. Examples of this form of bar are Dywidag Gewi-Steel (Dywidag-Systems International Ltd) and Macalloy Mac500 (McCalls Special Products Ltd): data for these products are given in Tables 3.4 and 3.5 respectively. Couplers, end nuts and fittings are available for all the various forms of thread.

(ii) Mild steel
Mild steel bars are rarely used for rock bolts mainly because they are more expensive per kN of load carried than high yield bars. In addition, mild steel bars are formed with a smooth rather than a deformed surface and hence generate a lower bond stress between the tendon and any surrounding grout. However, for reference purposes, the characteristic rupture and yield strengths for a range of cut and rolled threaded bars are provided in Table 3.6.

(iii) Stainless steel
Austenitic stainless steel bars (Grade 302, 304 or 316 to BS 970: various parts and dates or BS 6744: 1986), with diameters of between 16 and 40mm have been used for rock bolts. Cut or rolled threads can be provided to such bars. The characteristic rupture and yield strengths for a range of products are given in Table 3.7.

(iv) High tensile steel
Because they require protection against corrosion, prestressing quality high tensile steel bars are not commonly used for rock bolts particularly for permanent works. Furthermore, for the majority of diameters available, the bars are over-strong for most rock bolting applications.

hapter 3
/pes of Rock Bolts

e used, and these may be ribbed to increase strength. A bbed plate deforms as the load in the bolt reaches a ertain level and this provides some warning of verloading. Faceplates used in conjunction with orrosion protected rock bolts often have protection pigot tubes attached, these are similar to those lescribed in BS 8081: 1989 for ground anchorages. Where the tendon is not perpendicular to the faceplate, he load may be transferred uniformly to the plate hrough a hemispherical nut or washer bedded in a suitable tapered seating; alternatively a pair of bevelled washers can be used. Where the load to the rock bolt is to be applied by a torque wrench, washers are usually hat ed and lubricated to reduce friction. Where a bolt is t....oned by an hydraulic jack, usually a purpose made foot is attached to the jack so that the force acts directly through the washer system thereby avoiding eccentric loading between the jack and faceplate. For permanent installations, consideration should be given to protecting the thread and nut from damage and corrosion by a cap assembly or by a cover of structural grade concrete. When used, a cap should be filled with approved grease or other corrosion protection compound.

3.4.2 Centralisers

Centralisers are attached to the tendon to ensure correct alignment and a minimum cover of grout.

3.4.3 Grouts

(Cementitious grouts would usually be formed from one of the following;
a) Ordinary Portland cement to BS 12: 1996
b) Rapid hardening cement to BS 12: 1996
c) Portland blast furnace cement to BS 1370: 1979
d) Low heat Portland cement to BS 1370: 1979
e) Sulphate resisting Portland cement to BS 4027: 1996
f) Low heat Portland blast furnace cement to BS 4246: 1996
Cement used in grout capsules should comply with BS 12: 1996 or BS 915: 1983.

(ii) Epoxy and polyester resins in pumpable, pourable or capsule form are commonly used for rock bolting: such resins should be designed and recommended for this application. If appropriate, to suit the conditions of the particular application, the selection of material performance criteria should be established in conjunction with the manufacturer. Laboratory and field tests should be undertaken, or the results of previous tests should be available, to verify mix times, setting times and pull out capacity.

Corrosion protection

3.5.1 For permanent works, or where bolts are installed in a corrosive environment, the rock bolt (including the head) should be protected from corrosion. The degree and type of protection depends upon the design life of the bolting system, the corrosivity of the environment, and the severity of the consequences of failure. Means of assessing the aggressivity of a site are given for ground anchorages in BD 71 (DMRB 2.1.6), and for reinforced soils in BS 8006: 1995 as implemented through BD 70 (DMRB 2.1.5). In these, aggressivity is assessed by allocating weighted values to a range of variables and a similar system for rock bolts is provided in Table 3.12. This gives a general guide to aggressivity but it is important to understand the influence of individual factors and their affect on the specific installation. The corrosion of rock bolts has been discussed by Baxter (1997) and Franzén (1997).

3.5.2 Rock bolts are often considered to need a lower level of corrosion protection than ground anchorages for the following reasons.

(i) Most rock bolts for permanent works are required to be fully bonded after stressing. This is achieved either by the injection of a secondary grout to the free length soon after the bolt has been stressed, or by the use of a two-speed resin system.

(ii) The tendons of ground anchorages are usually formed from high tensile steels which are far more susceptible to stress corrosion cracking than the lower grades of steel more commonly used for rock bolts.

(iii) Rock bolts carry much lower individual loads than ground anchorages, and usually act in consort with other measures, such as shotcreting, to provide support. Thus the failure of a bolt would be far less significant to the overall support system than would the failure of a ground anchorage.

(iv) The loss of part of a bolt by corrosion may not lead to the catastrophic detensioning of the entire member.

Despite the foregoing it is important to remember that rock bolts are load carrying tensile members installed into natural ground which is inherently heterogeneous. Furthermore, a bolt may not always be installed entirely in accordance with the specification. Thus, for all sites,

ıe installation process and the corrosivity of the ground within which the bolts are installed must be assessed to determine the appropriate corrosion protection measures.

3.5.3 Details of various corrosion protection measures are given below.

(i) Sacrificial thickness

The specification of sacrificial thickness of steel for reinforced earth and soil nailing applications are covered by BS 8006: 1995 as implemented through BD 70 (DMRB 2.1.5). The corrosion allowances for a particular design life vary according to the aggressivity of the ground with the over-riding proviso that unprotected steel should not be used in highly aggressive conditions for permanent works. Such allowances may be adapted for rock bolting works. It should be noted that the sacrificial thickness (t) is applied to each exposed surface; thus the diameter of a bar is increased by $2t$.

At present, there is no way of predicting corrosion rates to a comfortable level of confidence. Because of this BS 8081: 1989 recommended that, as a general rule, permanent ground anchorages should be protected from corrosion but it proposed that a secondary grout cover may provide sufficient protection to low capacity permanent rock bolts used solely as secondary reinforcement.

Water flow in rock masses, and the corresponding transport of potentially corrosive fluids, is predominantly through fissures. Thus the local effect of water flow upon a particular bolt cannot be predicted well. Therefore it is recommended that permanent rock bolts should not be used without some form of corrosion protection and, where the failure of a bolt could lead to a significant risk to public safety, a sacrificial thickness of material should not be relied upon to provide longevity.

(ii) Secondary grouted annulus

Secondary grouting can be applied to various types of rock bolts. Where there is a risk that the failure of a bolt would have serious consequences it is not recommended that a cement grout annulus, by itself, be deemed adequate protection for the most aggressive ground conditions, or in the most demanding of work conditions. The execution of the grouting operations should ensure that an adequate cover of grout is provided along the full length of a bolt: the inflow of water into a drillhole can reduce severely the effectiveness of grouting operations, see for example Azir et al (1992).

For upward facing holes, grout is usually injected at the mouth of the hole and air expelled through a bleed tube installed to the distal end of the drillhole. For downward facing holes grout can be injected to the bottom of the hole, either through a small inlet tube or through a central hole within the bar. Alternatively a temporary oversized tube can be placed over the shank to the distal end of the free length; this tube is withdrawn as the secondary grout is injected. The bolt is then tensioned, or retensioned, before the secondary grout hardens. However secondary grouting techniques are time-consuming compared with a single pass two-pack resin capsule system.

The effectiveness of the method of grouting must be assessed when the drillholes are inclined at low angles to the horizontal (i.e. about ±10°). At such low angles, bleed or small losses of grout can leave parts of the bolt ungrouted.

Attention must also be given to the centring of the bolt within the drillhole. The problem with centralisers is that they restrict the available bore which can lead to the formation of grout blockages or air pockets, particularly with smaller diameter holes. Water flow within the rock mass is predominantly through fissures and the permeability of the intact rock is often relatively low compared to that of the rock mass. An appraisal of the properties of the rock mass and the proposed grout may demonstrate that the filling of the annulus with a dense homogeneous grout is of prime importance, and the use of centralisers could be counter-productive to this aim.

Where resin grouted rock bolts are fixed in place using a capsule system, the resins not only bond the free length of the bolt but effectively encase it within an inert medium. Such systems are commonly employed for permanent rock bolts, particularly where they form part of the secondary support system. For example they were used extensively at the Pen-y-Clip and Penmaenbach road tunnels on the A55 North Wales coast road: details have been provided by Littlejohn et al (1987) and Xu et al (1995).

(iii) Coatings

The most usual coating to the shank of a rock bolt is zinc applied through a hot dip process. In addition to providing a physical barrier, zinc will corrode preferentially to the steel substrate. With

minor mechanical damage, such as a scratch, the zinc adjacent to the breach will reduce the rate of corrosion of the underlying steel, and in some cases the resulting corrosion products will inhibit further corrosion at the breach. The rates of corrosion of a galvanised coating can vary markedly with both time and position, and currently the lifetime of a coating cannot be determined with a high degree of confidence. Thus it is not recommended that galvanising be used as the sole or primary corrosion protection measure where long term durability is a prime consideration. (The density of the galvanising can be assumed to be equivalent to 7.15g/m^2 per micron of coating thickness).

Epoxy resins are inert and provide a physical protection to the steel surface. The characteristics and use of these proprietary coatings should be defined in an approval certificate. Most of the proprietary systems that have been used involve the factory application of fusion bonded coatings. With these a coating of epoxy powder is deposited onto the pre-heated bars and allowed to cure in a heat catalysed reaction. Such coatings can be applied to galvanised bars, and the 'Combi-coat' (Ischebeck Titan Ltd) is claimed to enhance the service life of a galvanised bar by a factor of about 2 to 3.

The possibility of coatings being damaged during installation must be considered and site procedures should ensure that the extent of any such damage is minimised. A damage factor could be assumed in design which, effectively, would lead to the installation of additional rock bolts over and above that required to maintain stability. However this may not be applicable to all sites and applications, and the selection of an appropriate damage factor is problematic.

(iv) External sheaths

Details of externally protected rock bolt assemblies that have been used in practice are given in Figures 3.13 and 3.14. Typically, these require centring the bar within a corrugated plastic sleeve which is then filled with a cementitious grout, i.e. in a similar manner to ground anchorages. Indeed such rock bolts are often termed double corrosion protected, but note that neither BS 8081: 1989 nor BD 71 (DMRB 2.1.6) recognise grout as being an effective corrosion protection barrier.

There are important differences between an externally protected rock bolt and a double corrosion protected ground anchorage. Firstly, unlike ground anchorages, most bolts are not debonded over their free length: with permanent bolts the free length is grouted following its tensioning. Secondly, the protection to the bolt does not necessarily extend over the complete bar and head assembly. For example as shown in Figure 3.13, the base of the bolt is exposed: bolts fixed by resin capsules require some form of puncturing, stirring and mixing device at their distal end. In other cases the primary bond length is left exposed with the external sheath covering only the free length. In addition, it is not uncommon for the protection provided to the outer head of permanent ground anchorages to be omitted for rock bolts. For example where the bolts are incorporated into a shotcrete lining, the lining may be deemed to obviate the need for protection to the cap. This accords with the view that the bolts and the shotcrete are part of an integrated support system.

Figure 3.14 shows the arrangement of a double corrosion protected rock bolt which meets the requirements of BS 8081: 1989 except that the arrangement at the head is not as complex because the bolt is fully bonded after tensioning and is incorporated into shotcrete facing. If the head of the rock bolt is to be left exposed, the head assembly should be capped and protected in a similar manner to the requirements of BD 71 (DMRB 2.1.6).

Figure 3.15 shows details of a rock bolt where a heat-shrink sleeve has been fitted to the free length of a coarse threaded bar.

External sheaths have been used in combination with hot dip galvanised and epoxy coated bolts, see for example Smith (1994).

(v) Corrosion resistant bars and fittings

Glass fibre reinforced composites and stainless steels have been used to form the tendons and other components of rock bolts. The use of either of these materials bears a cost premium and so their use is usually only justified where longevity is a particular concern. It should not be assumed that such materials will not deteriorate over time, but in most situations they are essentially durable. In many cases they are simpler to install than steel bars that require some form of protection.

ISCHEBECK®

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Dec. 1993

INFO 02-E-93

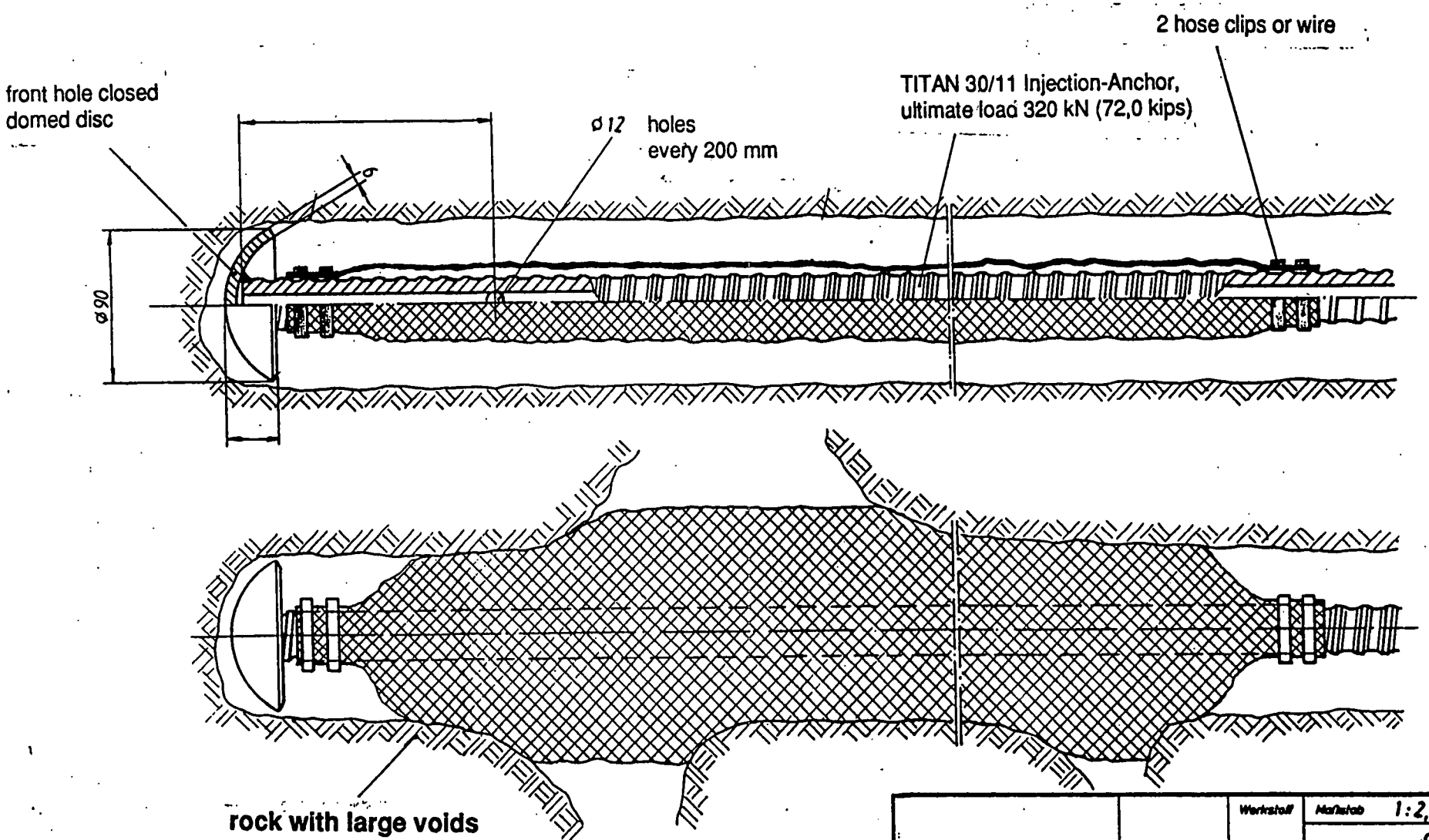
TITAN GEOTEXTILE SOCK WITH REINFORCED SEAM IDEAL FOR VOIDS ANCHORS IN ROCK WITH LARGE VOIDS PREVENTS EXCESSIVE WASTE OF GROUT

PROCEDURE OF INSTALLATION (see drawing on reverse):

1. Drill the hole with a DTH hammer
2. Make notes at what depth the voids occur
3. Close front hole of TITAN anchor and weld-on domed plate
4. Drill through holes every 200 mm through the TITAN anchor in the area of the anchor which will be at the position of the void in the rock which needs to be sealed
5. The length of sock is dependant on the size of the void and the rock friction strength
6. Place the geotextile sock over the anchor
7. Fix and tighten the ends of the geotextile sock by wire or hose clips
8. Insert into the predrilled hole, if required couple and add further lengths of TITAN anchors
9. Pump grout through the inside of our anchor with 8 to 12 bar pressure and fill and expand the sock. Effected by this pressure grouting, the grout mixture (water and cement) is dehydrated and the water is pressed out of the fine mesh leaving the cement to cure instantly.
   If a fully grouted bolt should be required, a left in place grout hose (passing alongside the sock) will fill the bottom behind the sock. The remaining grout can be filled from the top after the sock has been expanded.

prices:	**on request**
packing unit:	25 meters
minmimum quantity per size:	100 meters

further sizes upon request



			Werkstoff	Maßstab 1:2,5
				8-305/01-00
	92	Datum	Name	TITAN GEOTEXTILE SOCK VOID SEALING
	Bearb.	1.7.		
	Gepr.			
	Norm			

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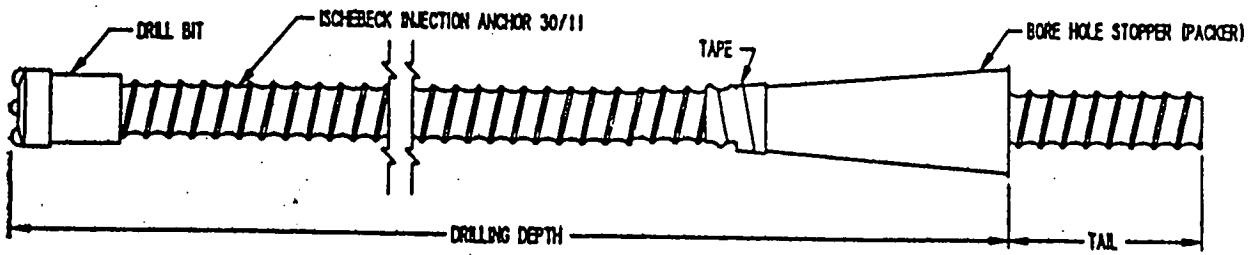
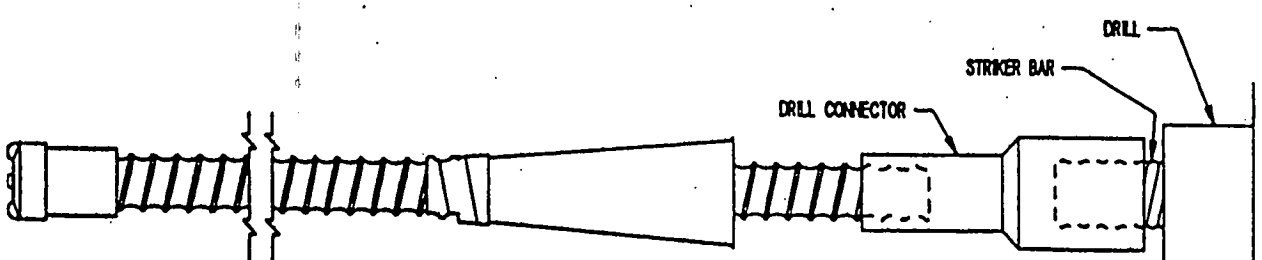
5828 Ennepetal 13

OVERHEAD HOLLOW ROCK BOLT INSTALLATION

PREPARATION OF ANCHOR

1) SCREW DRILL BIT ONTO ONE END OF BAR.
2) MEASURE DESIRED ANCHOR LENGTH AND MARK BAR.
3) SCREW BORE HOLE STOPPER ONTO BAR SO THAT LARGER DIA. END IS ON MARK.
4) TAPE FRONT OF BORE HOLE STOPPER SECURELY IN PLACE.



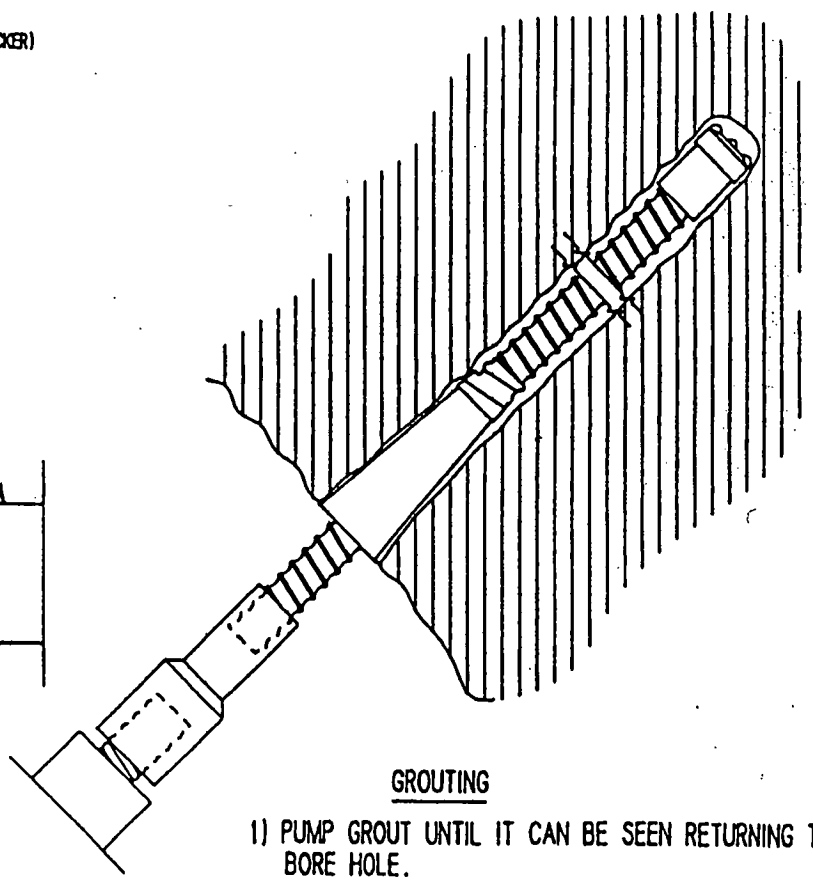


INSTALLING ANCHOR TO DRILL RIG

1) SCREW DRILL CONNECTOR TO STRIKER BAR.
2) SCREW ANCHOR TO DRILL CONNECTOR.

DRILLING THE ANCHOR

1) DRILL THE ANCHOR TO PROPER DEPTH USING AIR OR WATER FLUSHING AS SPECIFIED BY ENGINEER.
2) BORE HOLE STOPPER WILL JAM ITSELF INTO BORE HOLE TO CREATE GROUT PACKING.



GROUTING

1) PUMP GROUT UNTIL IT CAN BE SEEN RETURNING THROUGH BORE HOLE.

NOTE:
BORE HOLE STOPPER REQUIRES MIN. DIA. 1-5/16" AND MAX. DIA. 2-1/4" BORE HOLE.

E 1:3

05/10/93 CH-818

ISCHEBECK TITAN LIMITED
GEOTEXTILE GROUT SOCK SYSTEM

The Ischebeck Titan Grout Sock System allows anchorage in ground conditions where cavities or fissure would result in excess grout loss and poor grout bonding using conventional grouting techniques.

The system uses a tubular fabric sock made of a strong open weave nylon. It is robust enough to resist tearing against the drill hole but still allows grout to be forced through the material membrane in a controlled manner.

The sock is attached to the Ischebeck Titan hollow tendon at the surface end with a jubilee clip or tie wrap. The end of the sock is sealed in the same manner. This allows the sock to be inflated by pressure pumping a grout mix through the Ischebeck hollow bar. The sock then moulds itself into the voids or fissures creating a belling effect. Grout is also squeezed through the sock material forming a chemical bond.

Applications

- Ground Anchors in poor ground or broken/fissured rock
- Stiching Anchors or Tie Bolts for bridge arch repairs or strengthening
  Repairs to structurally sensitive buildings
  Repairs to structures where grout loss would be damaging to the environment eg. canal walls or harbour walls.

Sizes Available

The Ischebeck Titan Grout Sock is available is 80mm and 150mm diameters with other sizes available depending on quantities required.

Ischebeck Titan Tendon

Anchor/Pile Type	Unit		TITAN 30/16	TITAN 30/11	TITAN 40/16	TITAN 52/26
Nominal Outside Diameter	mm		30	30	40	52
Inside Diameter	mm		16	11	16	26
Ultimate Load	kN		220	320	660	929
Yield At Fracture	kN		180	260	525	730
Yield Stress $T_{0.2}$	N/mm^2		470	580	590	550
Cross Section (A)	mm^2		382	446	879	1337
Allow. Shear Force (Q)	kN		58	88	164	240
Allow. Shear Stress	N/mm^2		180	230	200	200
Material			Black	Black Combi Coat Inox	Black Combi Coat Inox	Black

ISCHEBECK TITAN LIMITED
Formwork & Falsework Systems
Trenching Systems - Injection Anchors

John Dean House,
Wellington Road,
Burton upon Trent,
Staffordshire. DE14 2TG

Telephone (01283) 515677
FAX (01283) 516126

Euro prices for Geotextile Sock installations

Consumables		
30/16 black hollow stem bar	€ 11.60	per metre
150mm dia sock	10.25	
80mm dia sock	8.53	
46mm dia carbide drill bit	38.78	each
42mm dia button bit	16.05	
55mm dia button bit	58.17	
75mm dia hardened clay bit	15.38	
200 x 200 x 8 washer plate	6.28	
Black spherical collar nut	7.35	
Plastic bore hole stopper	7.13	
Load indicator	26.30	
Black coupling	16.05	
Wedge disc	12.70	
35mm Eye Bolt	15.38	
Shackle M20 to 30/16	33.65	

Accessories		
S22 flushing head with integrated holder	€1,199.86	each
Spare seals for flushing head	39.89	

Larger bar prices on request

November 2001

DRAFT
prEN 14199

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

June 2001

ICS

English version

Execution of special geotechnical works - Micropiles

Ausführung von besonderen geotechnischen Arbeiten (Spezialtiefbau) - Pfähle mit kleinen Durchmessern (Minipfähle)

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 288.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard was established by CEN in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. prEN 14199:2001 E

Contents

Foreword

This document has been prepared by CEN /TC 288, "Execution of special Geotechnical Works".

This document is currently submitted to the CEN Enquiry.

This document has been prepared by the Working Group WG 8 of the Technical Committee CEN/TC 288 "Execution of special Geotechnical Works".

The general scope of TC 288 is the standardisation of the execution procedures for geotechnical works, including testing and control methods, and the required material properties. WG 8 has been charged with the subject area of micropiles.

The document has been prepared to stand along side ENV 1997-1. Clause 7 of this Standard covers design aspects of micropiles.

It has been drafted by a working group comprising delegates from 14 countries and is based on the review of national and international codes of practice.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this document: Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

1.1 This Standard establishes general principles for the execution of piles :

— which have a small diameter (smaller than 300 mm outside diameter for bored piles and smaller than 150 mm for displacement piles) ;

— and which can be typically installed by means of small rigs.

These piles are herein after referred as "micropiles".

1.2 Micropiles are structural members to transfer actions to the ground and may contain bearing elements to transfer loads and or to limit deformations. Their shaft and base resistance may be improved (mostly by grouting) and they may be constructed with (see Figure 1):

— uniform cross section (stralght shaft) ; or

— telescopically changing shaft dimensions ;

— shaft enlargements ; and/or

— base enlargement.

1.3 Other than practical considerations, there are no limitations regarding shaft or base enlargements, length, rake (definition of rake, see Figure 2) or slendemess ratio.

1.4 The provisions of the Standard apply to (see Figure 3) :

— single micropiles ;

— micropile groups ;

— micropile walls ;

— reticulated micropiles.

1.5 The micropiles which are the subject of this Standard can be installed into the ground using drilling, driving or a combination of these methods.

1.6 The material of micropiles covered by this Standard can be:

— steel, cast iron or other reinforcement materials ;

— grout, mortar or concrete ;

— a combination of above.

1.7 Mixed-in-place columns and timber piles are not included in this Standard. Columns constructed by jet grouting are covered by prEN 12716. Ground anchors are covered by EN1537. Nails used in soil reinforcement are covered by prEN WG 9/TC 288.

1.8 Micropiles are often used for working under restricted access and/or head room conditions and for the underpinning of existing structures.

1.9 Micropiles may be used for :

— foundations of new structures (particularly in very heterogeneous soil or rock formations) ;

— reinforcing or strengthening of existing structures to increase the capacity to transfer load to depth with acceptable load settlement characteristics ;

— reducing settlements and/or displacements ;

— forming a retaining wall ;

— reinforcing of soil to form a bearing and/or retaining structure ;

— improving slope stability ;

— securing against uplift ;

— other applications where micropile techniques are appropriate.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 196, *Methods of testing cement.*

ENV 197-1:1992, *Cement - Composition, specifications and conformity criteria – Part 1 : Common cements.* (cancel).

ENV 206:1997, *Concrete - Performance, production, placing and compliance criteria.*

EN 287-1:1992, *Approval testing of welders – Fusion welding – Part 1 : Steels.*

EN 288-1:1992, *Specification and qualification of welding procedures for metallic materials – Part 1 : General rules for fusion welding.*

EN 288-2:1992, *Specification and qualification of welding procedures for metallic materials – Part 2 : Welding procedure specifications for arc welding.*

EN 288-3:1992, *Specification and qualification of welding procedures for metallic materials – Part 3 : Welding procedure tests for the arc welding of steels.*

EN 445:1996, *Grout for prestressing tendons – Test methods.*

EN 499:1994, *Welding consumables - Covered electrodes for manual metal arc welding of non alloy and fine grain steels - Classification.*

EN 791, *Drill rigs – Safety.*

EN 996, *Piling equipment – Safety Requirements.*

prEN 1008, *Mixing water for concrete - Specification for sampling, testing and assessing the suitability of water, including wash water from recycling installations in the concrete industry, as mixing water for concrete*

EN 1536:1999, *Execution of special geotechnical work : Bored piles.*

EN 1537:1999, *Execution of special geotechnical work : Ground anchors.*

ENV 1991-1:1994, *Eurocode 1 : Basis of design and actions on structures – Part 1 : Basis of design.*

ENV 1992-1-1:1991, *Eurocode 2 : Design of concrete structures – Part 1-1 : General rules and rules for buildings.*

ENV 1993-1-1:1992, *Eurocode 3 : Design of steel structures – Part 1-1 : General rules and rules for buildings.*

ENV 1993-5:1997, *Eurocode 3 : Design of steel structures – Part 5 : Piling.*

ENV 1994-1-1:1992, *Eurocode 4 : Design of composite steel and concrete structures – Part 1-1 : General rules and rules for building.*

ENV 1997-1:1999, *Eurocode 7 : Geotechnical design – Part 1 : General rules.*

ENV 1997-2:1999, *Eurocode 7 : Geotechnical design assisted by testing – Part 2 : Laboratory testing.*

ENV 1997-3-1999, *Eurocode 7 : Geotechnical design assisted by testing – Part 3 : Design assisted by field testing.*

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

ENV 10080:1995, *Steels for reinforcement of concrete - Weldable ribbed reinforcing steels B500 – Technical delivery conditions for bars, coils and welded fabric.*

EN 10113-1:1993, *Hot-rolled products in weldable fine grain structural steels – Part 1 : General delivery conditions.*

EN 10113-2:1993, *Hot-rolled products in weldable fine grain structural steels - Part 2 : Delivery conditions for normalized rolled steels.*

EN 10113-3:1993, *Hot-rolled products in weldable fine grain structural steels - Part 3 : Delivery conditions for thermomechanically rolled steels.*

prEN 10138-4:2000, *Prestressing steels - Bars.*

prEN 10138-5:1991, *Prestressing steels – Quenched and tempered wire.*

EN 10149-1, *Hot rolled flat products made of high yield strength steels for cold forming – Part 1 : General delivery conditions.*

EN 10149-2, *Hot rolled flat products made of high yield strength steels for cold forming – Part 2 : Delivery conditions for thermomechanically rolled steels.*

EN 10149-3, *Hot rolled flat products made of high yield strength steels for cold forming – Part 3 : Delivery conditions for normalized or normalized rolled steels.*

EN 10210-1:1994, *Hot finished structural hollow sections of non-alloy and fine grain structural steels – Part 1 – Technical delivery requirements .*

EN 10210-2:1997, *Hot finished structural hollow sections of non-alloy and fine grain structural steels – Part 2 : Tolerances, dimensions and sectional properties.*

EN 10219-1:1997, *Cold formed welded structural hollow sections of non-alloy and fine grain steels – Part 1 : Technical delivery requirements.*

EN 10219-2:1997, *Cold formed welded structural hollow sections of non-alloy and fine grain steels – Part 2 : Tolerances, dimensions and sectional properties.*

EN 12699:1997, *Execution of special geotechnical work : Displacement piles.*

prEN 12716:1997, *Execution of special geotechnical work : Jet-grouting.*

prEN 12794:1997, *Precast concrete foundation piles.*

EN 24063:1993, *Welding, brazing, soldering and braze welding of metals – Nomenclature processes and reference numbers for symbolic representation on drawings.*

EN 25817:1997, *Arc welded joints in steels - Guidance on quality levels for imperfections* (ISO 5817:1992).

EN 29692:1992, *Metal-arc welding with covered electrode, gas-shielded metal-arc welding and gas welding - Joint preparation for steel* (ISO 9692:1992)

7.5.3 Starter bars or dowel bars for connection to a superstructure shall be in accordance with ENV 1992-1-1.

7.5.4 When steel reinforcement is considered as the bearing member of a micropile, the design shall be in accordance with ENV1993.

7.5.5 When steel reinforcement and mortar or concrete are considered as bearing members of the micropile, the design shall be in accordance with ENV1992 or ENV 1994.

7.5.6 The design value of bond strength between grout, mortar or concrete and the bearing elements of steel or cast iron in accordance with ENV 1994-1 (bars, tubes or sections) shall have been agreed before the commencement of the works.

7.5.7 Unless otherwise specified the bond strength between grout, mortar or concrete and the bearing element of steel or cast iron (bars, tubes or sections) shall be at least 400 kPa).

7.5.8 The grout, mortar or concrete cover, shall be specified in the design documents according to 7.7.

7.6 Couplers and nipples

7.6.1 Reduced section due to the thread shall be calculated on the base of the nominal diameter at the bottom thread (minimum section).

7.6.2 Couplers and nipples shall be dimensioned for all actions which can occur during installation.

7.7 Corrosion protection of steel elements.

7.7.1 Steel components of low strength steel (σ_e < 600 MPa) :

7.7.1.1 The protection against corrosion of steel elements placed in a micropile shall take into account :

— the aggressiveness of the environment (groundwater, soil, stray electric currents,etc.) ;

— the type of load (tension or compression) ; and

— the micropile type.

NOTE A corrosion protection may consist of :

— a minimum cover of grout, mortar or concrete ;

— a loss of steel thickness ;

— specific precautions.

7.7.1.2 Unless otherwise specified for micropiles situated in a low aggressive environment (in accordance to ENV 206) no specific precautions against corrosion shall be taken when the minimum cover exceeds the values given in Table 1.

Table 1 – Minimum cover for reinforcement of low strength steel for cast in place micropiles in a low aggressive environment

	Micropiles designed for working only in compression (in mm)	**Micropiles designed for working in tension and/or in bending** (in mm)
Grout	20	30
Mortar	35	40
Concrete	50	50

NOTE Choice of class of environmental aggressiveness should be done with a specific care (e.g. its evolution with time should be considered) and take into account the type of cover (grout, mortar or concrete).

7.7.1.3 For micropiles with a design life time of less than 2 years, the minimum cover may have 10 mm less than the value given in Table 1.

7.7.1.4 Values of the grout cover smaller than those given in Table 1 shall only be applied when the loss of steel thickness and possible debonding from the steel are considered in the design.

NOTE Guidance on corrosion rates are given in annex D.

7.7.1.5 If corrosion is taken into account as corrosion allowance, only effective cross section shall be utilized in dimensioning.

7.7.1.6 In some cases par. 7.7.1.4 may be applied to couplers only and not to the reinforcing elements.

7.7.1.7 The grout, mortar or concrete cover of reinforcement given in table 1, installed inside a permanent casing may be reduced by 10 mm from the internal face of the casing if the thickness of the permanent casing is at least 4 mm.

7.7.1.8 For micropiles in an aggressive environment (e.g. classes 5 in accordance with ENV 206) specific precautions shall be taken for example by :

— using special cement type ;

— a greater thickness of grout cover or special mix design ;

— considering an extra loss of steel thickness ;

— special corrosion protection as described in EN 1537 ;

— the use of an adequate chemical steel composition ;

— cathodic protection ;

— organic or inorganic coatings or treatment ;

— use of permanent casings or liners.

7.7.2 Steel components of high strength steel (σ_0 > 600 MPa) and pre stressing steel :

7.7.2.1 When steel components of high strength steel and pre stressing steel are used corrosion protection shall be in accordance with EN 1537.

7.7.3 Couplers

7.7.3.1 For couplers the same rules of corrosion protection shall be applied as for the other steel elements.

7.7.3.2 The corrosion protection of the couplers shall be compatible with corrosion protection provided to the reinforcing elements.

7.7.3.3 Particular care shall be given to the continuity of the corrosion protection at couplers.

7.8 Spacers and centralizers

7.8.1 The design of spacers and centralizers shall take into account the size of the hole, the weight of the reinforcement, the grout, mortar or concrete cover and the possible disturbance of soil during the insertion of the reinforcement.

7.8.2 Spacers and centralizers shall not impede grout, mortar or concrete flow.

7.9 Micropile enlargement

7.9.1 Where micropile enlargements are considered, the method of forming the enlargement and the bearing area and shaft perimeter to be used in the design shall be agreed.

NOTE Typical examples of enlargements are shown in Figure 4.

7.9.2 When redrives are used to form enlarged bases or enlarged shafts on cast in place micropiles, the method used to form the micropile and the nominal value of base and shaft perimeter to be used in the design shall be agreed before commencement of the work.

7.10 Connections to the superstructure.

7.10.1 Unless otherwise specified the connection between the micropile and the superstructure shall be designed for the micropile capacity.

7.10.2 For micropiles of reinforced mortar or concrete the connection shall be designed in accordance with ENV 1992-1-1.

7.10.3 For micropiles with bearing elements the selected method of load transfer between the bearing element and the superstructure shall be given in the project documentation.

7.10.4 The overlength of the reinforcement or bearing element shall be specified in the project documentation (see Figure 5).

7.11 Spacing of micropiles

7.11.1 The spacing of micropiles shall be considered in relation to micropile type, micropile diameter, length of micropile, the ground conditions, and their behaviour in groups.

7.11.2 The possible interference of one micropile with another during installation should be considered when determining micropile spacing, orientation and installation sequence.

7.12 Special requirements for micropiles installed through very soft and unstable soils

7.12.1 In unstable soils it can be necessary to provide a sacrificial lining or permanent casing to contain the fresh grout, mortar or concrete.

7.12.2 For micropiles installed through soil layers with characteristic undrained shear strength of less than 15 kPa buckling should be considered taking into account the geometrical construction tolerances.

— the type of reinforcement (cage, tube, bar) ;

— the condition of filling (dry or submerged condition).

8.6.4.4 The installation of the reinforcement or bearing element shall assure its alignment with the micropile axis and maintain the correct grout,mortar or concrete cover over its full length.

8.6.4.5 The temperature of the reinforcement or bearing element shall be higher than – 5 °C when installed.

8.7 Grout preparation

8.7.1 General

8.7.1.1 The grout preparation and the grouting procedure shall be carried out in such a way that the required design strength of the material is assured. For design of grout material see Clause 6.4.

8.7.2 Batching and mixing

8.7.2.1 Contamination of the grout and its constituents shall be avoided during storage, handling and delivery.

8.7.2.2 The proportioning of grout components shall be carried out with certified measuring devices with tolerances not exceeding 5 % and respecting the tolerances given by the suppliers.

8.7.2.3 Batching and/or mixing processes shall be controlled in accordance with par. 6.4.8.4.

8.7.2.4 Mixers shall be selected to ensure the homogenéity of the grout.

8.7.2.5 An intermediate holding tank should be located between the mixing tanks and the pump(s). The mix in the holding tank should be agitated to prevent segregation and/or premature setting.

8.7.3 Pumping and delivery

8.7.3.1 The grout pumps and injection systems shall be chosen in accordance with the intended injection technique.

8.7.3.2 The injection pressure should be measured as close to the point of placement as is practicable.

8.8 Grouting

8.8.1 General

8.8.1.1 The following grouting methods can be employed (see Figure 6) :

— filling up the borehole with grout.

— grouting under pressure :

  — single step through a temporary casing ;

  — single step through a bearing element ;

  — single step through tube-à-manchettes ;

  — multiple step through tube-à-manchettes ;

— grouting during driving.

NOTE Grouting meets one or more of the following functions :

— to create or improve the bond between the micropile shaft and the surrounding ground to allow the design shaft bearing capacity to be mobilised ;

— to protect the reinforcement against corrosion ;

— to improve the structural capacity of the micropile ;

— to strengthen and seal the ground immediately adjacent to the micropile in order to enhance the ground micropile capacity.

8.8.1.2 The method of grout placement shall be determined by the ground conditions, the job specifications (shaft and end bearing capacity) the type of grout and equipment used.

8.8.1.3 For friction bearing micropiles, high pressure multistage grouting may be used to increase the friction resistance by introducing further grout into the ground and raising the normal stresses at the ground/grout interface. This may be carried out before or after installation of the reinforcement.

8.8.2 Borehole testing and pregrouting

8.8.2.1 For micropiles installed into rock, borehole testing and pregrouting shall be performed when relevant and/or required by the specifications.

NOTE General information on borehole testing and pregrouting is given in informative annex E.

8.8.3 Filling up the hole with grout

8.8.3.1 The interval between the completion of the hole and the filling up of the hole with grout shall be kept as short as possible.

8.8.3.2 During grouting of the micropile measures shall be taken to ensure that the micropile length is fully grouted.

8.8.3.3 When filling up the hole with the tremie method or through the drill rods or reinforcement, the end of the tremie pipe or drill rods shall remain submerged in the grout and grouting shall continue until the consistency of the grout emerging is almost the same as that of the injected grout.

8.8.3.4 When filling up the hole, air and drilling fluids shall be able to escape to permit complete grout filling.

8.8.3.5 For drilled holes the remained cuttings shall be able to escape when filling the hole.

8.8.4 Grouting under pressure

8.8.4.1 General

8.8.4.1.1 The grouting pressure shall be specified in the project documentation or defined in the method statement.

8.8.4.1.2 Grouting under pressure should be stopped when a sudden drop down of the injection pressure is observed.

8.8.4.2 Single step grouting through a temporary casing

8.8.4.2.1 The reinforcement shall be placed before the temporary casing is extracted.

8.8.4.2.2 During extraction of the temporary casing the grout level within the casing shall be brought back up to ground level before the next length of casing is removed.

8.8.4.2.3 The injection pressure should be applied at least every 2 m during the extraction of the casing.

Annex D
(informative)

Guidance on corrosion rates

D.1 General

This annex gives guidance on the loss of thickness of steel bearing piles and steel sheet piling du to corrosion.

D.2 Bearing piles

Unless otherwise specified, for both serviceability and ultimate limit states the loss of thickness (in millimetres) die to corrosion of piles on the side in contact with soil, with or without groundwater, should be taken from Table D.1 and for piles in water should be taken from Table D.2, depending on the required design working life of the construction.

The loss of thickness due to atmospheric corrosion may be taken as (0,01) mm per year in normal atmospheres and as [0,02] mm per year in locations close to the sea.

D.3 Sheet piling

Unless otherwise specified, the loss of thickness for parts of sheet pile walls in contact with soil, with or without groundwater, should be taken from Table D.1, depending on the required design working life of the construction. Where sheet piles are in contact with soil on both sides, the corrosion rates apply to each side.

Unless otherwise specified, for both serviceability and ultimate limit states the loss of thickness for unprotected parts of sheet pile walls in contact with river or sea water should be taken from Table D.2, depending on the required design working life of the construction.

The loss of thickness due to atmospheric corrosion may be taken as (0.01) mm per year in normal atmospheres and as [0.02] mm per year in locations close to the sea.

NOTE The following effects have a major influence on the corrosion rates given in Tables D.1 and D.2 :

— whether the structure is above or below the groundwater table ;

— the variation of the level of the groundwater table ;

— the presence of oxygen.

Table D.1 – Loss of thickness (mm)] due to corrosion for piles and sheet piles in Soils, with or without groundwater

Required design working life	5 years	25 years	50 years	75 years	100 years
Undistributed natural soils (sand, silt, clay, schist, etc.)	0,00	0,30	0,60	0,90	1,20
Polluted natural soils and industrial grounds	0,15	0,75	1,50	2,25	3,00
Aggressive natural soils (swamp, marsh, peat, etc.)	0,20	1,00	1,75	2,50	3,25
Non-compacted and non-aggressive fills (clay, schist, sand, silt, etc.)	0,18	0,70	1,20	1,70	2,20
Non-compacted and aggressive fills (ashes, slag, etc.)	0,18	0,70	1,20	1,70	2,20

NOTE 1 Corrosion rates in compacted fills are lower than those in non-compacted ones. In compacted fills, the figures in the table should be divided by two.

NOTE 2 The value given are only for guidance. Local conditions should be considered because they might affect the actual corrosion rate, which can be lower or higher than the average value given in the table.

NOTE 3 The values given for 5 years and 25 years are based on measurements, whereas the other values are extrapolated.

Table D.2 – Loss of thickness [mm] due to corrosion for piles and sheet piles in fresh water or in sea water

Required design working life	5 years	25 years	50 years	75 years	100 years
Common fresh water (river, ship canal, etc.) in the zone of high attack (water line)	0,15	0,55	0,90	1,15	1,40
Very polluted fresh water (sewage, industrial effluent, etc.) in the zone of high attack (water line)	0,30	1,30	2,30	3,30	4,30
Sea water in temperate climate in the zone of high attack (low water and splash zones)	0,55	1,90	3,75	5,60	7,50
See water in temperate climate in the zone of permanent immersion or in the intertidal zone	0,25	0,90	1,75	2,60	3,50

NOTE 1 The higher corrosion rate is usually found at the splash zone or at the low water level in tidal waters. However, in most cases, the highest stresses are in the permanent immersion zone.

NOTE 2 The values given are only for guidance. Local conditions should be considered because they might affect the actual corrosion rate, which can be lower or higher than the average value given in the table.

NOTE 3 The values given for 5 years and 25 years are based on measurements, whereas the other values are extrapolated.

Recent Projects Using Ischebeck Titan Injection Rock Bolts

Project	Consulting Engineer	Client	Contractor	Application
Canary Wharf, London	Ove Arup/ Mott MacDonald	Taylor Woodrow	Keller Ground Engineering	900kN Permanent Tie Rods
Stirling Rock Fences	TRL- Babtie Geotechnical	Stirling District Council	Phase 1 Can Ltd Phase 2 Rocklift	Permanent Rock Bolts
West Highland Line Tunnels	Bullen Consultants	Scot Rail	Albion Drilling (Services) Ltd	Permanent Roof Bolts
Ratho Quarry Climbing Centre	Ramage Young & Partners	Moidart Developments Ltd	Albion Drilling (Services) Ltd	Permanent 1500kN Rock Bolts
Liffey Board Walk	Muir Associates	Dublin Corporation	Descon / Pierse Contracting	Permanent Rock Bolts
Inverness to Wick Railway	Scott Wilson	Railtrack	Carillion/ Albion	Permanent Rock Bolts through elevated rail support walls
Reston Embankment	Donaldson Associates	Railtrack	Albion Drilling	Permanent Rock Bolts for rock nets

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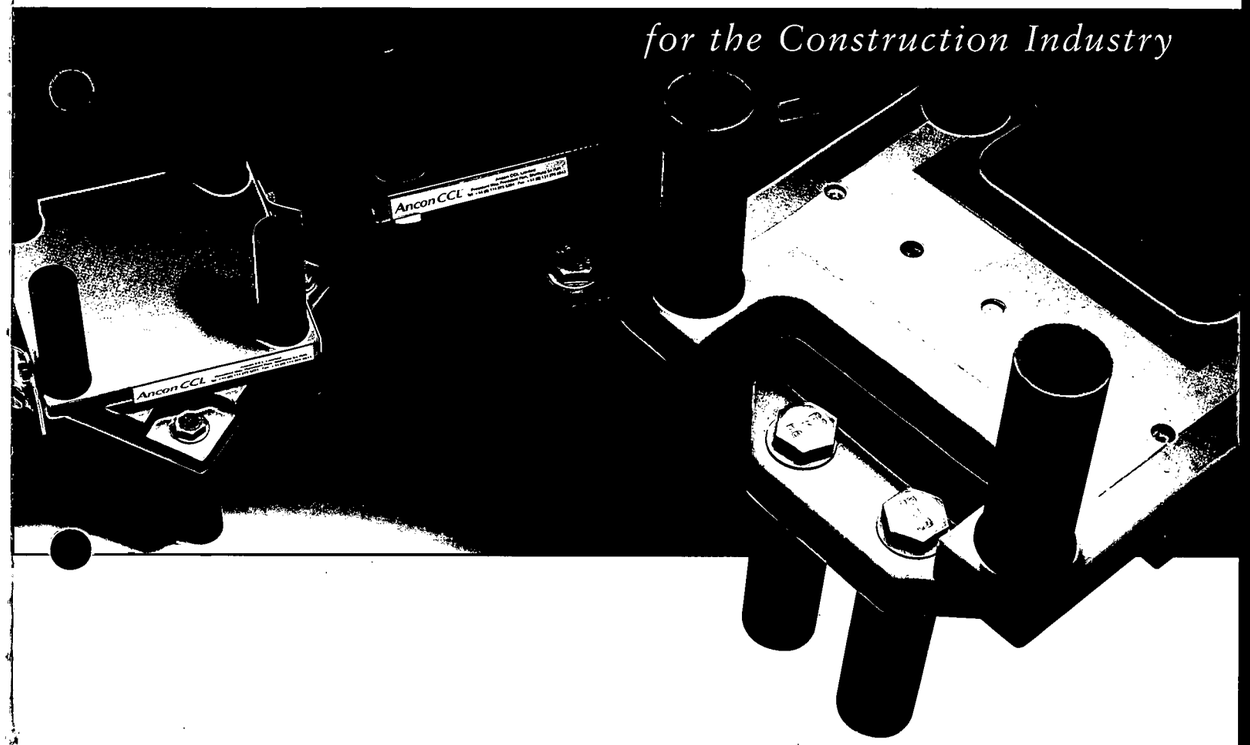
March 2000			

Structural Bearings

for the Construction Industry



If you require further information on any of the products featured in this brochure please contact Ancon CCL International

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Website: http://www.anconccl.com

BS EN ISO 9001 : 1994
FM12226 Sheffield

Ancon CCL

Structural Bearings

Ancon CCL®

CONTENTS

ANCON CCL INTERNATIONAL

Ancon CCL International designs and manufactures construction products which are used in building and civil engineering structures. Years of experience and a reputation for manufacturing expertise have produced a range of products which is known and respected throughout the world.

The Company prides itself on its ability to work with specifiers and users of the company's products, providing design expertise and technical advice on the correct selection and use of its products.

Ancon CCL International is a division of Ancon CCL Limited, a group of companies which supplies a wide range of construction products for use in the building and civil engineering industries. Other companies within the group are located in Australia, Switzerland, UAE, UK and USA.

DESIGN SERVICE

Ancon CCL International provides technical assistance on the selection of the most appropriate bearings. Our technical staff will be pleased to discuss individual applications.

In order to facilitate the design process relevant information should be supplied in the form of the table which appears on page 11.

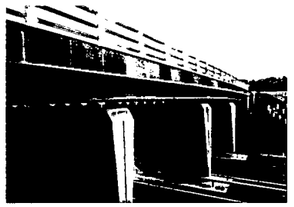
QUALITY ASSURANCE

Ancon CCL products are designed and manufactured to the quality requirements of BS EN ISO 9001 : 1994.

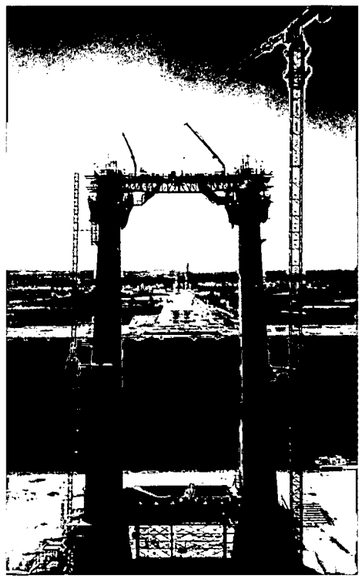
BS EN ISO 9001 : 1994
FM12226 Sheffield

STRUCTURAL BEARINGS

Bearings are used in various civil engineering structures, particularly bridges, to transfer vertical forces from one structural member to another. They are also required to restrict or permit linear or rotational movement in the vertical plane. Where horizontal movement is restricted the horizontal forces will be transferred through the bearing to the lower structure.



Bearings are available in carbon steel as standard, and in stainless steel for applications where corrosion is a potential problem or life cycle costing benefits are sought. All Ancon CCL bearings are designed to meet the requirements of BS 5400 : Section 9.1 and 9.2.

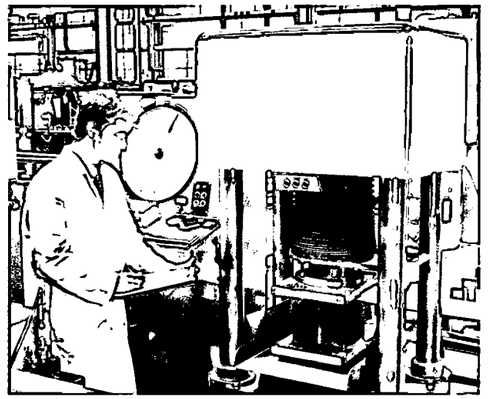


TESTING

Ancon CCL International has well equipped in-house facilities which are regularly used for testing bearings. Tests can be observed by independent witnesses when this is required.

Our compression test frame is one of the largest in the UK. An imposed rotation of the bearing can be accommodated when this is required. Sliding friction tests can also be carried out using this facility.

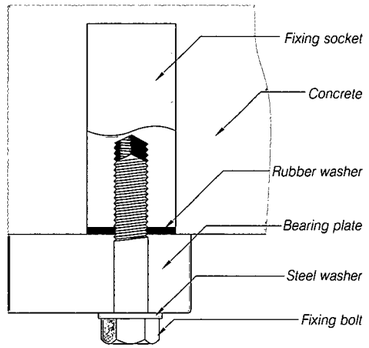
In-house testing is carried out in accordance with BS 5400 : Section 9.2 : 1983 and BS EN ISO 9001 : 1994.



INSTALLATION OF MECHANICAL POT, FIXED PIN & UNIGUIDE BEARINGS

These bearings must be securely bolted in position. They are delivered to site pre-assembled with the component parts held together with temporary fixings. Special care must be taken to ensure that guided bearings are correctly orientated.

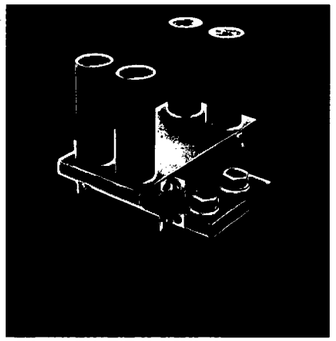
Bearings are supplied complete with bolts for fixing to steelwork or with sockets or cast-in plates for fixing to concrete. Bearings will normally be bedded on a cementitious or epoxy mortar. Details of appropriate mortars and grouts are included in the table below.



STORAGE AND HANDLING

Ancon CCL Bearings are manufactured to exacting quality standards. In order to ensure that these products perform as intended, they should be handled with care and installed correctly. The bearings should be stored in a clean and safe environment in order to prevent damage.

All bearings are supplied fitted with transit brackets in order to ensure working surfaces remain in contact before and during installation. They must not be used for lifting the bearings and should be removed only when the bearing is correctly installed.



MORTARS AND GROUTS FOR BEDDING BEARINGS

Ancon CCL International supplies a range of mortars and grouts for bedding and fixing bearings. The type of mortar or grout will depend on the bearing to be fixed and the thickness to be filled.

Type of Mortar or Grout		TecFix E305	TecPatch EFG Putty	TecPatch E16	TecGrout E33	TecGrout CS
Application		Thin Bed Epoxy Mortar	Standard Bed Epoxy Mortar	High Build Epoxy Mortar	Epoxy Grout	Cementitious Grout
Application Thickness	(mm)	3 - 15	10 - 20	4 - 40	10 - 50	10 - 100
Compressive Strength	(N/mm²)	70	90	100	85	65
Tensile Strength	(N/mm²)	14	16	14	21	3.6
Flexural Strength	(N/mm²)	34	27	37	38	10
Density	(kg/m³)	1600	1950	1950	1900	2250
Pot Life at 20°C	(minutes)	40	75	45	90	260

Strengths for cementitious TecGrout CS are measured at 28 days.
All other epoxy mortars and grouts are measured at 7 days.

PLAIN PAD AND STRIP BEARINGS

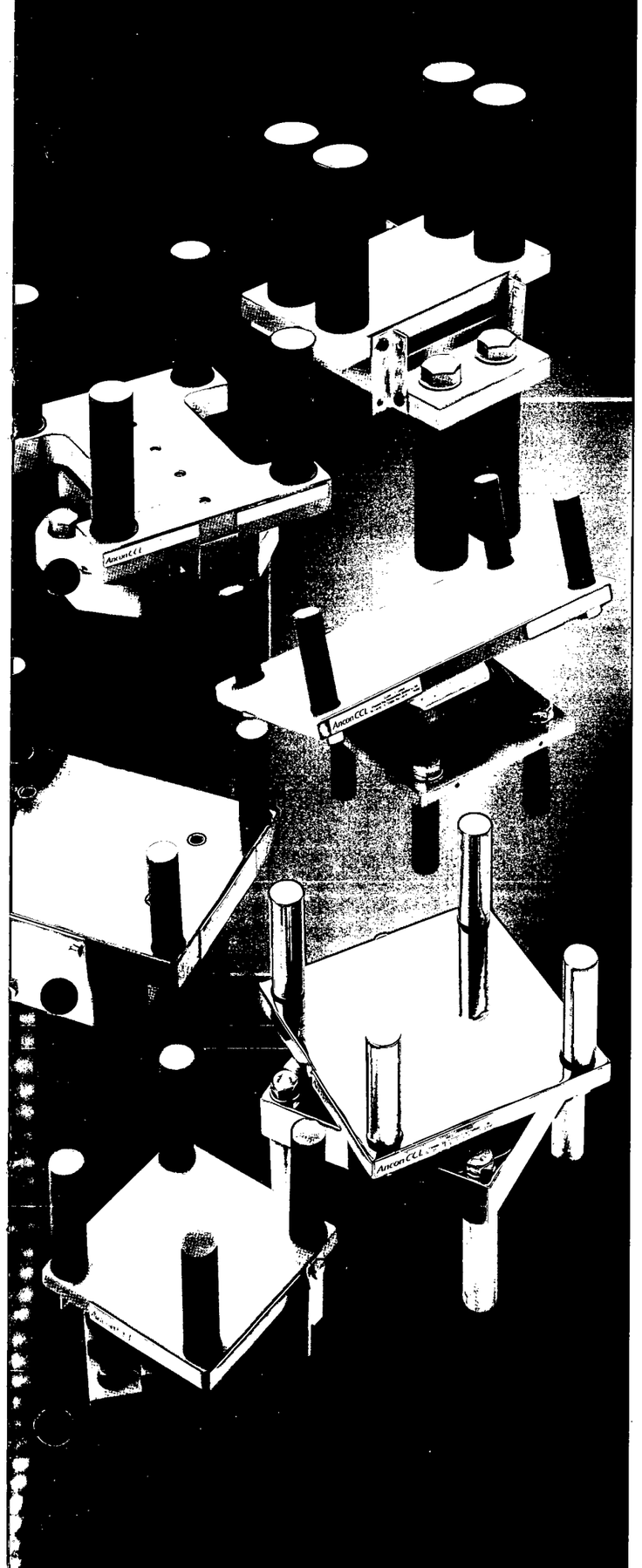
Unreinforced elastomeric pads and strips are manufactured in 60 IRHD elastomer to BS5400 . Part 9 : 1983. The pads and strips are produced from sheets 1 metre wide by 5 metres long. Any size of bearing can be supplied from this material, but the more popular sizes are listed in the following tables together with performance characteristics.

Plain Unreinforced Elastomeric Strips

Thickness (mm)	Width (mm)	SLS Vertical Load (kN/m)	Rotational Capacity (Rads/100kN/m)	Theoretical Compressive Stiffness (kN/mm/m)	Maximum Shear Movement (mm)	Theoretical Shear Stiffness (kN/mm/m)
10	100	250	0.00861	347	7.0	9.00
	150	563	0.00169	1,171	7.0	13.50
	200	900	0.00053	2,777	7.0	18.00
	250	1,125	0.00021	5.425	7.0	22.50
	300	1,350	0.00010	9,375	7.0	27.00
12	100	208	0.01490	200	8.4	7.50
	150	469	0.00293	678	8.4	11.25
	200	833	0.00092	1,607	8.4	15.00
	250	1,125	0.00037	3,139	8.4	18.75
	300	1,350	0.00017	5,425	8.4	22.50
15	100	167	0.02913	102	10.5	6.00
	150	375	0.00574	347	10.5	9.00
	200	667	0.00181	823	10.5	12.00
	250	1,042	0.00073	1,607	10.5	15.00
	300	1,350	0.00035	2,777	10.5	18.00
20	100	125	0.06909	43	14.0	4.50
	150	281	0.01363	146	14.0	6.75
	200	500	0.00431	347	14.0	9.00
	250	781	0.00176	678	14.0	11.25
	300	1,125	0.00084	1,171	14.0	13.50
25	100	100	0.13497	22	17.5	3.60
	150	225	0.02665	75	17.5	5.40
	200	400	0.00842	177	17.5	7.20
	250	625	0.00344	347	17.5	9.00
	300	900	0.00166	600	17.5	10.80

Plain Unreinforced Elastomeric Pads

Thickness (mm)	Length (mm)	Breadth (mm)	SLS Vertical Load (kN)	Rotational Capacity (Rads/100kN)	Theoretical Compressive Stiffness (kN/mm)	Maximum Shear Movement (mm)	Theoretical Shear Stiffness (kN/mm)
10	200	150	64	0.02645	75	7.0	2.70
	300	150	113	0.01300	153	7.0	4.05
	300	200	180	0.00511	292	7.0	5.40
	400	200	267	0.00312	479	7.0	7.20
	400	250	385	0.00151	789	7.0	9.00
	500	250	521	0.00103	1,150	7.0	11.25
	500	300	675	0.00057	1,725	7.0	13.50
	600	300	810	0.00042	2,337	7.0	16.20
	600	400	1,080	0.00016	4,363	7.0	21.60
12	200	150	54	0.04554	43	8.4	2.25
	300	150	94	0.02237	89	8.4	3.38
	300	200	150	0.00878	170	8.4	4.50
	400	200	222	0.00535	279	8.4	6.00
	400	250	321	0.00258	462	8.4	7.50
	500	250	434	0.00171	675	8.4	9.38
	500	300	586	0.00097	1,016	8.4	11.25
	600	300	750	0.00071	1,380	8.4	13.50
	600	400	1,080	0.00028	2,597	8.4	18.00
15	200	150	43	0.08868	22	10.5	1.80
	300	150	75	0.04351	45	10.5	2.70
	300	200	120	0.01705	87	10.5	3.60
	400	200	178	0.01038	144	10.5	4.80
	400	250	256	0.00501	239	10.5	6.00
	500	250	347	0.00342	349	10.5	7.50
	500	300	469	0.00118	528	10.5	9.00
	600	300	600	0.00138	718	10.5	10.80
	600	400	960	0.00054	1,361	10.5	14.40
20	200	150	32	0.20971	9	14.0	1.35
	300	150	56	0.01028	19	14.0	2.02
	300	200	90	0.04023	37	14.0	2.70
	400	200	133	0.02447	61	14.0	3.60
	400	250	192	0.01179	101	14.0	4.50
	500	250	260	0.00805	148	14.0	5.63
	500	300	352	0.00443	225	14.0	6.75
	600	300	450	0.00325	307	14.0	8.10
	600	400	720	0.00127	585	14.0	10.80
25	200	150	26	0.40915	4	17.5	1.08
	300	150	45	0.20054	9	17.5	1.62
	300	200	72	0.07842	19	17.5	2.16
	400	200	107	0.04768	31	17.5	2.88
	400	250	154	0.02295	52	17.5	3.60
	500	250	208	0.01566	76	17.5	4.50
	500	300	281	0.00861	116	17.5	5.40
	600	300	360	0.00631	158	17.5	6.48
	600	400	576	0.00247	302	17.5	8.64



RANGE OF STRUCTURAL BEARINGS

Mechanical Pot Bearings

Mechanical pot bearings are available in three types; fixed, guided sliding and free sliding, and in a variety of capacities. All three types allow rotation. Fixed bearings provide restraint in all horizontal directions, Guided bearings allow movement in one horizontal direction and Free Sliding bearings allow movement in all horizontal directions.

Fixed Pin or Removable Dowel Bearings

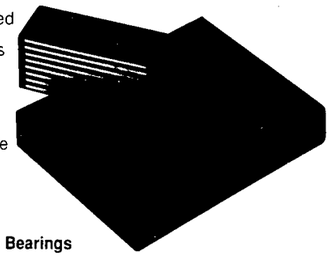
The Fixed Pin bearing provides restraint in all horizontal directions and can be used with Laminated Elastomeric bearings. The Elastomeric bearing would support the vertical load and the Fixed Pin bearing would take the horizontal loads.

Uniguide or Shear Key Bearings

Uniguide bearings are used at the opposite end to Fixed Pin bearings to allow expansion from the fixed end, but provide restraint in the other direction. Uniguide bearings can be used in conjunction with Laminated Elastomeric bearings. The Elastomeric bearing would support the vertical load, the Uniguide bearing would take the lateral horizontal load.

Laminated Elastomeric Bearings

Laminated Elastomeric bearings allow horizontal movement by shear deflection, and allow rotation by angular deformation. Where horizontal movement needs to be controlled or large horizontal loads resisted, Laminated Elastomeric bearings should be used in conjunction with Fixed Pin or Uniguide bearings.



Plain Pad and Strip Bearings

Unreinforced elastomeric pads and strips are used where low loads and small movements are expected. They are the cheapest type of bearing, readily available and easy to install.

SELECTION OF BEARINGS

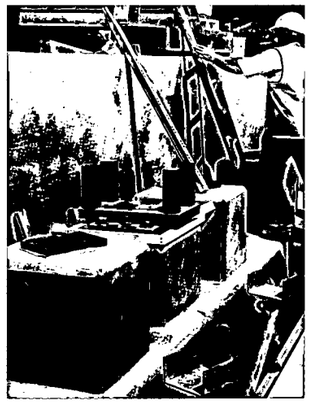
There are many factors to be considered before the most appropriate arrangement of bearings can be determined for a particular application. The table opposite provides an overall indication of the features of each type of bearing.

ARRANGEMENT OF BEARINGS

Bearing arrangements will vary depending on the size of the structure, the anticipated loading, the type of bearings being used, and the range of movement expected. Typical arrangements could be as shown.

Symbols

- All translations are fixed, rotation possible.
- Horizontal movement in one direction, rotation possible.
- Horizontal movement in all directions, rotation possible.
- All translations are fixed, rotation possible, no vertical load.
- Movement allowed in one direction only, no vertical load.



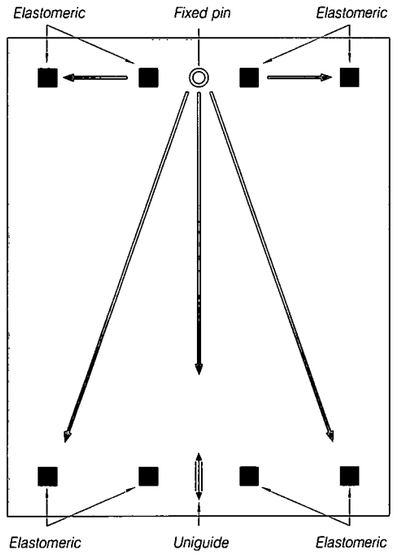
Fixed Pin Bearing between Two Laminated Elastomeric Bearings

Guided Sliding and Free Sliding Bearings, Brynglas Malpas Relief Road

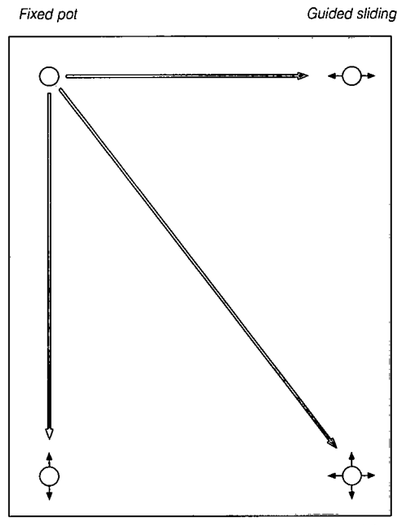
Type of Bearing		Fixed Pot	Free Sliding Pot	Guided Sliding Pot	Fixed Pin	Uniguide	Laminated Elastomeric	Plain Pad and Strip
Direction of Force	Vertical	✔	✔	✔	✘	✘	✔	✓
	Longitudinal	✔	✘	✔	✔	✘	✓	✓
	Transverse	✔	✘	✘	✔	✔	✓	✓
Rotation Permitted	Longitudinal	✔	✔	✔	✓	✓	✔	✓
	Transverse	✔	✔	✔	✓	✓	✔	✓
Movement Permitted	Longitudinal	✘	✔	✘	✘	✔	✓	✓
	Transverse	✘	✔	✔	✘	✘	✓	✓

Key ✔ Suitable ✘ Not suitable ✓ Limited

Elastomeric, Fixed Pin and Uniguide Bearings

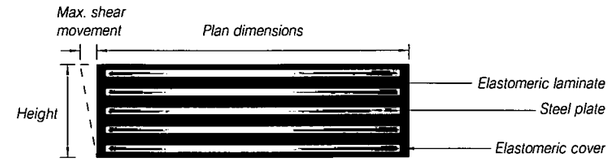


Mechanical Pot Bearings



DIMENSIONS AND PROPERTIES

Material properties vary and the table below is for guidance only. For specific applications please contact our technical staff.



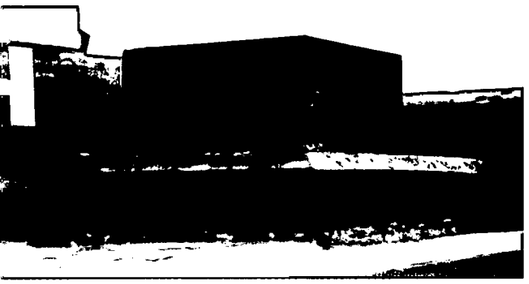
Elastomeric Bearing – Table of Dimensions for Standard Bearings

Bearing Reference	Plan Dimension (mm)	Height (mm)	Weight (kg)	Ks (kN/mm)	Kc (kN/mm)	Zero Shear No Rotation SLS Vertical Load (kN)	Zero Shear With Rotation SLS Vertical Load (kN)	Zero Shear With Rotation Rotational Capacity (Rads)	Maximum Shear With Rotation SLS Vertical Load (kN)	Maximum Shear With Rotation Rotational Capacity (Rads)	Maximum Shear With Rotation Max. Shear Movement (mm)
1010-01-05ENR2	100 x 100	14	0.4	0.90	97	90	40	0.0135	30	0.0101	7.0
1010-02-05ENR2	100 x 100	21	0.6	0.60	58	90	38	0.0213	29	0.0161	10.5
1010-03-05ENR2	100 x 100	28	0.8	0.45	41	90	37	0.0287	28	0.0213	14.0
1010-04-05ENR2	100 x 100	35	1.05	0.36	32	82	36	0.0362	26	0.0262	17.5
1510-01-05ENR2	150 x 100	14	0.63	1.35	217	170	86	0.0130	66	0.0099	7.0
1510-02-05ENR2	150 x 100	21	0.95	0.90	130	170	80	0.0201	58	0.0145	10.5
1510-03-05ENR2	150 x 100	28	1.07	0.675	93	170	78	0.0273	55	0.0193	14.0
1510-04-05ENR2	150 x 100	35	1.58	0.54	73	154	76	0.0342	52	0.0252	17.5
2015-01-05ENR2	200 x 150	14	1.27	2.70	892	524	240	0.0056	188	0.0044	7.0
2015-02-05ENR2	200 x 150	21	1.90	1.80	543	524	225	0.0088	174	0.0067	10.5
2015-03-05ENR2	200 x 150	28	2.53	1.35	390	524	220	0.0118	170	0.0090	14.0
2015-04-05ENR2	200 x 150	35	3.17	1.08	304	524	216	0.0149	162	0.0113	17.5
2015-05-05ENR2	200 x 150	42	3.80	0.90	250	524	214	0.0179	160	0.0135	21.0
2015-06-05ENR2	200 x 150	49	4.43	0.77	211	524	212	0.0210	157	0.0157	24.5
2515-01-05ENR2	250 x 150	14	2.29	2.60	479	450	200	00.0087	160	0.0068	9.1
2515-02-05ENR2	250 x 150	21	3.50	1.60	256	452	175	0.0145	140	0.0110	14.7
2515-03-05ENR2	250 x 150	28	4.71	1.16	175	452	170	0.0203	135	0.0155	20.3
2515-04-05ENR2	250 x 150	35	5.91	0.91	133	430	165	0.0260	130	0.0197	25.9
2515-05-05ENR2	250 x 150	42	7.12	0.75	107	350	160	0.0317	125	0.0240	31.5
2520-01-08ENR3	250 x 200	19	3.06	3.46	895	734	300	0.0048	220	0.0038	9.1
2520-02-08ENR3	250 x 200	30	4.67	2.14	482	734	245	0.0079	189	0.0061	14.7
2520-03-08ENR3	250 x 200	41	6.28	1.55	329	734	240	0.0113	186	0.0088	20.3
2520-04-08ENR3	250 x 200	52	7.86	1.22	250	734	235	0.0145	183	0.0114	25.9
2520-05-08ENR3	250 x 200	63	250	280	310	734	230	0.0177	180	0.0136	31.5
3020-01-08ENR3	300 x 200	19	3.67	4.15	1240	960	385	0.0048	310	0.0038	9.1
3020-02-08ENR3	300 x 200	30	5.60	2.57	669	960	335	0.0078	310	0.0063	14.7
3020-03-08ENR3	300 x 200	41	7.53	1.86	458	960	330	0.0112	260	0.0086	20.3
3020-04-08ENR3	300 x 200	52	9.46	1.46	348	960	325	0.0144	250	0.0111	25.9
3020-05-08ENR3	300 x 200	63	11.40	1.20	281	960	320	0.0175	245	0.0134	31.5
3025-01-08ENR3	300 x 250	19	4.58	5.19	1957	1386	490	0.0031	390	0.0024	9.1
3025-02-08ENR3	300 x 250	30	7.00	3.21	1062	1386	450	0.0046	350	0.0040	14.7
3025-03-08ENR3	300 x 250	41	9.41	2.33	729	1386	430	0.071	335	0.0056	20.3
3025-04-08ENR3	300 x 250	52	11.83	1.82	554	1386	410	0.0091	320	0.0071	25.9
3025-05-08ENR3	300 x 250	63	14.24	1.50	447	1386	405	0.0112	315	0.0087	31.5
3025-06-08ENR3	300 x 250	74	16.66	1.27	375	1386	400	0.0132	310	0.0102	37.1
3025-07-08ENR3	300 x 250	85	19.07	1.10	323	1386	395	0.0152	305	0.0117	42.7
4025-01-08ENR3	400 x 250	19	6.11	6.92	3202	1882	800	0.0031	650	0.0024	9.1
4025-02-08ENR3	400 x 250	30	9.33	4.29	1748	1882	710	0.0050	540	0.0038	14.7
4025-03-08ENR3	400 x 250	41	12.55	3.10	1202	1882	680	0.0070	525	0.0054	20.3
4025-04-08ENR3	400 x 250	52	15.77	2.43	916	1882	660	0.0089	510	0.0069	25.9
4025-05-08ENR3	400 x 250	63	19.00	2.00	740	1882	655	0.0110	505	0.0084	31.5
4025-06-08ENR3	400 x 250	74	22.21	1.70	620	1882	650	0.0130	500	0.0100	37.1
4025-07-08ENR3	400 x 250	85	25.43	1.48	534	1882	645	0.0150	495	0.0115	42.7
4030-01-08ENR3	400 x 300	19	7.33	8.31	4586	2274	1420	0.0020	1284	0.0015	9.1
4030-02-08ENR3	400 x 300	30	11.20	5.14	2519	2274	996	0.0035	994	0.0026	14.7
4030-03-08ENR3	400 x 300	41	15.06	3.72	1736	2274	920	0.0049	752	0.0038	20.3
4030-04-08ENR3	400 x 300	52	18.92	2.92	1325	2274	876	0.0063	730	0.0048	25.9
4030-05-08ENR3	400 x 300	63	22.79	2.40	1071	2274	850	0.0077	718	0.0059	31.5
4030-06-08ENR3	400 x 300	74	26.65	2.04	899	2274	830	0.0091	710	0.0069	37.1
4030-07-08ENR3	400 x 300	85	30.52	1.77	774	2274	816	0.0105	686	0.0080	42.7
4030-08-08ENR3	400 x 300	96	34.38	1.57	680	2274	800	0.0119	650	0.0091	48.3
4535-01-11ENR4	450 x 350	24	12.60	8.86	3626	3006	760	0.0018	590	0.0014	11.2
4535-02-11ENR4	450 x 350	39	19.42	5.25	1904	3006	760	0.0035	580	0.0026	18.9
4535-03-11ENR4	450 x 350	54	26.24	3.73	1291	3006	750	0.0050	575	0.0039	26.6
4535-04-11ENR4	450 x 350	69	33.06	2.89	976	3006	740	0.0064	560	0.0050	34.3
4535-05-11ENR4	450 x 350	84	39.88	2.36	785	3006	720	0.0079	554	0.0062	42.0
4535-06-11ENR4	450 x 350	99	49.70	1.99	656	3006	710	0.0094	550	0.0073	49.7
4535-07-11ENR4	450 x 350	114	53.52	1.73	564	3006	700	0.0109	550	0.0085	57.4

Notes: *The load capacities in the tables are based on 50% live and 50% dead loads. The rotations and movements are assumed to be reversible.*
The values for load capacity at zero and maximum shear are calculated with BS 5400 : Section 9.1, but are interrelated with the rotational capacity of the bearing.

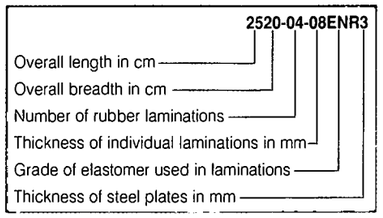
LAMINATED ELASTOMERIC BEARINGS

Laminated Elastomeric bearings accommodate load, translational and rotational movement by elastic deformation. They are moulded as a single unit under pressure and heat, and reinforced with steel plates which are totally encased within the elastomer. Ancon CCL bearings are designed to meet BS 5400 Part 9.1 and 9.2, and when required, the Highways Agency requirements listed under BD 20/92.



Where horizontal movement needs to be controlled they should be used with Fixed Pin or Uniguide bearings.

The code for each bearing relates to the bearing size, number and thickness of laminates and the hardness of the elastomeric compound.



Standard thickness of elastomeric laminates - 5, 8 or 11mm

Grades of elastomer - CNR grade 50, DNR grade 55, ENR grade 60

Thickness of steel plates - 2, 3 or 4mm (No. of plates = No. of laminates + 1)

Top and bottom cover - 2.5mm

Side cover - 4.5mm

Example:

Bearing reference 2520-04-08ENR3

Number of elastomeric laminates = 4

Thickness of laminates = 8mm

Number of plates = 4+1 = 5

Thickness of plate = 3mm

Total thickness = (2.5+2.5) + (4x8) + (5x3) = 52mm

INSTALLATION OF LAMINATED ELASTOMERIC BEARINGS

For in-situ construction, the bearing should be protected to avoid grout or concrete from encasing or damaging the sides of the bearings. This is easily achieved by surrounding the bearing with expanded polystyrene and taping adequately between the top surface of the bearing and the polystyrene. The polystyrene should be carefully removed after the structure has been cast.

When pre-cast concrete beams and structural steel beams are to be seated on laminated bearings, movement of the bearings should be prevented during installation of the beams. This can be achieved by using epoxy resin based bedding mortars below the bearing to provide sufficient bond between the mortar and the bearing. In addition, a skim coating layer of mortar can be placed above the bearing prior to beam installation to allow for minor irregularities between the two surfaces.

Elastomeric bearings must be fixed on the top and bottom faces if positive fixity is required. This can be determined by our design team.

Base Fixity

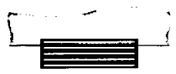
Cast into recess in the concrete and bedded with epoxy or cementitious grout (TecGrout E33 or CS).

Cast onto epoxy mortar and built up at the edges (TecPatch EFG putty).

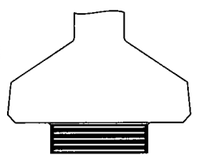
Glued onto smooth mortar plinth with epoxy mortar (TecFix E305, TecPatch EFG or E16 depending on the thickness).

Top Fixity

Cast into in-situ concrete deck.

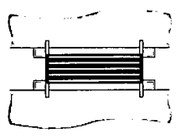


Glued onto soffit of precast concrete or steel beam with thin bed epoxy mortar (TecFix E305).



Top and Bottom

Fixed top and bottom by auxiliary steel plates (extreme cases).



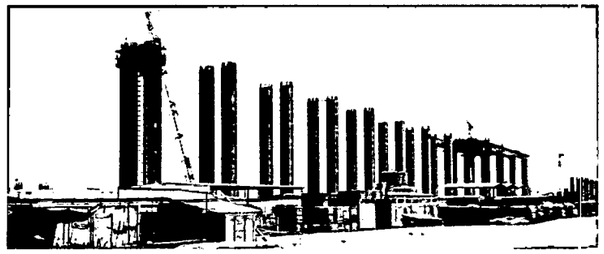
APPLICATIONS

Ancon CCL International supplies products and services to contracts throughout the world. The following are a few of the projects which use our structural bearings.

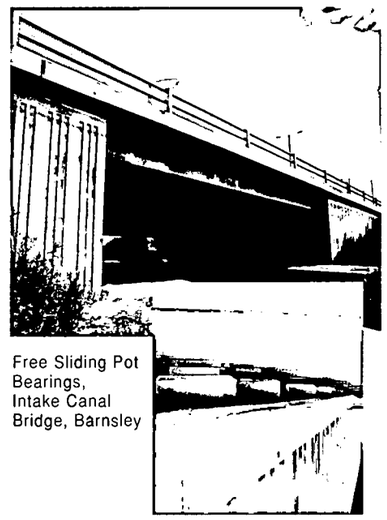
Guided Sliding Pot Bearings, Entrance Bridge to Royal Small Arms Development, Enfield Island

Guided Pot Bearings, Don Valley Stadium, Sheffield

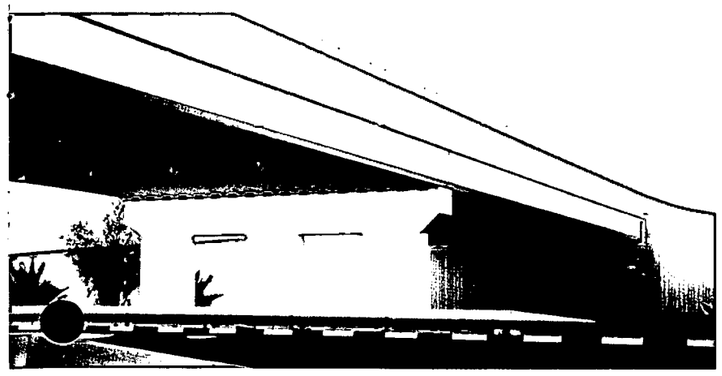
Ladies Hospital, Berne, Switzerland



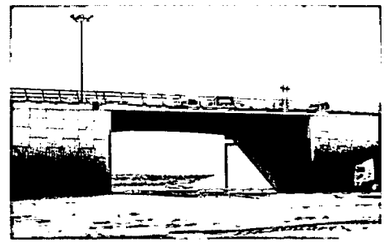
Suez Canal Bridge, Egypt



Free Sliding Pot Bearings, Intake Canal Bridge, Barnsley



Al Shahama Interchange, Abu Dhabi



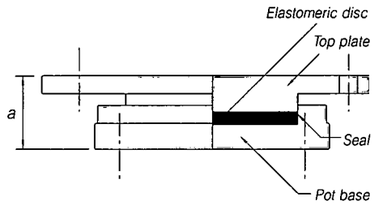
Al Nadr Interchange, Sharjah

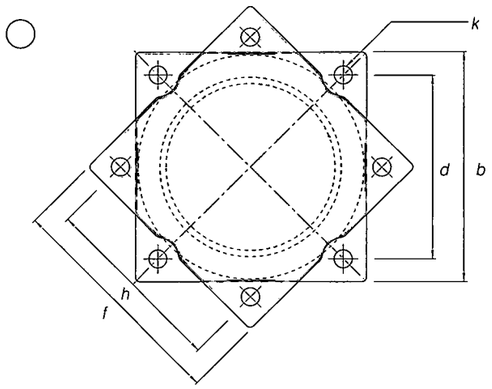
MECHANICAL POT BEARINGS

There are three types of mechanical pot bearings, all of which are available in a range of capacities and sizes. Each type utilises a piston, rubber disc and pot base, with variations to suit.

Fixed Pot Bearings

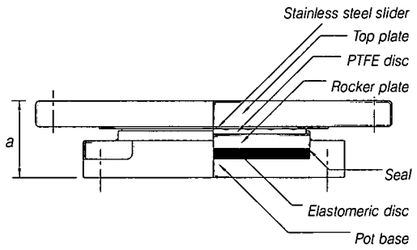
The projecting piston of the top plate is fully retained by the metal pot of the bottom plate to provide full restraint in the horizontal plane. The deformation of the elastomeric disc allows multi-directional rotation to take place.

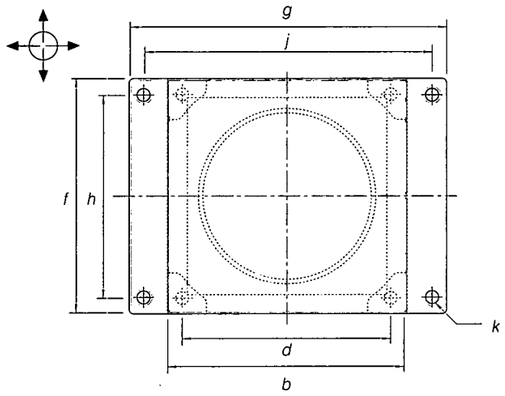




Free Sliding Pot Bearings

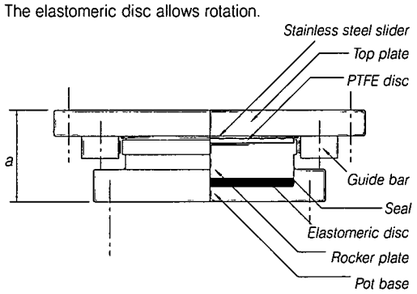
High quality stainless steel plates and a lubricated dimpled PTFE disc allow free horizontal movement between the two sections of the bearing. The elastomeric disc allows for rotation.

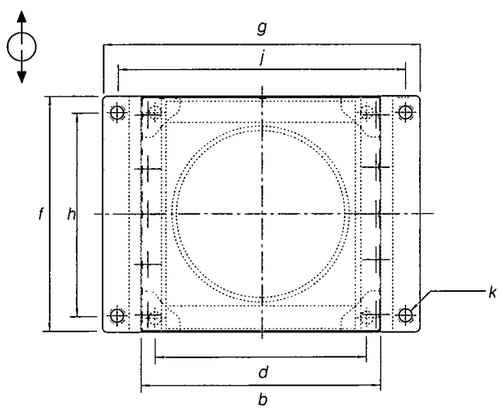




Guided Sliding Pot Bearings

The two guide bars resist the load in one direction whilst allowing movement. The stainless steel plates and PTFE disc allow horizontal movement to take place in the opposite direction. The elastomeric disc allows rotation.





Notes: *Dust Exclusion Skirts and Movement Indicators are available if required. Please ask for a quotation.*
Free Sliding and Guided Sliding Pot Bearings supplied in stainless steel do not require a stainless steel slider.

BRIDGE BEARING DESIGN DATA SCHEDULE

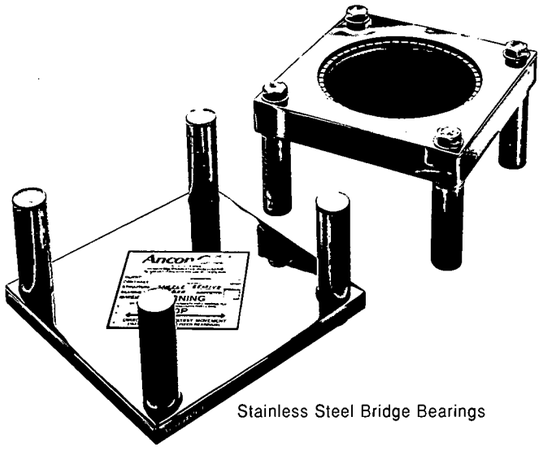
To assist the enquiry and design process please provide the relevant information in the table below
(Please photocopy as required)

Bearing Mark/Reference							
Bearing Type							
No. per Type							
SLS/ULS Contact Pressure (N/mm²)	Upper Face SLS/ULS						
	Lower Face SLS/ULS						
Standard contact pressures are 20N/mm² at SLS and 27N/mm² at ULS. Please indicate if alternative pressures are required. Ancon CCL International recommends the use of high performance bedding mortars e.g. TecGrout GS, Combextra BB or approved alternative.							
Maximum Vertical Load at SLS (kN)	Maximum						
	Permanent						
	Minimum						
Maximum Vertical Load at ULS (kN)	Maximum						
Maximum Horizontal Load at SLS (kN)	Transverse						
	Horizontal						
Maximum Horizontal Load at ULS (kN)	Transverse						
	Horizontal						
Rotation (Rad)							
Movement Capacity at ULS (mm)	Transverse						
	Longitudinal						
Upper Seating Material							
Lower Seating Material							
Other Comments							

STAINLESS STEEL BEARINGS

For applications where corrosion is a potential problem, bearings can be designed and manufactured in the appropriate grade of stainless steel to ensure that both performance and corrosion resistance criteria are met.

Stainless steel has been used by the construction and civil engineering industries for over fifty years. Its use continues to increase rapidly as the benefits of stainless steel over more traditional materials have become more widely recognised.



Stainless Steel Bridge Bearings

Stainless steel offers many advantages to the specifier:

- Excellent corrosion resistance
- Life cycle costing benefits
- Resistance to unsightly staining
- High ductility and strength
- Excellent high and low temperature properties
- Non-magnetic

LIFE CYCLE COSTING

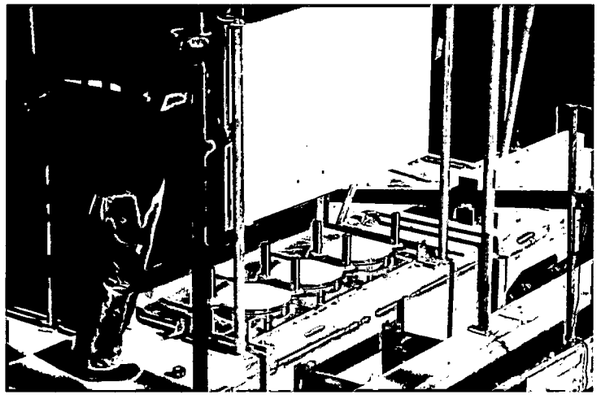
Life cycle costing is increasingly recognised as the true way to establish the cost of construction components. The maintenance-free life and the confirmed integrity of stainless steel means that no costly remedial or refurbishment measures are required during the life of the structure.

As the trend to higher specification and longer life continues, stainless steel will provide long term, cost effective solutions to specifiers' problems.

MATERIAL SPECIFICATION

There are many grades of stainless steel. The grade used in the manufacture of Ancon CCL Bridge Bearings is 316.

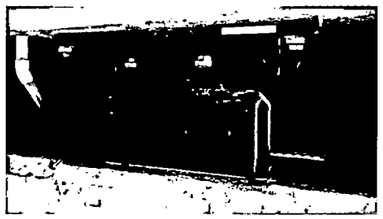
This is recommended for highly corrosive areas such as marine locations or heavily polluted industrial environments.



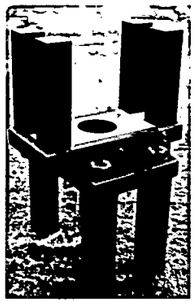
Ladies Hospital, Berne, Switzerland

CUSTOM BEARINGS

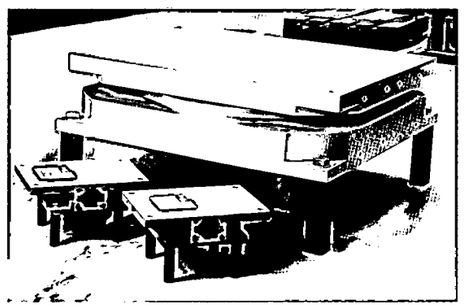
In addition to the standard range of mechanical bearings, Ancon CCL International designs and manufactures bearings to suit loadings, movement requirements or space limitations which are outside the scope of the standard range.



Pot Bearing Fitted with Uplift Restraint



Fixed Pin Bearing for Precast Concrete Sign Gantry A1-M1 Link



1800 Tonne Capacity Free Sliding Pot Bearing, BNFL

PF Fixed Bearing – Table of Dimensions for Standard Bearings

Bearing Reference		PF50	PF100	PF150	PF200	PF250	PF300	PF400	PF500	PF750	PF1000	PF1500	PF2000
SLS Permanent Vertical Load (kN)		330	670	1000	1330	1660	2000	2670	3330	5000	6660	10000	13330
SLS Total Vertical Load (kN)		500	1000	1500	2000	2500	3000	4000	5000	7500	10000	15000	20000
SLS Horizontal Load (kN)		110	210	225	255	350	380	545	810	930	1300	1850	2100
ULS Vertical Load (kN)		650	1300	2000	2660	3330	4000	5330	6500	9750	13000	19500	26000
ULS Horizontal Load (kN)		140	270	300	330	470	500	710	1050	1200	1690	2400	2700
Overall Height	*a*	54	71	84	89	103	115	131	140	166	202	247	282
Base Length and Width	*b*	180	245	300	350	385	415	485	545	670	770	940	1085
Base Bolt Centres (Square)	*d*	145	200	255	305	320	360	420	460	590	675	830	975
Top Plate Length and Width	*f*	180	245	300	350	385	415	485	545	670	770	940	1085
Top Bolt Centres (Square)	*h*	145	200	255	305	320	360	420	460	590	675	830	975
Bolt Size	*k*	M12	M16	M16	M16	M20	M20	M24	M30	M30	M36	M42	M42

Assumptions: 1. Minimum load is at least 20% of total load 2. 30% of minimum load is used as frictional resistance to horizontal load 3. Total rotations are up to 0.015 rads 4. Lower and upper seating pressures approach 20N/mm² at SLS 5. Lower and upper seating pressures approach 27N/mm² at ULS 6. 5mm mortar under base.

PS Free Sliding Bearing – Table of Dimensions for Standard Bearings

Bearing Reference		PS50	PS100	PS150	PS200	PS250	PS300	PS400	PS500	PS750	PS1000	PS1500	PS2000
SLS Permanent Vertical Load (kN)		330	670	1000	1330	1660	2000	2670	3330	5000	6660	10000	13330
SLS Total Vertical Load (kN)		500	1000	1500	2000	2500	3000	4000	5000	7500	10000	15000	20000
ULS Vertical Load (kN)		650	1300	2000	2660	3330	4000	5330	6500	9750	13000	19500	26000
Overall Height	*a*	62	85	95	101	113	128	144	158	190	208	253	296
Base Length and Width	*b*	180	245	300	350	385	415	485	550	665	775	940	1190
Base Bolt Centres (Square)	*d*	145	200	255	305	330	360	430	470	600	650	840	995
Top Plate Length	*f*	210	260	300	335	365	385	440	480	570	720	890	960
Top Plate Width	*g*	290	370	425	475	530	560	630	700	825	960	1160	1300
Top Plate Bolt Centres - Longitudinally	*h*	175	215	250	290	310	330	375	425	505	640	790	865
Top Plate Bolt Centres - Transversely	*j*	255	325	380	430	475	505	575	645	760	880	1060	1205
Bolt Size	*k*	M12	M16	M16	M16	M20	M20	M20	M20	M24	M30	M36	M36

Assumptions: 1. Minimum load is at least 20% of total load 2. 30% of minimum load is used as frictional resistance to horizontal load 3. Total rotations are up to 0.015 rads 4. Lower and upper seating pressures approach 20N/mm² at SLS 5. Lower and upper seating pressures approach 27N/mm² at ULS 6. 5mm mortar under base 7. Movements +/- 25mm SLS.

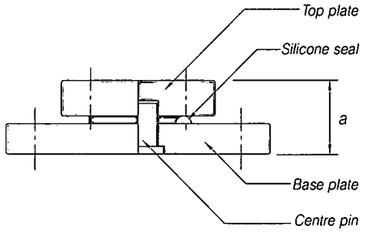
PG Guided Sliding Bearing – Table of Dimensions for Standard Bearings

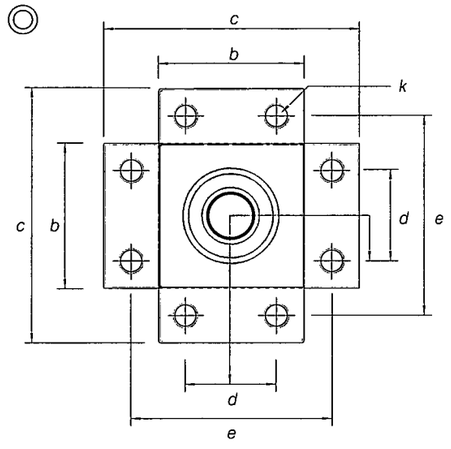
Bearing Reference		PG50	PG100	PG150	PG200	PG250	PG300	PG400	PG500	PG750	PG1000	PG1500	PG2000
SLS Permanent Vertical Load (kN)		330	660	1000	1330	1660	2000	2670	3330	5000	6660	10000	13330
SLS Total Vertical Load (kN)		500	1000	1500	2000	2500	3000	4000	5000	7500	10000	15000	20000
SLS Horizontal Load (kN)		100	200	220	240	350	380	510	610	890	1350	1700	2100
ULS Vertical Load (kN)		650	1300	2000	2660	3330	4000	5330	6500	9750	13000	19500	26000
ULS Horizontal Load (kN)		130	250	280	310	440	475	670	790	1120	1580	2200	2550
Overall Height	*a*	100	114	122	134	149	159	175	189	227	270	306	360
Base Length and Width	*b*	180	245	300	350	385	415	485	545	670	770	940	1085
Base Bolt Centres (Square)	*d*	145	200	255	305	330	360	420	460	590	675	830	975
Top Plate Length	*f*	225	275	315	350	380	410	460	500	600	720	900	1000
Top Plate Width	*g*	315	380	415	470	515	545	615	690	810	935	1140	1280
Top Plate Bolt Centres - Longitudinally	*h*	190	230	270	305	325	355	395	420	520	625	790	890
Top Plate Bolt Centres - Transversely	*j*	280	335	370	425	460	490	550	610	730	840	1030	1170
Bolt Size	*k*	M12	M16	M16	M16	M20	M20	M24	M30	M30	M36	M42	M42

Assumptions: 1. Minimum load is at least 20% of total load 2. 30% of minimum load is used as frictional resistance to horizontal load 3. Total rotations are up to 0.015 rads 4. Lower and upper seating pressures approach 20N/mm² at SLS 5. Lower and upper seating pressures approach 27N/mm² at ULS 6. 5mm mortar under base 7. Movements +/- 25mm SLS.

FIXED PIN BEARINGS

The Fixed Pin bearing has a central pin located in the base plate. The top plate of the bearing is recessed to accept the pin and will provide restraint in all horizontal directions. Fixed Pin bearings will not transfer any vertical load. The vertical load would generally be taken by Laminated Elastomeric bearings positioned each side of the Fixed Pin bearing.



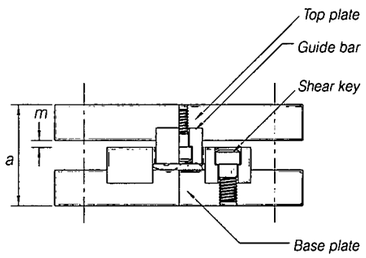


Fixed Pin Bearing – Table of Dimensions for Standard Bearings

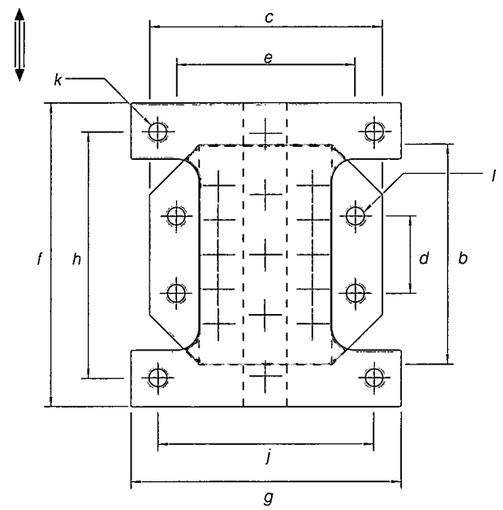
Bearing Reference		FP25	FP50	FP75	FP100	FP125	FP150	FP200
SLS Horizontal Load (kN)		250	500	750	1000	1250	1500	2000
ULS Horizontal Load (kN)		350	700	1050	1300	1565	2100	2800
Overall Height	*a*	90	120	140	140	150	160	170
Top Plate & Base Plate Width	*b*	175	245	310	390	450	530	670
Top Plate & Base Plate Length	*c*	285	425	530	610	650	730	890
Top & Base Plate Bolt Centres - Transversely	*d*	110	150	200	280	340	420	560
Top & Base Plate Bolt Centres - Longitudinally	*e*	220	330	420	480	540	620	770
Bolt Size	*k*	M24	M36	M42	M42	M42	M42	M42
No. of Bolts (Top & Base)		4	4	4	4	6	6	10

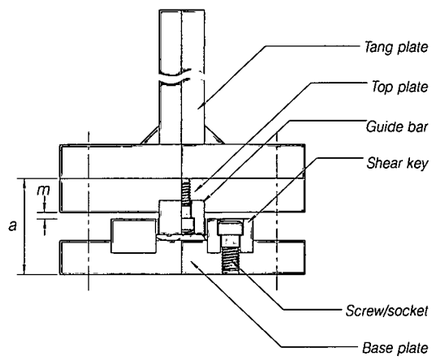
UNIGUIDE BEARINGS

The Uniguide bearing has a central guide bar recessed into the top plate. This guide bar is located between two other guide bars recessed into the bottom plate. Uniguide bearings are used to allow expansion from the fixed end but provide restraint in the other direction. Uniguide bearings will not transfer any vertical load. Laminated Elastomeric bearings would usually be positioned each side of the Uniguide to take the vertical load.



In situations where space is restricted the bolting of the top plate can prove difficult. Uniguide and Fixed Pin bearings can be supplied with an optional tang plate to overcome this problem. This provides a permanent anchor for the bearing within the concrete.





Uniguide Bearing – Table of Dimensions for Standard Bearings

Bearing Reference		UG200	UG300	UG400	UG500	UG750	UG1000	UG1500	UG2000
SLS Horizontal Load (kN)		200	300	400	500	750	1000	1500	2000
ULS Horizontal Load (kN)		280	415	560	700	1030	1400	2100	2800
Overall Height	*a*	110	120	140	158	185	220	239	249
Base Plate Length	*b*	180	255	280	320	350	400	510	670
Base Plate Width	*c*	255	270	330	360	470	560	560	560
Base Plate Bolt Centres - Longitudinally	*d*	80	90	100	120	130	140	400	560
Base Plate Bolt Centres - Transversely	*e*	200	205	250	280	375	450	450	450
Top Plate Length	*f*	325	350	420	440	495	550	600	760
Top Plate Width	*g*	255	270	330	360	470	560	750	750
Top Plate Bolt Centres - Longitudinally	*h*	270	285	340	360	400	440	490	650
Top Plate Bolt Centres - Transversely	*j*	200	205	250	280	375	450	640	640
Top Bolt Size	*k*	M20	M24	M30	M30	M36	M42	M42*	M42**
Base Bolt Size	*l*	M20	M24	M30	M30	M36	M42	M42*	M42**
Clearance	*m*	8	10	10	10	10	10	12	12

Assumptions: 1. Movements are +/- 25mm SLS and +/- 40mm ULS

* 6 Bolts ** 8 Bolts

CLANCO FLOORS & CEILINGS

ADMINISTRATION OFFICE
38 TOMNAHURICH STREET, INVERNESS, IV3 5DS

Phone 01463 242102 ***E-mail clanco@zetnet.co.uk*** ***Fax 01463 225003***

Information for the Operating & Maintenance File

Cairngorm Funicular Railway

Content

Ceiling Suspension System — Armstrong Prelude TL — Armstrong Ceilings Ltd
Ceiling Tiles — Armstrong Dune Plus — Armstrong Ceilings Ltd.
MF Ceilings — Gyproc Wallboard — British Gypsum Limited

Personal Data Redacted

Clan Floors (Inverness) Ltd.
Tuesday, May 21, 2002

GYPROC

Safety Data Sheet

Plasterboards

1 IDENTIFICATION OF THE SUBSTANCE/ PREPARATION AND COMPANY

Substance/ Preparation **Plasterboards**

Gyproc Wallboard
Gyproc Wallboard Duplex
Gyproc Core Board
Gyproc DuraLine XL
Gyproc DuraLine XL Moisture Resistent
Gyproc DuraLine XL Severe
Gyproc Fireline
Gyproc Fireline Duplex
Gyproc Fireline Moisture Resistant Board
Gyproc Gypwall Board
Gyproc Handi-board
Gyproc Handi-board Duplex
Gyproc Industrial Grade Board
Gyproc Moisture Resistant Board
Gyproc Plank
Gyproc SoundBloc
Gyproc SoundBloc Moisture Resistant

Manufacturer **British Gypsum Limited**
Head Office
East Leake
Loughborough
Leics. LE12 6HX

Telephone **08705 456123**

2 COMPOSITION/INFORMATION OF INGREDIENTS

General Composition:- Calcium sulphate dihydrate encased in paper liners, natural constituents may include minor amounts of quartz. Small quantities of chopped glass fibre, microsilica and vermiculite may be added, with starch, foam and dispersants.

Fireline, DuraLine XL and Core boards include small quantities of chopped man-made mineral fibre and micro silica.

Moisture Resistant and Core boards include a silicone and/or wax additive.

Duplex boards are backed with a metallised polymer or polyethylene film.

Industrial Grade and Modular Grid boards are faced with a polyvinylchloride film and backed with metallised polymer or polyethylene film.

3 HAZARDS IDENTIFICATION

These products are not classified as hazardous under CHIP 2000. Refer to Section 15 - Regulatory Information.

Dust from sawing or sanding may irritate the respiratory system, skin and eyes.

4 FIRST AID MEASURES

Inhalation	Remove person to fresh air.
Skin Contact	Flush and wash with water and soap.
Eye Contact	Wash eye with clean water for 10 mins and seek medical advice if irritation persists.
Ingestion	Wash mouth out and drink plenty of water.

Please note should any symptoms persist obtain medical assistance.

5 FIRE FIGHTING MEASURES

The products are fire resistant, but facings or packaging may burn.

All fire extinguishers are suitable media, observing normal fire fighting procedures.

6 ACCIDENTAL RELEASE MEASURES

Not applicable.

7 HANDLING AND STORAGE

Minimise and control dust when sawing or sanding plasterboards in confined spaces.

When manually handling plasterboards, use correct manual handling techniques according to size, thickness and density (Refer Section 9).

Store in dry conditions, on firm level ground and to preserve stability do not stack above 3 metres high.

Plasterboards will not support body weight between rafters, joists or frame members.

Fixers must work from an independent support system.

British Gypsum

8 EXPOSURE CONTROLS/PERSONNEL PROTECTION

Occupational Exposure Limits

OES - Occupational Exposure Standards
Plaster Total Inhalable 10mg/m³ 8hrTWA
Respirable 4mg/m³ 8hr TWA

MEL - Maximum Exposure Limit
Quartz (silica) Total Inhalable 0.3mg/m³ 8hr TWA
MMMF (Man Made Mineral Fibres) 5mg/m³ 8hr TWA (gravimetric method)

Refer to current edition of HSE EH40 "Occupational Exposure Limits".

Note The Man Made Mineral Fibres used in plasterboards are non respirable with fibre diameters in excess of 10µm.

Personal Protection

Respiratory When sawing or sanding plasterboards, use local exhaust system to control dust or wear a half face mask to EN149 Class FFP 2s, if dust cannot be controlled.

Skin — Wear gloves to avoid prolonged or repeat contact.

Eye — Wear safety goggles to BS EN 166 when sawing or sanding, or when handling products overhead.

9 PHYSICAL AND CHEMICAL PROPERTIES

Appearance:- Flat sheet boards in different widths and thickness, with square tapered or rebated edges.

Thickness	9.5mm - =	weight/m²	7.0kgs approx.
	12.5mm -		9.0kgs
	15.0mm -		11.5kgs
	19.0mm -		14.5kgs
(SoundBloc)	12.5mm -		10.5kgs
	15.0mm -		12.5kgs
(Duraline XL)	13.0mm -		11.5kgs

Note all dimensions and weights are only approximate, reference should be made to product technical information publications.

10 STABILITY AND REACTIVITY

No special physical conditions need to be avoided or restrictions regarding incompatible materials.

11 TOXICOLOGICAL INFORMATION

No known toxicological effects.

12 ECOLOGICAL INFORMATION

Stable product with no known adverse environmental effects.

13 DISPOSAL CONSIDERATIONS

Dispose at an authorised landfill site according with the Waste Management Licensing Regulations 1994.

14 TRANSPORT INFORMATION

Not classified as hazardous for transport.

15 REGULATORY INFORMATION

Not classified as hazardous under the Chemicals (Hazard, Information and Packaging for Supply) (Amendment) Regulations 2000 (CHIP 2000).

This Safety Data Sheet prepared in accordance the approved Code of Practice L62:- Safety data sheets for substances and preparations dangerous for supply (2nd Edition).

16 OTHER INFORMATION

Sources of key data used to compile Safety Data Sheet:

The Control of Substances Hazardous to Health Regulations 1999 (COSHH).

Health & Safety Executive Guidance Note EH40 Occupational Exposure Limits (current edition).

Recommended uses - Gyproc plasterboards are used as internal linings in buildings. Moisture resistant grades may also be used in protected external situations or in temporary exposure conditions.

This information reflects typical values and is not a product specification.

No warranty is hereby expressed or implied.

Note to User

This Safety Data Sheet does not constitute the users own workplace risk assessment, which is required under COSHH (The Control of Substances Hazardous to Health) Regulations 1999.

Written Enquiries
Written enquiries should be addressed to:

British Gypsum Limited
Technical Advice Centre
East Leake
Loughborough
Leicestershire
LE12 6JT

Technical Service
British Gypsum technical staff are available for discussion and to render technical advice through the following numbers when the Company's products are being specified or used.

FM 52358

Telephone 08705 456123

Fax 08705 456356

E-mail: bgtechnical.enquiries@bpb.com

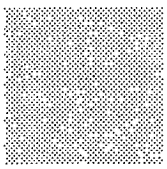
Web: www.british-gypsum.bpb.com

British Gypsum

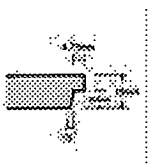
9813M - Prima Dune Plus MicroLook

PHOTOS

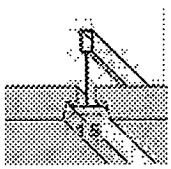
Surface



Edge detail



Grid



View room scene

RECOMMENDED SUSPENSION SYSTEM

Grid

Designer grids

Prelude 15 exposed system

VISUAL CHARACTERISTICS

Surface	Dune Plus	Pattern	No specific pattern
Edge detail	MicroLook	Module	500.0 * 500.0
Colour	White	Cost	Lower to medium price range

TECHNICAL CHARACTERISTICS

Sound absorption alpha w	0.55	Sound attenuation Dncw (dB)	32
Light reflectance (%)	83	Humidity resistance (%RH)	95

Fire reaction

United Kingdom Class 0 / Class 1 (BS 476)

FURTHER OPTIONS AVAILABLE WITH THIS SURFACE

Colour

Blue Mountain (BT)	Cannelle (CK)
Cannelle (CK)	Carrara (CA)
Carrara (CA)	Naxos (NX)
Naxos (NX)	Opal (OL)
Opal (OL)	Platinum (PN)
Platinum (PN)	Toledo (TO)
Toledo (TO)	

Edge detail

Board

SL2

Tegular

Note:
If you wish to receive the fire test report, please contact your local Armstrong Internal Technical Sales office.

9813M - Prima Dune Plus MicroLook

MAINTENANCE OF MINERAL WOOL CEILING TILES

After Completion

Sometimes buildings are not occupied after completion and hand-over to the client. In such cases, to save energy costs, the building is allowed to cool and minimum background heating is provided to protect the finishes. Below 11°C the likelihood of condensation increases. To allow equalisation of the prevailing conditions above and below the ceiling, panels or access tiles should be temporarily removed. This option may not be available if the ceiling is to provide the passive fire protection of the building. Heat build up caused by solar heat gain may need dispersing to reduce the risk of condensation at or after dusk.

Special attention should be given to the situations where the presence of additional insulation, either on the back of the ceiling or within the roof construction. This may alter the temperature gradient in the construction with the corresponding movement of the dew point. The installation should therefore be checked by calculation and if there is a risk of condensation, the ceiling void should be sufficiently ventilated to avoid this. It may also be necessary to fit a vapour barrier or vapour check between the suspended ceiling and the thermal insulation to control these effects.

Re-commissioning

When a building is to be recommissioned, following a period where only background heating has been provided, the need to control the likelihood of condensation must not be overlooked.

Heating must be applied on a continuous basis for a minimum of 14 days. The internal temperature should be raised by 1-2°C per 24-hour period with controlled ventilation provided during the day to expel any water vapour from the building.

General Maintenance

Maintenance on suspended ceilings should only take place after the effect of the work on the technical functions of the installation has been fully considered. If in doubt, please consult Armstrong Internal Technical Sales (freephone: 0800 371849).

Armstrong mineral wool ceilings require no more maintenance than painted ceilings, however, when maintenance is necessary, certain procedures should be followed. This will ensure that high performance and attractive appearance are maintained.

Cleaning

First remove surface dust from the ceiling using a soft brush. Pencil marks, smudges etc. may be removed with an ordinary art gum eraser. An alternative method of cleaning is with a moist cloth or sponge dampened in water containing mild soap or diluted detergent. The sponge should contain as little water as possible. The ceiling must not be made wet. After washing, the soapy film should be wiped off with a cloth or sponge lightly dampened in clear water.

- *Abrasive cleaners must not be used.*
- *Ceramaguard ceilings are unaffected by moisture and can be made damp with no adverse results.*
- *ML Bio and Mylar tiles can be repeatedly washed and will withstand mild detergent and germicidal cleaners.*
- *Specialist contractors offer cleaning services using chemical solutions. Where these methods are employed, it is recommended that a trial operation is first carried out (in an unobtrusive area) so that the result and overall affect can be assessed*

Replacement or access of installed product

While minor damage on ceiling tiles and boards can be repaired using commercially available fillers, a colour match is rarely achieved. When surface damage is extensive, consideration should be given to replacing the panels.

Methods exist for the replacement of installed ceiling tiles. Due to natural ageing the installation of new material in this situation is likely to introduce colour variation. This effect can be substantially reduced either by redecoration of the complete surface or by using the new tiles in a specific area and using the reusable existing tiles to refurbish elsewhere.

During access or removal of products, dust accumulated on the ceiling from various sources within the building may make it necessary for approved respiratory equipment to be worn. Such protection is deemed necessary when the total weight of inhalable dust exceeds 5mg/m^3 or 2 fibres/ml, when averaged over an 8-hour time period.

Re-painting

Most Armstrong tiles can be re-painted without appreciable loss of acoustical efficiency, provided the following precautions are adhered to:

- *Spraying is the preferred method as it is more economical and covers irregular surfaces more uniformly than roll coating or brushing*
- *For best results, panels should be removed from the suspension grid, laid flat for painting, then allowed to dry thoroughly while still flat before being re-installed*
- *Armstrong sell tins of water based emulsion paints for renovating localised damage on recently installed ceiling panels*
- *Generally basic white emulsion & water should be used in the ratio 8:1*
- *In heavily soiled areas the exposed grid may require attention; this is made easier if the panels are temporarily lifted*
- *Certain Armstrong products cannot be re-painted due to the manufacturing techniques involved. i.e. ML Bio & Mylar*
- *The paint used, irrespective of application method, should be of a good grade from a reputable manufacturer. Airless spraying usually gives the best results. The spray stream' directed perpendicularly to the material surface, moving the spray gun back and forth to obtain a uniform coating*
- *For brush painting; first remove loose dust with a light brush. Apply paint to the four sides of the tile first then touch paint at several points of the tile surface before brushing to obtain an even surface coating*
- *Roll coating is normally employed for speed but may require additional work in brush painting relief detail omitted by the roller*
- *Avoid closing acoustical perforations with paint (as these give tiles much of their absorption characteristics)*

If there are any queries please contact:

Armstrong Internal Technical Sales
Tel: Freephone 0800 371849

Armstrong

Prelude TL

PHYSICAL DATA

Face dimension (mm)	24
Profile type	Exposed System
End detail	
Main runner	By-pass connection
Cross tee	Hook system
Cross tee / Main runner interface	Butt-cut

AVAILABLE COLOURS

Aluminium (AL)	Black (BK)	Blue (BE)
Brass (BS)	Brown (BN)	Carrara (CA)
Chrome (CE)	Global white	Green (GN)
Ivory (IY)	Opal (OL)	Platinum (PN)
Red (RD)	White RAL9010 (WR)	

SUSPENSION SYSTEM ITEMS

Product name	Item No.	Slot spacing	Dimensions
Cross tee			
Prelude 24 TL Cross tee	113031	300	1200x24x35
Prelude 24 TL Cross tee	113032	300	1200x24x35
Prelude 24 TL Cross tee	113233	250	1000x24x35
Prelude 24 TL Cross tee	113433	300	1800x24x35
Prelude 24 TL Cross tee	113633	300	1500x24x35
Prelude 24 TL Cross tee unslotted	112031	Not applicable	600x24x35
Prelude 24 TL Cross tee unslotted	112032	Not applicable	600x24x35
Prelude 24 TL Cross tee unslotted	112233	Not applicable	500x24x35
Prelude 24 TL Cross tee unslotted	112433	Not applicable	300x24x35

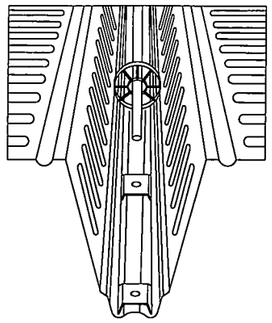
Prelude TL

Ribdeck 210

DECKING INSTALLATION

Columns and Ribdeck 210
The steel profiled sheeting can easily be cut and fitted to accommodate awkward column shapes, minimising grout loss during concreting. When there is no supporting steelwork, steel angle brackets will have to be provided by the steelwork fabricator to support the decking.

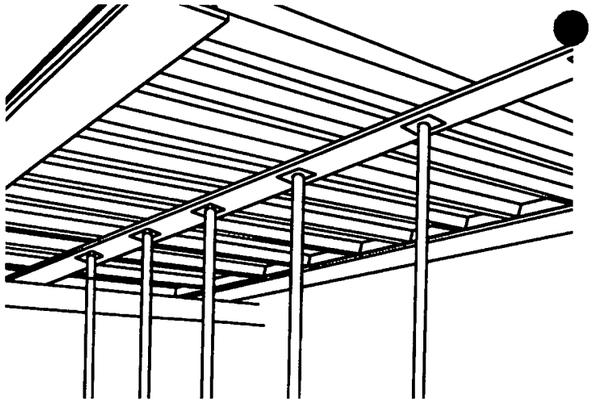
Rib reinforcement and mesh placement
The Ribdeck 210 design always allows for the inclusion of 1 single



reinforcement bar in each profile rib. The bar size can vary from 10mm to 25mm diameter and the centre of the bar is located 70mm above the profile bottom flange, which automatically ensures a 50mm spacing to the webs of the profile. It can easily be fitted when 100mm diameter plastic circular reinforcement locators or spacers are used which ensure both the vertical and horizontal location of the bar is correct.
Over the deep decking, standard reinforcing mesh, like A142, A193, and A252 can be used, positioned towards the top of the slab. The cover to the reinforcement mesh should be a minimum of 15mm and a maximum of 45mm with minimum laps of 300mm for A142 mesh and 400mm for A193 and A252 mesh. This will require support at close centres during construction.

Casting concrete
Before commencing the concrete pour, the decking must be cleared of all dirt and grease which could adversely influence the performance of the hardened slab. The oil left on the decking from the roll forming process does not have to be removed.
Care should be taken to avoid heaping of concrete in any area during the casting sequence. The temporary and local construction loading of 1.5kN/m2 which is allowed for in the load/span tables, should never be exceeded.

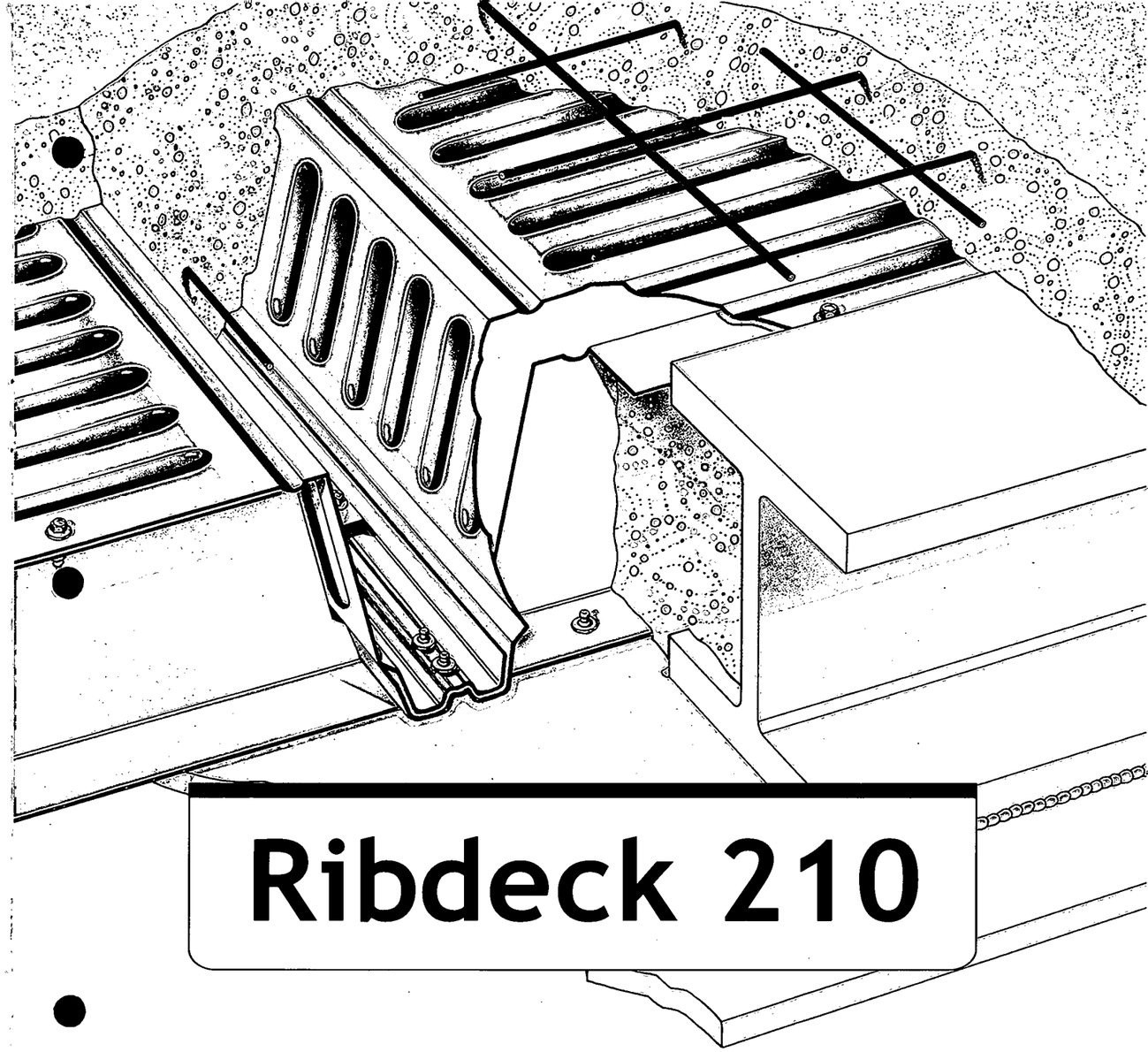
Temporary supports
In instances when the design span exceeds the unpropped construction stage capacity of the decking, it is necessary to sustain the weight of wet concrete and construction loads by adding additional temporary supports to the permanent beams.
In order to provide continuous support to the profiled sheeting, spreader beams (timbers) should be used which have to be independently propped at, for instance, 600mm centres to accommodate each profile rib separately.
Where temporary props are used it is important that:
(a) The timbers and props are of adequate strength and construction.
(b) The props are placed at midspan or at other suitable centres if more props per span are required. Please contact RLSD technical department.
(c) The propping timbers are to provide a minimum bearing width of 100mm. This can be achieved either by using two 50mm wide standard runners side by side or one runner on its side.
(d) The propping structure is not to be removed until the concrete has reached at least 70% of its characteristic strength.



Ribdeck 210

RICHARD LEES STEEL DECKING

Richard Lees Steel Decking Ltd Moor Farm Road West, The Airfield, Ashbourne, Derbyshire, DE6 1HD, United Kingdom
Tel: +44 (0) 1335 300 999 Fax: +44 (0) 1335 300 888 www.rlsd.com Email: rlsd.decks@skanska.co.uk



Ribdeck 210

RICHARD LEES STEEL DECKING

Ribdeck 210

In the tabulations below, P represents one row of propping at mid-span, 2P represents two rows of propping, one at each of the third points. Where neither is stipulated the construction does not require propping. N.S. represents not suitable.

FIRE/LOAD/SPAN TABLE—NORMAL WEIGHT CONCRETE

BAR DIA. (mm)	SLAB DEPTH (mm)	SLAB S.WT. (kN/m²)	60 MINS IMPOSED LOAD (kN/m²)					90 MINS IMPOSED LOAD (kN/m²)					120 MINS IMPOSED LOAD (kN/m²)				
			3.50	5.00	6.70	10.00	15.00	3.50	5.00	6.70	10.00	15.00	3.50	5.00	6.70	10.00	15.00
			CLEAR SPANS (m)					CLEAR SPANS (m)					CLEAR SPANS (m)				
12	290	3.01	4.74	4.27	3.88	3.35	2.84	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
16			P6.32	P5.69	5.17	4.46	3.79	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
20			2P7.90	2P7.12	P6.46	P5.58	4.74	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
25			2P8.10	2P7.68	2P7.29	P6.42	P5.51	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
12	300	3.24	4.76	4.30	3.92	3.39	2.89	4.43	4.01	3.65	3.16	2.69	N.S.	N.S.	N.S.	N.S.	N.S.
16			P6.35	P5.74	P5.22	4.52	3.85	P5.91	P5.34	4.86	4.21	3.58	N.S.	N.S.	N.S.	N.S.	N.S.
20			2P7.94	2P7.17	P6.52	P5.65	4.81	2P7.39	2P6.68	P6.08	P5.26	4.48	N.S.	N.S.	N.S.	N.S.	N.S.
25			2P8.26	2P7.85	2P7.48	2P6.65	P5.62	2P8.26	2P7.85	2P7.48	2P6.58	P5.60	N.S.	N.S.	N.S.	N.S.	N.S.
12	310	3.48	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
16			2P6.38	P5.78	P5.27	4.58	3.91	P5.94	P5.38	4.91	4.26	3.64	N.S.	N.S.	N.S.	N.S.	N.S.
20			2P7.97	2P7.23	2P6.59	P5.72	4.88	2P7.42	2P6.73	P6.14	P5.33	4.55	N.S.	N.S.	N.S.	N.S.	N.S.
25			2P8.41	2P8.00	2P7.64	2P6.76	P5.62	2P8.41	2P8.00	2P7.64	2P6.66	P5.62	N.S.	N.S.	N.S.	N.S.	N.S.
12	315	3.60	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
16			2P6.39	P5.80	P5.30	4.61	3.94	P5.95	P5.40	4.93	4.29	3.66	P5.48	4.97	4.54	3.95	3.37
20			2P7.99	2P7.25	2P6.62	P5.76	4.92	2P7.44	2P6.75	P6.13	P5.36	4.58	2P6.84	2P6.21	P5.67	P4.93	4.21
25			2P8.49	2P8.08	2P7.72	2P6.82	P5.59	2P8.49	2P8.08	2P7.71	2P6.70	P5.59	2P8.49	2P7.77	2P7.09	2P6.17	P5.27
12	320	3.72	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
16			2P6.40	P5.82	P5.32	4.63	3.96	P5.96	P5.42	P4.95	4.31	3.69	P5.49	P4.99	4.56	3.97	3.40
20			2P8.00	2P7.28	2P6.65	P5.79	P4.95	2P7.45	2P6.78	2P6.19	P5.39	4.61	2P6.86	2P6.23	P5.70	P4.96	4.24
25			2P8.56	2P8.16	2P7.80	2P6.87	P5.57	2P8.56	2P8.16	2P7.74	2P6.74	P5.57	2P8.56	2P7.79	2P7.12	2P6.20	P5.31
12	330	3.95	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
16			2P6.43	2P5.86	P5.37	4.69	4.02	2P5.98	P5.46	P5.00	4.36	3.74	P5.51	P5.02	4.60	4.01	3.44
20			2P8.03	2P7.32	2P6.71	2P5.86	P5.02	2P7.48	2P6.82	2P6.25	P5.45	4.68	2P6.88	2P6.27	P5.75	P5.02	4.30
25			2P8.71	2P8.32	2P7.95	2P6.98	P5.52	2P8.71	2P8.32	2P7.81	2P6.82	P5.52	2P8.60	2P7.84	2P7.19	2P6.27	P5.38
12	340	4.19	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
16			2P6.45	2P5.89	P5.41	P4.74	4.07	2P6.01	P5.49	P5.04	4.41	3.79	P5.53	P5.05	4.64	4.06	3.49
20			2P8.06	2P7.37	2P6.76	2P5.92	P4.99	2P7.51	2P6.86	2P6.30	P5.51	P4.74	2P6.91	2P6.31	2P5.79	P5.07	4.36
25			2P8.71	2P8.47	2P8.11	2P7.08	P5.48	2P8.71	2P8.47	2P7.87	2P6.89	P5.48	2P8.63	2P7.89	2P7.24	2P6.34	P5.45
12	350	4.42	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
16			2P6.47	2P5.93	2P5.45	P4.78	4.12	2P6.03	2P5.52	P5.08	4.45	3.83	2P5.54	P5.08	P4.67	4.10	3.53
20			2P8.09	2P7.41	2P6.82	2P5.98	P4.95	2P7.53	2P6.90	2P6.35	2P5.57	P4.79	2P6.93	2P6.35	2P5.84	P5.12	4.41
25			2P8.41	2P8.41	2P8.24	2P7.17	2P5.44	2P8.41	2P8.41	2P7.93	2P6.96	2P5.44	2P8.41	2P7.94	2P7.30	2P6.40	2P5.44

Use of fire/load/span tables
The tables indicate the maximum achievable composite span. This span relates to the minimum failure criteria which may be a construction, composite or fire limit state. It should be noted that shorter spans or lesser loadings may obviate the need for propping. Please contact our technical department for specific guidance on this matter.
The composite slabs are designed to satisfy the normal structural requirements of BS 5950: Part 4 and the fire resistance period specified.
The tables cover a range of spans for various imposed loads [kN/m²]for given slab thickness [mm], rib reinforcement diameter [mm] and fire resistance periods for single span conditions, both unpropped and propped. The information is provided using both lightweight and normal weight concrete. The decking material has a nominal thickness of 1.25mm. All composite slabs have a 30 minutes fire resistance, provided minimum slab thicknesses of 270mm for lightweight concrete and 280mm for normal weight concrete are maintained for fire insulation purposes, together with minimum rebar.

Spans
The spans as noted in the tables are the actual clear spans between edges of supports.

Construction load
Generally a 1.5 k N/m² construction load is taken into account, in accordance with BS 5950: Part 4. No allowance is made for heaping concrete during the casting operation.

Deflection
Deflections are limited to L/180 for the construction stage and L/350 for the composite stage.

Span/thickness ratio
In order to control deflections, the suggested maximum ratios of slab span to slab thickness are 30 for lightweight concrete and 35 for normal weight concrete.

Deck material
1.25mm thick zinc coated steel to BS EN 10147: 1992, S350GD, Z275NA, with a guaranteed minimum yield stress of 350N/mm². Minimum zinc coating mass is 275 g/m² total including both sides.

Concrete
The concrete is assumed to be Grade 30, with a maximum aggregate size of 20mm. The weight of concrete is taken to be normal weight 2400kg/m³ and lightweight 1900kg/m³. The role of the concrete is very important in that it insulates the reinforcement and controls the transmission of heat through the floor. In both these respects lightweight aggregate concrete has a better performance than normal weight concrete.

Rib reinforcement
Every rib in the decking layout, located at 600mm centres, requires additional reinforcement in the form of one single reinforcement bar with a guaranteed minimum yield stress of 460 N/mm². This bar provides part of the structur strength of the slab as well as fire resistance. The bars are always placed 70mm above the bottom of the slab and in the centre of the rib. This can be achieved by using 100mm diameter circular spacers to locate the bar.

Crack control/distribution fabric
A mesh for crack control and load distribution should be included in accordance with clauses 6.7, 6.8 and 6.9 of BS 5950: Part 4.

Mesh cover
The top cover to the mesh reinforcement should be a minimum of 15mm and a maximum of 45mm with minimum laps of 300mm for A142 mesh and 400mm for A193 and A252 mesh.

Temporary supports
When temporary supports are used during the construction stage, spreader beams parallel to the permanent supports should be incorporated to provide

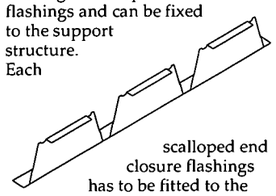
Ribdeck 210

DECKING INSTALLATION

The decking must be positively fixed to the supporting structure, in order to avoid movement during construction and excessive deflection during the pouring of concrete.
The required fixing frequency of main fasteners is 1 per profile trough at all permanent supports, i.e. main fixings at 600mm centres along the support.
When fixing onto a steelwork support structure, heavy duty shot firing pins or self drilling/tapping fasteners should be used. The steelwork must be stable and adequately restrained with support for the deck around columns and openings.
In the case of other support systems, such as brickwork, blockwork, and concrete, the profiled decking must be fixed using adequate masonry fixings. Additional to the main fixing the profile top flanges are fixed to the 50mm returns of the scalloped end closure flashings with self-drilling fasteners at a frequency of 1 fixing per pitch (see the following end closure flashings section).
Side laps are to be stitched at 350mm centres along the bottom trough of the profile. The location of the fasteners is indicated by means of pre-punched indentation in the male over-lap tail of the profile, so as to speed up the stitching. It is advisable to use self-drilling fasteners with a minimum 5.5mm diameter.

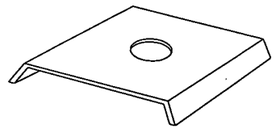
Notes
1. Every side-lap fastener should also fix and locate a trough shear connector clip into position. This clip is partly responsible for the composite action of the decking with the hardened concrete (see Trough shear-bond connector clips section adjacent).
2. When a ceiling is to be suspended from the fasteners, the minimum thread length of the fasteners is 25mm.

End closure flashings
In order to minimise grout loss at the profile ends during the concrete pour, the Ribdeck 210 decking is delivered together with scalloped end closure flashings. These flashings are manufactured from 1.6mm gauge galvanised steel and are generally 1800mm long. They have to be fixed to the support structure before the decking is placed, after which the decking will drop over the flashings and can be fixed to the support structure.
Each



scalloped end closure flashings has to be fitted to the support structure with a minimum of 2 heavy duty shot firing pins or self-drilling tapping fasteners.
Apart from minimising grout loss during the casting of concrete, these flashings also provide exact alignment of the decking during construction and shear strength to prevent web crippling. Due to their location, when used in combination with BS Slimflor beams, they provide the necessary concrete cover to the beam, thus ensuring the inherent fire resistance of the combined RLSD/British Steel Slimflor system.

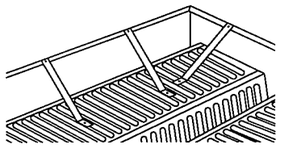
Trough shear-bond connector clips
When the Ribdeck 210 profile is required to perform compositely with the concrete slab, the side-lap fastenings will have to be combined with additional trough shear connector clips. Made from 1.5mm gauge galvanised steel, these clips fit into the bottom flange profile overlap detail and are pre-punched with an 8mm diameter hole to allow for the penetration of 5.5mm diameter self-drilling fasteners. Based on a net quantity of 4.7 clips per metre squared, RLSD advises that a minimum quantity of 5 clips per metre squared is included for in the take-off quantities. However, when the decking is used as a



permanent shuttering only, the design does not require the application of trough shear-bond connector clips.

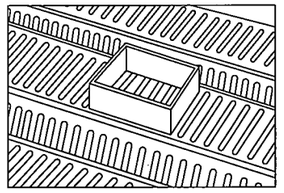
Cantilevers
Ribdeck 210 decking can be end cantilevered to the limits shown in our Practical Details section. When side cantilevers are required, stub beam or brackets should be provided by the steelwork fabricator. Cantilevers should always be assessed for possible cantilever reinforcement requirements in accordance with BS 8110: Part 1.

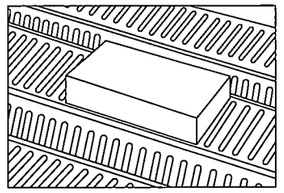
Edge-trim
For retention purposes of wet concrete to the correct level at the decked floor perimeters,



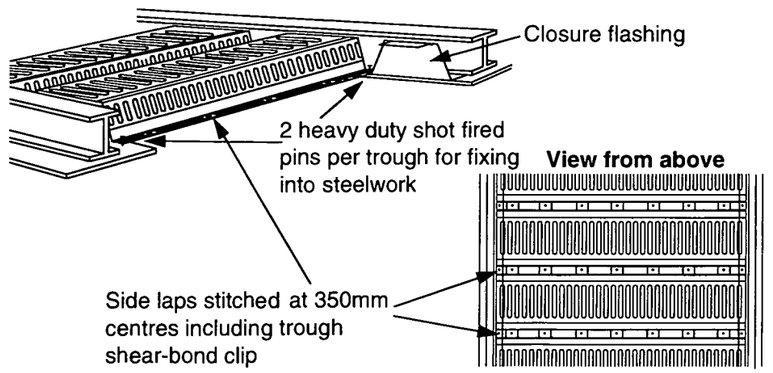
galvanised steel edge trim can be used. It is normally supplied in 3m lengths and in gauges 1.2mm to 2.0mm thick.
Edge trim is usually shot-fired to the steel support structure and the top of the trim is connected to the decking with restraint straps at approximately 400mm centres using either pop-rivets or self drilling fasteners. Restraint strap centres are smaller with Ribdeck 210 applications because the edge trim is generally of greater height than for traditional floor decking systems.

Penetrations
Should it be necessary to provide a hole through the floor decking, these openings can be made in the 425mm wide top flange of the Ribdeck 210 decking. The metal should only be cut after curing of the concrete slab. Before the actual concrete pour, any openings should be boxed out with timber





shuttering or dense polystyrene blocks.
For isolated openings at right angles to the deck span RLSD offers the following guidelines which should always be checked by the consulting engineer.
(a) Up to 300 mm wide square penetrations can be made in the centres of profile top flanges and are acceptable without additional reinforcement other than the minimum crack control mesh.
(b) Up to 425mm wide (profile top flange width) and 1000mm long openings may require additional reinforcement, to be designed in accordance with BS 8110.
(c) Openings larger than 425mm wide require trimming steelwork, to be supplied by the steel fabricator. This is due to the fact that at least 1 structurally reinforced profile rib will have to be taken out of the slab.
A close grouping of openings transverse to the span of profile should be treated as a single large hole and might therefore require additional reinforcement of trimming steelwork to suit.
After the slab has reached 70% of its minimum required characteristic strength, a nibbler or power saw can be used to cut out the openings.



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Ribdeck 210

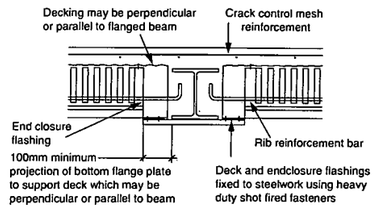
PRACTICAL DESIGN DETAILS

The design details as shown below will cover most of the practical on-site solutions for using 210 decking in combination with British Steel Slimflor beams. These details can also be applied to all constructions using different steel top-hat beams. However, when fixing onto different supporting structures or when other detail solutions are required, please contact Technical Department for assistance.

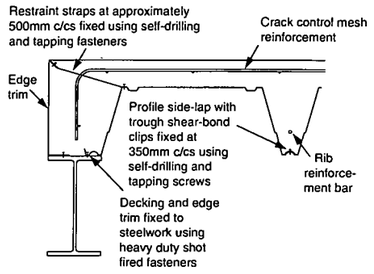
Flashings
Edge trim flashings are generally supplied in three-metre lengths in gauges of 1.2mm to 2.0mm thick galvanised steel, depending on the slab thickness and/or possible cantilevers.

End closure flashings
The special scalloped end closure flashings are generally supplied in 1.8m length (3 profile pitches) in 1.6mm gauge galvanised steel.

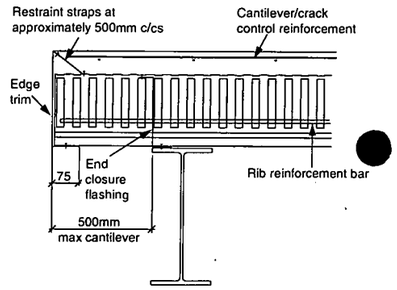
Typical 210/BS Slimfor beam connection detail



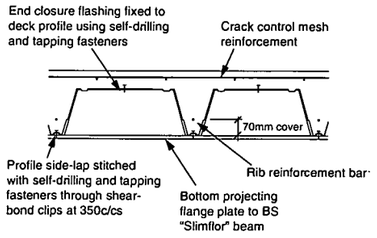
Typical side perimeter detail with downstand beam



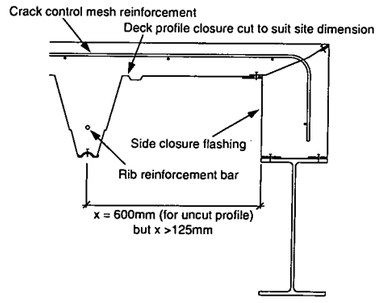
Typical end cantilever detail



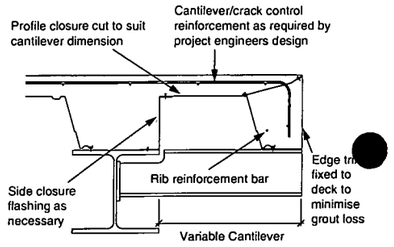
Typical 210 cross-section detail looking at beam with end-closure flashing



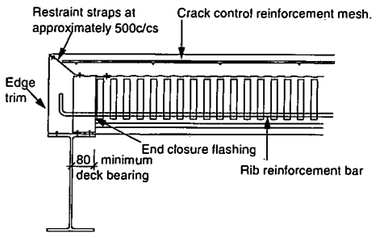
Side perimeter detail with flexible decking arrangement and downstand beam



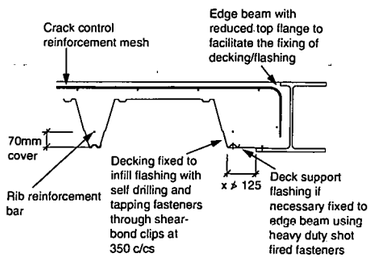
Typical side cantilever detail with stub bracket



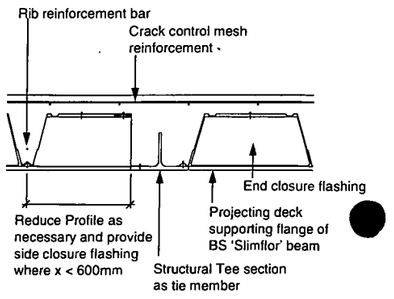
Typical end perimeter detail with downstand beam



Side perimeter detail for small dimensional profile lay-out adjustments on to steelwork



Typical tie-member cross-section detail for multi-storey application



Ribdeck 210

In the tabulations below, P represents one row of propping at mid-span, 2P represents two rows of propping, one at each of the third points. Where neither is stipulated the construction does not require propping. N.S. represents not suitable.

FIRE/LOAD/SPAN TABLE—LIGHTWEIGHT CONCRETE

BAR DIA. (mm)	SLAB DEPTH (mm)	SLAB S.WT. (kN/m²)	60 MINS IMPOSED LOAD (kN/m²)					90 MINS IMPOSED LOAD (kN/m²)					120 MINS IMPOSED LOAD (kN/m²)				
			3.50	5.00	6.70	10.00	15.00	3.50	5.00	6.70	10.00	15.00	3.50	5.00	6.70	10.00	15.00
			CLEAR SPANS (m)					CLEAR SPANS (m)					CLEAR SPANS (m)				
12	280	2.23	4.96	4.41	3.96	3.38	2.84	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
16			P6.62	P5.88	5.28	4.50	3.79	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
20			P7.57	P7.04	P6.41	5.60	4.74	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
25			P7.68	P7.18	P6.54	5.71	4.98	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
12	290	2.42	5.00	4.46	4.01	3.43	2.89	5.00	4.46	4.01	3.43	2.89	N.S.	N.S.	N.S.	N.S.	N.S.
16			P6.67	P5.94	5.35	4.58	3.86	P6.67	P5.94	5.35	4.58	3.86	N.S.	N.S.	N.S.	N.S.	N.S.
20			P7.67	P7.25	P6.66	P5.72	4.74	2P7.73	P7.25	P6.66	P5.72	4.74	N.S.	N.S.	N.S.	N.S.	N.S.
25			2P7.84	P7.40	P6.80	P5.93	5.17	2P7.84	P7.40	P6.80	P5.93	5.17	N.S.	N.S.	N.S.	N.S.	N.S.
12	300	2.60	.5.04	4.50	4.06	3.49	2.94	5.04	4.50	4.06	3.49	2.94	4.84	4.33	3.91	3.35	2.83
16			P6.72	P6.00	5.42	4.65	3.93	P6.72	P6.00	5.42	4.65	3.93	P6.46	P5.77	5.21	4.47	3.77
20			2P7.88	2P7.45	P6.77	P5.81	4.70	2P7.88	2P7.45	P6.77	P5.81	4.70	2P7.88	P7.21	P6.51	P5.58	4.70
25			2P8.01	2P7.56	P7.06	P6.16	5.12	2P8.01	2P7.56	P7.06	P6.16	5.12	2P8.01	2P7.56	P7.06	P6.16	5.12
12	310	2.79	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
16			P6.76	P6.06	P5.48	4.71	3.99	P6.76	P6.06	P5.48	4.71	3.99	P6.50	P5.83	5.27	4.53	3.84
20			2P8.04	2P7.58	P6.85	P5.89	4.66	2P8.04	2P7.58	P6.85	P5.89	4.66	2P8.04	2P7.28	P6.59	P5.66	4.66
25			2P8.17	2P7.73	2P7.31	P6.39	5.08	2P8.17	2P7.73	2P7.31	P6.39	5.08	2P8.17	2P7.73	2P7.31	P6.39	5.08
12	320	2.97	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
16			P6.80	P6.12	P5.54	4.78	4.05	P6.80	P6.12	P5.54	4.78	4.05	P6.54	P5.88	P5.33	4.59	3.90
20			2P8.19	2P7.65	2P6.93	P5.97	4.63	2P8.19	2P7.65	2P6.93	P5.97	4.63	2P8.18	2P7.35	P6.66	P5.74	4.63
25			2P8.32	2P7.89	2P7.50	P6.62	5.05	2P8.32	2P7.89	2P7.50	P6.62	5.05	2P8.32	2P7.89	2P7.50	P6.62	5.05
12	330	3.16	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
16			2P6.84	P6.17	P5.60	4.84	4.11	2P6.84	P6.17	P5.60	4.84	4.11	P6.58	P5.93	P5.39	4.65	3.95
20			2P8.35	2P7.71	2P7.00	P6.05	4.60	2P8.35	2P7.71	2P7.00	P6.05	4.60	2P8.22	2P7.41	2P6.73	P5.82	4.60
25			2P8.48	2P8.04	2P7.66	2P6.84	5.01	2P8.48	2P8.04	2P7.66	2P6.84	5.01	2P8.48	2P8.04	2P7.66	2P6.84	5.01
12	340	3.35	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
16			2P6.88	P6.22	P5.66	4.90	4.17	2P6.88	P6.22	P5.66	4.90	4.17	2P6.61	P5.98	P5.44	4.71	4.01
20			2P8.50	2P7.77	2P7.07	P6.12	4.57	2P8.50	2P7.77	2P7.07	P6.12	4.57	2P8.27	2P7.47	2P6.80	P5.89	4.57
25			2P8.63	2P8.20	2P7.82	2P6.97	4.98	2P8.63	2P8.20	2P7.82	2P6.97	4.98	2P8.63	2P8.20	2P7.82	2P6.97	4.98
12	350	3.53	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
16			2P6.92	2P6.26	P5.71	4.96	4.19	2P6.92	2P6.26	P5.71	4.96	4.19	2P6.65	P6.02	P5.49	4.76	4.06
20			2P8.64	2P7.83	2P7.14	P6.19	4.54	2P8.64	2P7.83	2P7.14	P6.19	4.54	2P8.31	2P7.53	2P6.86	P5.95	4.54
25			2P8.78	2P8.35	2P7.97	2P6.91	4.96	2P8.78	2P8.35	2P7.97	2P6.91	4.96	2P8.78	2P8.35	2P7.97	2P6.91	4.96

continuous support to the profiled steel sheeting. The temporary supports should be specified to be of adequate strength and size.

Imposed load capacity
The imposed load capacities listed in the tables are inclusive of imposed live load, partition load, finishes, ceilings and services. The dead load of the composite slab has been considered in the development of the spans shown.

Shear connection
Ribdeck 210's cross-stiffening ribs and its trough shear connector clips provide an effective mechanical key for the concrete. In its design, the shear-bond capacity of the deck is added to that of the rib reinforcement bars which are located at 600mm centres, one per decking rib. It is possible that during the manufacturing process the metal may sustain minor cracking around the cross-stiffeners. This will in no way affect the efficiency of the profile.

Fire engineering method
The fire/load/span tables are based on fire engineering design method as developed by the Steel Construction Institute in Ascot. The method is described in SCI Publication 056: The Fire Resistance of Composite Floors with Steel Decking (2nd Edition). The capacity of the slabs to bear load in fire condition is purely based on the capacity provided by the single reinforcement bar, located in every rib of the composite slab. If necessary, the fire capacity can be improved by taking top reinforcement into account.

Fire resistance test
The thermal characteristics of Ribdeck 210 composite slabs have been confirmed by 2 indicative fire tests on both a normal weight concrete and light weight concrete sample. The tests have been carried out at Warrington Fire Research Centre and the analysis has been done by SCI.

Fire insulation
To satisfy the fire insulation requirements of BS 5950: Part 8, minimum slab thicknesses are indicated in each table. Because the slab over the top flange of the Ribdeck 210 deck is rather wide (425mm) compared with other decks, it is recommended that the slab thicknesses above the deck are increased by 10mm compared with the BS 5950: Part 8 values (which apply generally to shallow deck profiles).

Technical services
Richard Lees Steel Decking Ltd Technical Department offers a comprehensive advisory service on design of composite flooring which is available to all specifiers and users. For spans, loads, slab depths and concentrated loads such as dense wall blocks etc. not covered by the tables, please refer to Richard Lees Steel Decking Ltd Technical Department.

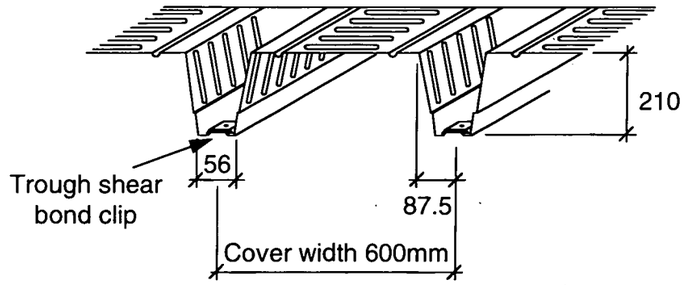
Inherent fire resistance
The building method, comprising Ribdeck 210 slabs and British Steel's Slimflor beams, has an inherent fire resistance of 60 minutes for the steel beam, without the requirement of additional fire protective materials to the steelwork or slabs.

Slimflor beams
For further information on slim floor construction, using Ribdeck 210 decking in conjunction with British Steel Slimflor beams, please refer to the SCI design guide "Slim floor construction using deep decking" or British Steel publication "Design in steel 3: Slimflor construction using deep decks".

Overall building costs
The high potential speed of Fast-Track construction achieveable using Ribdeck 210 floor decking significantly reduces total construction programme time. The deck arrives on site in bundles already cut to length, is then lifted into place and subsequently man handled to form a platform, thus allowing ease of erection and minimising cranage cost. Cladding and foundation costs can also be reduced due to the shallow floor zones and the relative light weight of the floors.

Ribdeck 210

PROFILE



SECTION PROPERTIES

Nominal Thickness [mm]	Design Thickness [mm]	Depth Profile [mm]	Weight Profile [kN/m²]	Area of Steel [mm²/m]	Moment of Inertia [cm⁴/m]	Ultimate Moment Capacity Sagging [kNm/m]	Hogging [kNm/m]
1.25	1.21	210	0.164	2017	816	23.25	18.6

CONCRETE VOLUMES AND SLAB WEIGHTS FOR VARYING SLAB THICKNESSES

Slab Thickness [mm]	NWC Slab Weight [kN/m²]	LWC Slab Weight [kN/m²]	Net Concrete Volume [m³/m²]
270	2.57	2.07	0.101
280	2.81	2.26	0.111
290	3.05	2.45	0.121
300	3.29	2.64	0.131
310	3.53	2.83	0.141
320	3.77	3.02	0.151
330	4.01	3.21	0.161
340	4.25	3.40	0.171
350	4.49	3.59	0.181

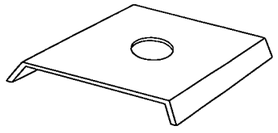
Notes

1. Ponding is not allowed for in the table.
2. "Slab thickness" is overall slab thickness measured from top of concrete to trough of metal deck.
3. The effective slab thickness in terms of concrete usage is slab thickness minus 169mm.

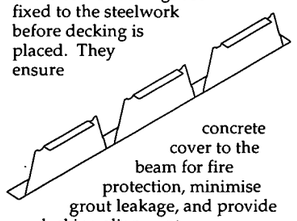
Testing
Ribdeck 210 has undergone an extensive test programme to establish its structural and composite performance. The Type 2 tests to determine shear-bond capacity to BS 5950: Part 4 were carried out at Salford University after initial research at the TNO Building and Research Institute in Holland.
The construction stage tests have been conducted in accordance with the European Recommendations (ECCS TC7) at the British Steel Technical Welsh Laboratories in Port Talbot. The fire insulation performance of the deck has been tested at Warrington Fire Research Establishment for both normal weight and light weight concrete in accordance with BS 5950: Part 8.

Flexibility
The long-span decking allows for maximum architectural design freedom while maintaining metal deck advantages with regard to service penetrations and on-site fixing flexibility. Due to the reduced number of beams, the number of steelwork connections is also reduced.

Trough shear-bond clip
Trough shear-bond clips are fixed at 350mm centres with profile side-lap fasteners. They provide part of the shear-bond capacity of the slab.

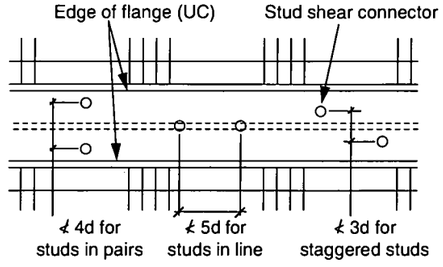


End closure flashing
End closure flashings are fixed to the steelwork before decking is placed. They ensure concrete cover to the beam for fire protection, minimise grout leakage, and provide decking alignment.



Composite beam design
Savings in beam weight of up to 30% can be achieved when the in-situ concrete slab is effectively anchored to the steel beam. The slab will then act as a compression flange to the beam. The connection between the slab and beam is generally realised by means of welding of carbon steel 19mm diameter shear studs of varying lengths. These studs can be fixed to the beam at the steel fabricator's works or on site. (Not thru-deck-welded)

Shear connector spacing
The maximum longitudinal spacing between shear connectors should not exceed 600mm or 4 times the slab depth. The slab depth is taken as the lesser depth of either the in-situ concrete over the top flange (UC) or over the top flange of the Ribdeck 210 decking. The minimum longitudinal spacing is 5 times the stud diameter and the minimum traverse spacing is 4 times the stud diameter (studs in pairs)



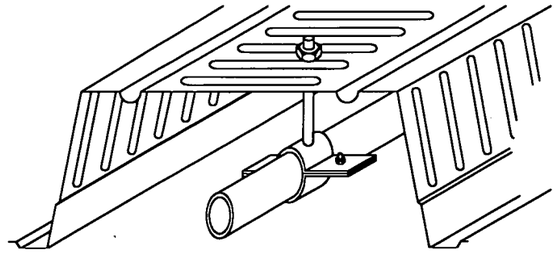
d = Nominal shank diameter of shear connector

Ribdeck 210

CEILINGS AND SERVICES HANGER SYSTEMS

Services suspension system
It is possible to accommodate services within the profile depth. The geometry of the ribs allows for the suspension of services from the profile top flange between the ribs. When combined with British Steel's Slimflor beams, up to 150mm diameter holes may be cut into the beam webs without significantly affecting the loadbearing capacity of the beams.

Pre-set threaded rod hangers
Services are suspended from so-called 'pre-set threaded rod' hangers which are installed before the concrete is poured.
The hanger is composed of a steel insert nut in a plastic housing which is fully encased in concrete after the slab has been poured. It leaves a circular opening underneath the slab which allows for the fixing of threaded rods into the steel nut of the concrete encased hanger.

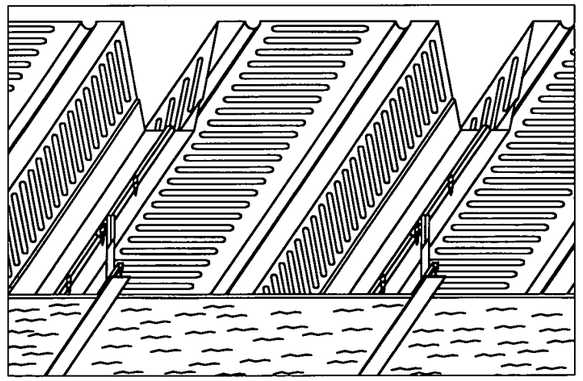


Installation
Openings are pre-punched or drilled into the top flange of the decking. The pre-set threaded rod hangers are subsequently inserted into these openings by hand, after which the concrete may be poured.
When the services are installed threaded rods are finger tightened into the steel nut and mechanically tightened. Finally, once the concrete has gained adequate strength, mechanical and electrical services can be connected to or hung from the threaded rods.

Ceiling hanger system
Ceilings can be suspended directly from the self drilling side-lap fasteners in the decking troughs, which at 600mm centres, are ideally lined up for standard ceiling tiles.

Push-on lock nuts
Push-on lock nuts are small steel clips which can be manually pushed on to the threaded areas of self drilling side-lap fasteners. A ceiling can subsequently be suspended from these nuts. The system is installed after the concrete slab has been poured and the concrete has reached design strength. As the push-on lock nuts have to be pushed onto the threaded area of a fastener, the minimum thread length of fasteners for this application is 25mm.

Installation
The push-on lock nut is manually pushed onto the drill-point of a side-lap fastener until it locks into position in the threaded area of the fastener. Its function is to fit another clip into place.
These other clips can be either suspension clips from which steel rods or wires can be suspended or they can be adjustable T-bar clips, to which 25mm T-bars can directly be connected.
As standard ceiling tiles, bearing onto the T-bars, are 600mm wide, this arrangement coincides perfectly with the profile pitch which also is 600mm.



LOADBEARING CAPABILITIES

System	Thread Size (mm)	Maximum Static Safe Working Load (kg)
Preset threaded rod hangers	6	100
	10	125
Push-on lock nuts	N/A	45

Notes

1. A minimum factor of safety of 4 has been applied to the safe working load capacities.
2. The push-on lock nuts have to be pushed onto the threaded area of the fasteners, in order to achieve their safe working load capacity. The minimum thread length of fasteners therefore has to be 25mm, when this system is applied.

References

1. BS 5950: Part 4:1994:Code of Practice for design of floors with profiled steel sheeting.
2. BS 5950: Part 3:Composite beams.
3. SCI-P-055: Design of composite slabs and beams with steel decking.
4. SCI-P-056: The fire resistance of composite floors with steel decking.
5. Salford University Report SJ 559: The behaviour of ComFlor 210 composite slabs, March 1993.
6. Long-span composite floor slabs: Msc. thesis H.J. Prins/R.G. Schuurman, Delft University 1990.
7. SCI-P- 127: Slimflor construction using deep decking,
8. British Steel Section Plates and Commercial Steels; Design in Steel 3: Slim floor construction using deep decks.

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Shot Fired Fixing of Steel Decking

INFORMATION SHEET SHOT4

Fixing and Securing

Steel decking panels can be efficiently and easily secured to structural steelwork beams using low velocity, powder-actuated fixings such as Hilti ENP2 nails applied using their DX 750 cartridge tools. If decking is used in conjunction with composite beams where through-deck welded shear studs are additionally provided, lighter duty Hilti DAK 16 tacking nails may be acceptable to the project Structural Engineer responsible for the design (applied with Hilti DXA40 or A41 tools). There is no requirement for special preparation of the structural steelwork beams or the decking when using these nails.

Full Lateral Restraint

Positive connection between the composite floor slab and the compression flanges of steel support beams may be achieved using either ENP2 or DAK 16 nails to resist lateral forces as given by the relevant clause of BS 5950:Part 1. The safe working loads per nail for nominal deck thickness are given in the table. As examples, values for lateral restraint with 0.9mm thickness decking are:

Nails at 333mm centres maximum for sheet ends:
ENP2 = 7.50kN/m, DAK16 = 2.40 kN/m
Nails at 666mm centres maximum for intermediate supports:
ENP2 = 3.75kN/m, DAK16 = 1.20 kN/m

Deck Thickness (mm)	ENP2 Shear (kN)	DAK 16 Shear (kN)
0.9	2.50	0.80
1.0	3.00	0.80
1.1	3.50	0.80
1.2	4.00	0.80

Diaphragm Action

Guidance on diaphragm action of steel decking during construction can be obtained from the SCI Advice Note AD175 (1995) and/or BS 5950:Part 9.

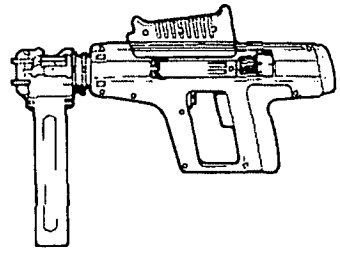
Hilti DX750 CartridgeTool & ENP2 nails
Hilti DX A40/A41 Cartridge Tools & DAK16 nails

1. Should be used only by suitably trained personnel in accordance with manufacturer's instructions.

2. Nails are suitable for fastening decking to structural steelwork up to 630 R_m and minimum 6mm thickness.

3. Technical advice can also be obtained from Hilti Technical Advisory Service, Manchester. Freephone 0800 886 100
e-mail gbsales@hilti.com web www.hilti.com
Alternative: Customers may wish to consider fixings by the Spit company Tel 0141 764 2700, e-mail support@itwspit.co.uk web www.itwspit.co.uk

DX-750 Cartridge Tool



Typical dimensions to show clearance/access required for use of tool

Site Operations

The instructions and safety advice of the manufacturer of the equipment used must always be obtained and followed by fully trained, certificated personnel who should use suitable ear defenders and safety goggles. The use of powder actuated fixings to tack down decking sheets is a single-operative task and no external power source is required.

Site Testing

Once nails have been installed, the quality of fix can be determined by using appropriate gauges, where suitable or by comparing the appearance of the fixing with the guidance diagrams and other information in the manufacturer's literature.

Nov 2001

Professional Fixing

Richard Lees Steel Decking has installed millions of square metres of decking and has more experience with structural flooring than anyone else. This experience is available to you and, if you have not obtained a quotation for installation on your UK project, please ask us for one.

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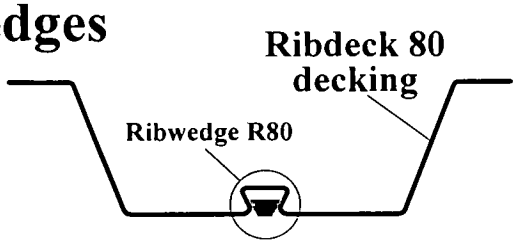
Web www.rlsd.com

Soffit Fixings

Holowedges

Holowedges for use only with Holorib Decking		
Thread Size	Maximum Safe Static Working Load	
4 mm	150 kg	Holowedges stamped
6 mm	200 kg	
8 mm	200 kg	
10 mm	200 kg	

Ribwedges

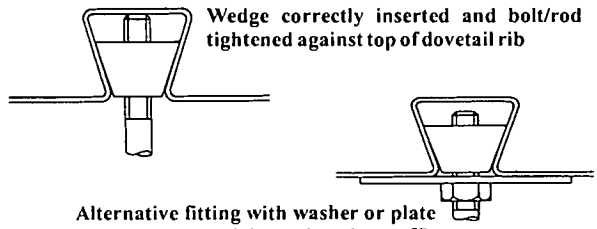


Ribwedges for use only with Ribdeck 80			
Type	Thread Size	Maximum Safe Static Working Load	Product
Ribwedge R80 (R80) wedges stamped R80	6 mm	100 kg	Use only with Ribdeck 80

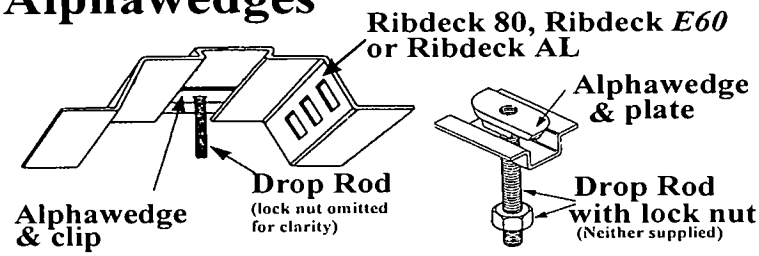
Wedge fixings allow the suspension of ceilings and othor static loads after the concrete slab has been cast and cured. Wedges are formed in mild steel EN1A, electrolytic zinc plated and bright passivated to BS 1706. They should be used only with the appropriate profiles and also fitted only as indicated in this information sheet. Wedges should not be fitted into ribs where deck panels lap.
Holowedge and Ribwedge fixings are stamped as indicated to identify their authenticity: the safe working loads noted apply when these wedges are fitted as indicated in this information sheet.

Installation of Holowedges & Ribwedges

1. Ensure that the correct wedges are selected
2. Thread wedges onto the required bolts or threaded rod.
3. Insert wedges into the dovetail ribs from underneath and rotate them through 90 degrees so that the sloped ends of the wedges bear onto the sloping sides of the decking ribs.
4. The bolts or threaded rod must then be finger tightened up to the roof of the dovetail rib with a final mechanical tightening to secure. Alternatively, wedges may be locked using large washers or plates set against the decking soffit.

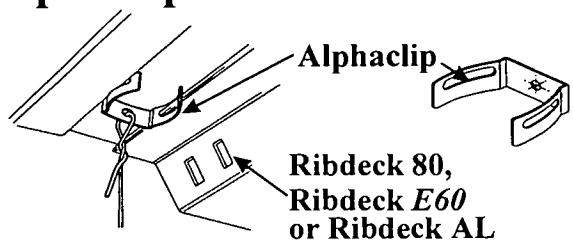


Alphawedges



Safe maximum static working load: 100 kg
Wedges threaded 6mm, 8mm & 10mm

Alphaclips



Safe maximum static working load: 5 kg

These fixings are suitable for Ribdeck 80, Ribdeck *E60*, Ribdeck AL and superseded profile Alphalok.
Alphawedges and Alphaclips are supplied by Lindapter International Ltd, Lindsay House, Brackenbeck Road, Bradford, West Yorkshire BD7 2NF Tel 01274 521444 Fax 01274 5211130. Information here is offered as a guide only, the instructions and guidance for use supplied by Lindapter should be sought and implemented.
A range of fixings is also available from Erico ltd., 52 Milford Road, Reading RG1 8LJ Tel 01189 588386 Fax 01189 594856

Notes applicable to all fixings

1. Wedges and clips should not be fitted until the concrete slab has matured
2. Wedges and clips act as vertical anchors only and must not be treated as nuts.
3. To avoid localised overloading of slabs, fixings should not be closely grouped. As a general guide it is recommended that wedges should be fitted on a nominal 600mm grid. Design advice for closer groupings should be obtained from the supervising structural engineer or our technical department.
4. Dynamic loads should be supported by embedded fixings.
5. Where additional fixings are required, proprietary anchors can be used as directed by the manufacturer and where approved by the building designer.

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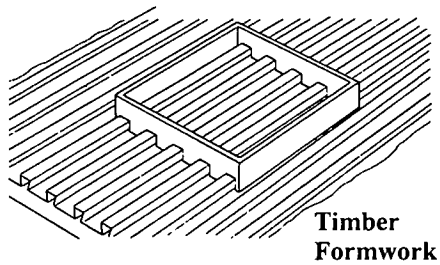
Construction Details

INFORMATION SHEET CD3b

Forming Holes

It is recommended that the following general rules are followed when forming service holes in composite slabs, they are provided only as guidance and particular requirements should be checked by the building designer. Richard Lees Steel Decking responsibilities exclude the design, supply or installation of any necessary framing or reinforcement, the cutting back of decking to form holes or any boxing out.



Openings at right angles to the direction of span of the decking:

1. Up to 250mm wide

No special treatment. Prior to placing of concrete, the opening should be boxed out. When the slab has cured, the deck should be cut out to form the opening using tools such as a reciprocating saw or nibbler.

2. Over 250mm but not more than 700mm wide

Additional reinforcement will be required around the opening as the deck local to it can no longer be considered to act compositely - it is recommended that this be in accordance with BS 8110. The opening should be formed as set out in item 1.

3. Over 700mm wide

Structural trimming steelwork will be necessary (edge trim to retain the concrete can be supplied by Richard Lees Steel decking, see other side of this sheet)

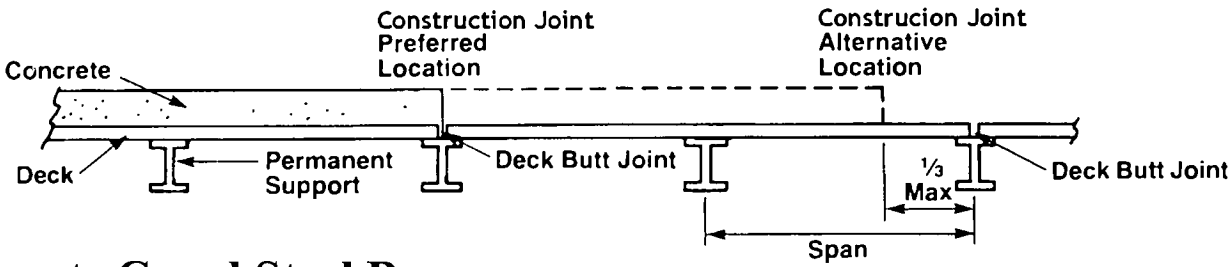
In all cases, the decking should be cut only after the slab has cured. The three size categories outlined above relate to openings in isolation and not to groupings of openings positioned transversely to the direction of span of the decking: such groups of openings should be treated as a single hole with a perimeter that encompasses all holes that are closer than 1. times the width of the largest hole.

Decking Around Columns - or similar penetrations

Decking should be cut to form a snug fit into the webs of columns and tape or expanding foam applied to minimise concrete loss. Where there are no beams available as supports and where column penetration exceeds 250mm, the steel frame supplier should fit simple angle brackets in the webs of columns.

Construction Joints (Depending on circumstances, pour sizes for slabs may be up to 1,000 m^2 or more)

If the limits of the concrete pour do not coincide with final, permanent slab edges, construction joints are used to define the extent of the pour. Where possible, they should be positioned over permanent supports at ends of decking panels. Where this is not possible, no more than the end thirds of panels should be left unpoured. The concreting subcontractor can use timber stop ends custom made to suit.

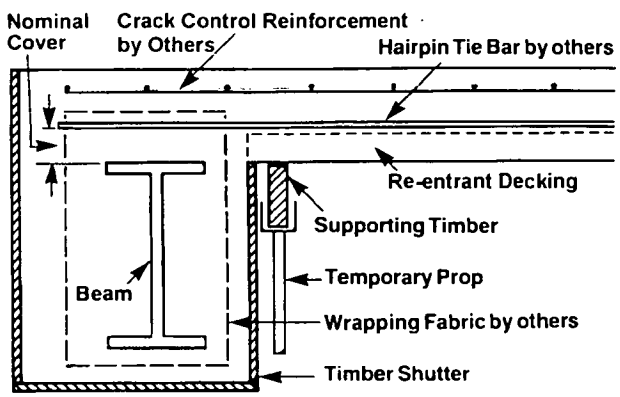


Concrete Cased Steel Beams

Using Holorib Re-entrant Decking Profile Only

Where fire requirements demand concrete encased perimeter beams, a practical procedure is that encasement be carried out off site, prior to erection. If this is not possible, decking panels should be fitted to the perimeter steel beams as normal to provide a working platform and then, prior to placing reinforcement/concrete, should be cut back to the line of the shuttering which will provide the necessary support and for which purpose it must be designed. Hairpin tie bars, as determined by the project structural engineer, should be placed in each trough of the decking prior to placing the concrete.

Where shuttering does not provide adequate support, temporary propping should be carried out as shown.



For further guidance, refer to MCRMA TP No.13, SCI P300 - ***Composite Slabs and Beams Using Steel Decking: Best Practice for Design and Construction***

Richard Lees Steel Decking
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August 2001

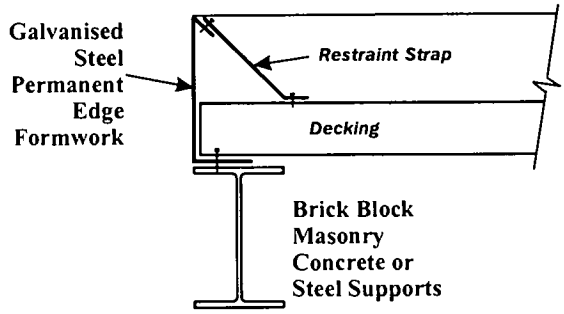
Construction Details

Edge Trim

Galvanised steel edge trim is not a structural component and is used only as permanent formwork to retain the wet concrete slabs and to avoid the need for timber shuttering. It is normally supplied in 3m lengths but may be in 2.5m lengths if obtained directly from our stock depots. Thicknesses - or gauges - are usually 1.0mm or 1.2mm, but can be up to 2mm when needed.

Edge trim is supplied complete with restraint strapping in standard 1.2m lengths to be cut to suit on site, fixings screws are only provided when Richard Lees Steel Decking is carrying out installation.

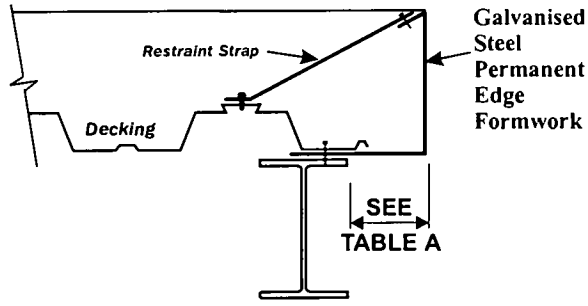
Cantilevered decking and edge trim require special consideration. Please refer to Table A for cantilevered edge trim and consult our technical department where conditions are outside the figures shown and also where decking is required to cantilever. Further permanent supports may need to be incorporated into the structure or temporary propping used during laying and curing of the concrete slabs. Where slab cantilevers occur the building designer should assess the need for rebar in the top of the concrete slabs.



Edge Trim Standard Detail

Table A	Maximum Edge Trim Overhang (mm)		
Slab Depth (mm)	Edge Trim Gauge (mm)		
	1.0	1.2	2.0
130	105	120	180
150	100	115	175
175	n/a	110	165
200	n/a	105	160
250	n/a	n/a	150

Figures apply to dense & lightweight concrete and where restraint straps are at not greater than 600 mm centres



Edge Trim Cantilever Condition

Minimising Concrete Loss

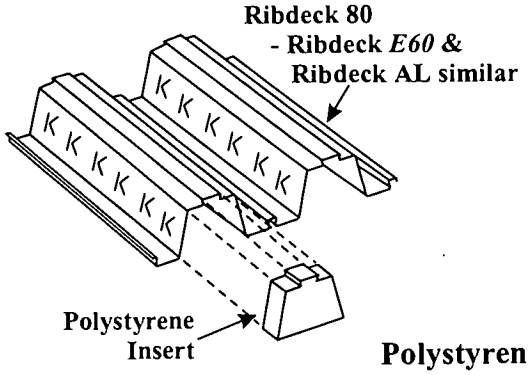
Holorib: Decking has been designed with positive lap joints that do not require seam stitching in normal usage.

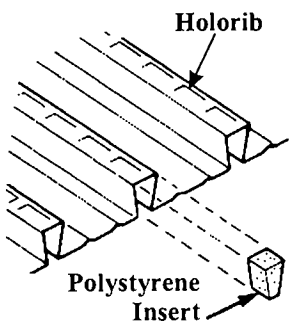
Ribdeck *E60* & Ribdeck AL: Lap joints must be seam stitched at 1.0 metre centres using self tapping screw fixings.

Ribdeck 80: Lap joints should be seam stitched using 3 self tapping screw fixings per span, one placed at midspan and the other two at quarter points but at spacings not greater than 1.5 metres.

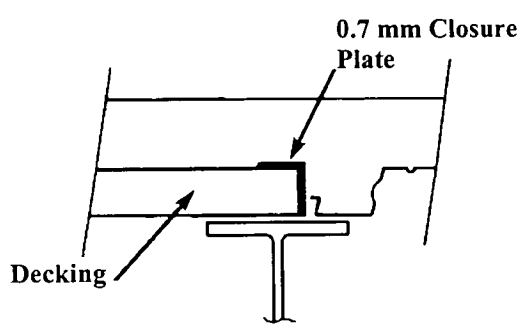
Where seam stitching is carried out, ensure that fixing screws effectively penetrate the under-lapped decking.

Decking layouts will normally allow ends of panels to be butted closely, but where this is not possible or where extra protection is required in situations such as exposed soffits or directly finished supporting structures, polystyrene inserts, adhesive tape and galvanised steel closures can be used. These items are not included in quotations unless specifically enumerated.





Polystyrene Inserts



Galvanised Steel Closure Plates

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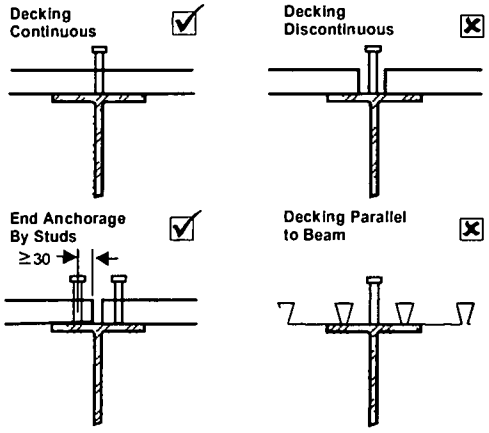


Decking contribution to transverse shear reinforcement

Transverse Reinforcement

Transverse reinforcement is included to ensure against longitudinal splitting of the concrete top flange. Resistance to splitting is contributed to by the concrete and steel top mesh. Where decking spans onto the beams it can also contribute to the shear resistance, but should not be considered when th decking spans parallel to the composite beams. Any shortfall in shea. resistance can be compensated for by additional steel bar reinforcement. For the decking to contribute as transverse reinforcement either, a) the deck should span continuously across the steel beams, or b) where the decking is discontinuous, both ends should be securely anchored to the beam top flanges by through-deck welded studs.

Preparation of Steel Flanges

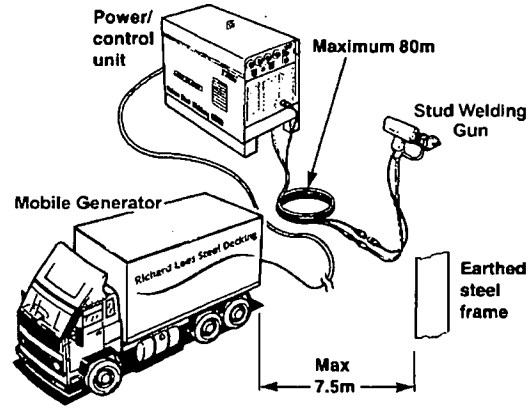
Any impurities present at the welding interface will lead to a decrease in weld quality. Richard Lees Steel Decking profiles are formed from Galvatite hot dipped galvanised steel with a G275 type coating. The through deck welding process can be successfully applied to this material provided that the top flanges of the steel beams are not primed, painted or galvanised and are also dry and free of dirt, grease and heavy rust. Light rusting that occurs after shot blasting is acceptable. The decking should fit tightly against the steel flanges in areas where welding is to be carried out, a condition which can generally be attained by the operative during the welding procedure.

NOTE: Impurities present on the steel top flanges will greatly increase the likelihood of stud failure. Defective studs can be identified using the procedures detailed below.

Stud Installation Equipment

Where RLSD is carrying out installation, access to within 7.5m of the structural steel frame will be required for a lorry mounted mobile generator unit. This unit consists of a 200KVA diesel generator and welding convertor, housed in the rear of a lorry which measures 9m in length, 2.6m wide and 3.5m high. From this position stud welding can be carried out at a radius of up to 80m.

Where access for our stud welding unit is restricted the following options are available:



- For earthing purposes, weld a steel section onto the structural steel frame on which we are to stud weld. This must be a minimum 50 x 50 x 10mm steel angle which must run from the frame to within 7.5m of where the stud welding unit will stand. The maximum radius of 80m from the unit will still apply.
- Larger multi-storey projects are often welded using mains power rather than mobile welding units. A 3 phase power supply of 415volt, 125amps / phase is required to which our welding convertor is connected, usually using a watertight 125amp plug and socket to allow easy connection and removal. The welding convertor is approximately 0.5m cubed and weighs only 0.5 tonne. This method provides a quiet, clean and environmentally friendly option.
- Where access is restricted and mains power is not available, a static generator can be provided to power the stud welding convertor. This 200KVA generator is housed in an acousterised unit, approximate size 4m long, 3m wide and 2.5m high, with a gross weight of approx 5 tonnes. Consideration must be given to the lifting and positioning of this unit onto the structure.

Hilti X-HVB shear connectors are an alternative suited to certain projects and can be investigated in conjunction with the projec Structural Engineer. They are L-shaped galvanised steel units that are shot fired onto structural steelwork to provide shea. connection. However, their capacity is less than that provided by welded shear studs and therefore more cleats may be necessary to provide the required composite action. There is no need for welding plant and attachment is achieved using Hilti's standard heavy duty fixing tool (DX750). Guidance and assistance in the UK may be obtained from Hilti 0800 886100.

Installation and Testing

Welded shear studs should be installed and tested in accordance with BS 5950: Part 3: Section 3.1: 1990 *Structural use of steelwork in building*, in accordance with the recommendations of the manufacturers of the studs and of the welding equipment and also in accordance with the layout and design specific to the individual projects. If any other testing independent of RLSD is required, it must be carried out whilst RLSD personnel and equipment are on still site so that return visits, and their cost, are avoided.

It is recommended that project teams familiarise themselves with *Composite Slabs and Beams Using Steel Decking: Best Practice for Design and Construction*, published by the Metal Cladding & Roofing Manufacturers Association in partnership with The Steel Construction Institute and available from them (SCI Publication P300 – MCRMA Technical Paper No. 13). This publication provides useful guidance about the process of design and construction using decking.

Cleaning the Decking

It is recommended that the decking is cleaned off by others as the final operation prior to concrete placement. Slight surface grease or oil residual from manufacture of the profile does not affect the interaction between decking and concrete and therefore need not be removed. It is also not essential that any residual broken ceramic ferrules from the stud welding operations are cleaned out providing they are left scattered.

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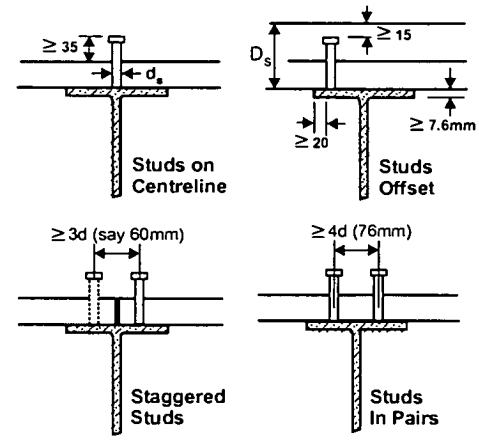
Composite Beams & shear studs

INFORMATION SHEET CB5

Guidance on the design of composite beams is given in BS 5950: Part 3: section 3.1. Within the design there is an essential requirement for the provision of positive means of transfer of horizontal shear forces between the steel beams and the in situ concrete slab above their top flange. This is commonly achieved with the use of headed shear studs welded through the decking panels to the top flanges of those steel beams.

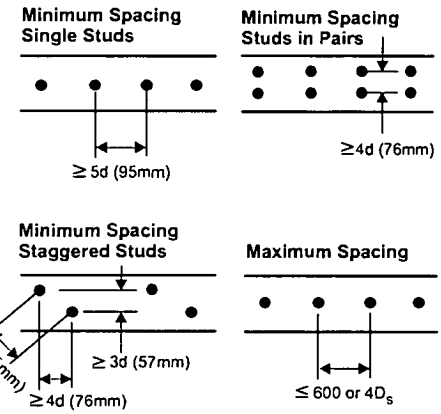
Shear Stud Specification

Shear studs are manufactured from low carbon steel with a minimum yield point of 350 N/mm^2 and ultimate tensile strength of 450 N/mm^2 and an elongation of 15%. For through-deck welding the studs should be specified with a shank diameter (d) of 19mm. Studs should project a minimum of 35mm above the decking profile and the top covering of concrete should be a minimum of 15mm. Studs may be positioned off the beam centrelines when the flange thickness is no less than 0.4 times the stud diameter. For d = 19mm, the minimum flange thickness is 7.6mm.



Spacing of Shear Studs

Minimum stud spacings are defined to ensure that concentrations of compressive forces do not occur in the concrete local to the studs as a result of overlapping force distribution cones and that each stud is adequately embedded. Maximum spacings are defined to prevent separation of the slab from the beams and to ensure an even transfer of shear force.



Stud Capacity

The capacity of headed studs in composite slabs with the decking ribs running perpendicular to the beam should be taken as their capacity in a solid slab multiplied by the reduction factor k given by the following expressions:

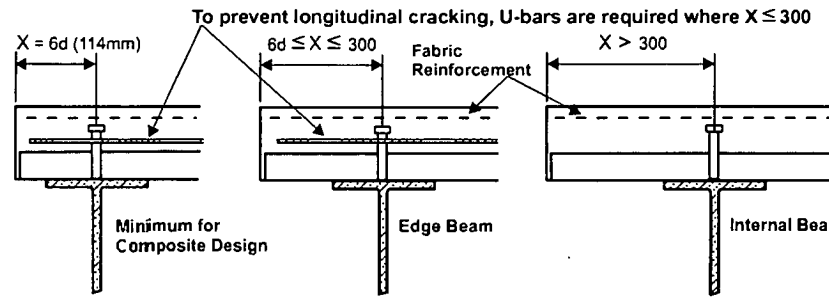
One stud per trough: k = 0.85 (br/Dp){(h/Dp)- 1}but k ≤ 1
Two studs per trough: k = 0.60 (br/Dp){(h/Dp)- 1}but k≤0.80

Stud frequency	Holorib	Ribdeck *E60*	Ribdeck AL	Ribdeck 80
1 per trough	k = 1.0	k = 1.0* Beneficial Side 30	k = 1.0* Beneficial Side 35	k = 0.85* Beneficial Side 48
2 per trough	k = 0.8	k = 0.8 Stagger 38 38	k = 0.8 In Line Or Staggered 48 48	k = 0.6 In Line Or Staggered 48 48

* For profiles with a central trough stiffener, the k factor is shown for studs welded on the beneficial side, i.e. on the side nearest to the beam end

Perimeter Beams and Internal Beams Adjacent to Significant Openings

For these beams to be designed as composite L-beams the edge of the slab must extend a minimum distance of 6 times the stud diameter (6 x 19 = 114mm) beyond the stud centreline. If this distance is greater than this value but still less than 300mm, the beams should be designed as composite edge beams and steel "U" bars detailed below the heads of the studs. When the edge of the slab distance exceeds 300mm beams may be designed as internal beams but with an appropriately reduced effective width and rebar added as necessary for longitudinal shear transmission.



Continues on reverse ➔

Fixing Note - Ribdeck 80: Lap joints must be seam stitched using 3 self tapping screw fixings per span, one placed at midspan and the other two at ¼ points but at spacings not greater than 1.50 metres **Fixing Note - Ribdeck *E60* & Ribdeck AL:** Lap joints must be seam stitched at 1.0 metre centres.	**Where seam stitching is carried out, ensure that the fixing screws effectively penetrate the under-lapped decking**

No personnel should walk or stand upon the decking until it is securely fixed in accordance with these instructions and in any event access over areas of installed decking should be kept to a minimum.
Minimum bearing requirements are: on steelwork 50mm; on concrete 50mm; on brickwork, blockwork and other materials 70mm.

Whilst it is possible to cut decking on site to accommodate notching around columns etc., this may affect the design capacity of the deck and the floor design calculations. Accordingly, specialist independent consideration should be given to the bearing and limiting span conditions for the pieces to be shaped, together with any adjoining panels.

HEALTH AND SAFETY INFORMATION: Decking is manufactured in mild steel coated with zinc, it may be covered in soluble protective oil which does not affect performance. Decking will have sharp edges and corners. Decking should be cut using motorised disc cutters such as Partner or Stihl.

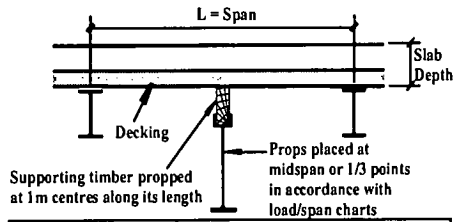
Hazard/Activity	**Precautionary and Protective Measures**
Skin abrasion from sharp edges and corners when handling decking. Skin contamination/irritation when in contact with protective oil.	Wear adequate gloves and protective clothing.
Particles of metal when cutting.	Wear safety goggles.
Iron oxide and zinc oxide fumes when stud welding.	Ensure adequate ventilation and use personal protective equipment.
Explosives and fumes when using powder actuated fixings.	Follow instructions for safe handling, use, disposal and control of cartridges issued by equipment supplier. Ensure adequate ventilation, use personal protective equipment.
Noise whilst handling, cutting, using driven fixings, etc.	Use appropriate ear defenders/ear plugs.

Deflection
Even the fixing of decking in accordance with these instructions will not prevent bending stresses and deflection of the sheeting taking place during concrete pouring or the application of any construction loads. Accordingly, such loads should not exceed the values stated on the limiting load/span chart that is available from RLSD on request.

Temporary Support

Temporary Support may sometimes be necessary to sustain the dead-weight of the wet concrete and any other construction loads (see product span/load tables, scheme drawings where provided, calculations where provided for the specific condition or the instructions of the supervising engineer). Except where specifically advised by RLSD's Technical or Construction departments, temporary props (and temporary props used where there are unsupported edges) must be in position and braced prior to installation of the decking where (a) Spans are 4.00m and over and temporary props are required for Holorib, Ribdeck *E60* and Ribdeck AL and (b) Spans are 5.00m and over and temporary props are required for Ribdeck 80.

- Any temporary support should:
- Be of adequate strength and braced construction with continuous sole and header plates. The following information is given as guidance only and must be checked for actual site conditions.
- Be positioned in accordance with the recommendations as shown on the limiting load/span chart (available on request).
- Ensure zero deflection of the deck at propped points prior to placement of concrete
- Offer an even and wide area of support so as to ensure that the structural integrity and appearance of the decking following pouring and setting is protected.
- Not be removed until the concrete has reached at least 70% of its characteristic strength.



Slab depth (mm)	Span 'L' (m)	Runner size	
		depth	width
120	3.25	175mm	50mm
130	3.75	200mm	50mm
150	4.25	225mm	50mm
200	4.75	225mm	75mm

ABOVE DATA OFFERED AS A GUIDE ONLY TO SIZE OF TIMBER RUNNER

Construction Loading

Loading during construction should not exceed the loads stated in the load/span tables (available on request). An allowance for temporary construction loads of 1.5kN/m^2 is made in the load/span tables, except where spans are less than 3.0m when an allowance of (4.50 ÷ span) kN/m^2 is made. This should never be exceeded without checking with our technical Department. Heaping of wet concrete whilst laying must be avoided.

Concreting

Decking must be clear of grease and dirt which could adversely affect the bonding. However, any water soluble oil remaining on the decking from the rolling processes need not be removed. Pour concrete evenly in the direction of span of decking, avoiding heaping : (a) with single spans, from supports towards midspan (b) with multiple spans, from supports towards panel ends.

Design

RLSD decking can be used both as permanent shuttering and tensile reinforcement. If any reinforcement performance is required from the decking it is imperative that the proper design calculations have established the suitability of the decking for its intended use. In any event an appropriate crack control mesh should be provided. Additional reinforcement may be required to comply with Building, Fire or other regulations. It is the customer's responsibility to ensure that the necessary approvals have been sought and received.

Professional Fixing Richard Lees Steel Decking has installed millions of square metres of decking and has more experience with structural flooring than anyone else. This experience is available to you and, if you have not obtained a quotation for installation on your UK project, please ask us for one.

Information contained within this document will satisfy the majority of cases. For non-standard situations, or if in doubt, please consult the RLSD Technical Department. Information applies only to the products shown, for other products please ask for relevant details.

Safety, Delivery, Handling & Fixing Steel Decking

Richard Lees Steel Decking Ltd www.rlsd.com Feb 2002 SDHF6

The terms contained herein form part of the CONTRACT. All terms defined herein shall bear the same meaning as those defined in Richard Lees Steel Decking Ltd (RLSD) Terms and Conditions of Sale. In the event of any conflict between such Terms and Conditions and these terms, RLSD's Terms and Conditions shall prevail.

Decking products should not be stored or used other than in accordance with the following notes and instructions together with any drawings (if supplied by RLSD) and specialist advice you have received.

Delivery Of Decking

Lengths of decking manufactured in accordance with RLSD layout drawings or customer schedules are made up to compact, banded bundles up to a maximum of 2 tonnes in weight. The size of each bundle depends on the required length of the panel, but approximates to 640mm wide x 750mm deep for **Holorib**; 1020 x 600 for **Ribdeck *E60;*** 910mm x 600mm for **Ribdeck AL**; 640mm x 600mm for **Ribdeck 80**. One bundle will cover up to 100 square metres depending on its length.

Where appropriate, bundles will be marked to correspond with RLSD layout drawings. Decking will be delivered in full loads as and when manufactured. Bundles should be lifted from delivery lorries and placed on framework at the levels and in positions appropriate for installation, ready for fixing and with paint-flashed sides all facing the same direction or as noted in the RLSD method statement. Care must be taken to avoid local overloading of the structure. Delivery lorries have a maximum unloading time of 2 hours. Unless otherwise agreed in writing before delivery, offloading and lifting to levels/positions is the responsibility of the customer.
The total load weight of the decking will vary in relation to the gauge and length of the panels being delivered. The following table gives typical panel weights in kilograms per **linear metre** of decking.

Holorib					**Ribdeck *E60***				**Ribdeck AL**				**Ribdeck 80**	
0.8	**0.9**	**1.0**	**1.1**	**1.2**	**0.9**	**1.0**	**1.1**	**1.2**	**0.9**	**1.0**	**1.1**	**1.2**	**1.2**	**Gauge**
7.2	8.1	9.0	9.9	10.8	9.4	10.4	11.4	12.5	9.2	10.3	11.3	12.4	9.4	**Weight kg/m**

To enable identification on site, each panel of decking has its gauge and yield stress stamped in the base of the trough on the overlap return side of the sheet. Additionally each bundle has a paint splash colour identification code: Z28: 0.8mm Green; 0.9mm Blue; 1.0mm Yellow; 1.1mm Orange; 1.2mm Red. Z35: As for Z28 but with the addition of a black stripe.

Transport and Access

Loads are normally delivered by articulated lorries of approximately 16 metres in length and with maximum gross weights of up to 36 tonnes. The turning circle of each lorry is approximately 19 metres. Access to the site and any off-loading areas should be a minimum of 6 metres wide. Standing and off-loading areas must be capable of supporting the total dead weight of the lorries and allowance should be made for the effect of bad weather and wear and tear from vehicles.

Lifting, Storing and Stacking

The customer should arrange for bundles to be lifted using protected chains, care being taken to position them correctly in accordance with slinging custom and practice so as to avoid excessive pressure across the sheets. Careless use of the slings can cause panels to be buckled. Under no circumstances should the bundles or sheets be removed from lorries by tipping, barring or similar means. When removing individual sheets from bundles they should be lifted directly and not dragged.

Since these products consist of galvanised steel, precautions should be taken to protect them if they are to be stored on site for any time and, more particularly, there should be no contact with any aggressive conditions which are liable to degrade the product. The following precautions are considered essential if the panels are to be stored:

- Do not leave uncovered stacks lying in the open. Store undercover and away from doorways.
- If stacks cannot be kept under cover, erect a simple scaffolding around them and cover with a waterproof sheet, leaving space between the cover and the sheet to allow circulation of air.
- Stacks should be stored off the floor surface or ground and so far as possible on a slope so that, in the event of water penetration of the protective covering, it can drain away.
- Regular inspection should be carried out so as to ensure absence of moisture collection or penetration into the stacks.
- Sheets should not be stored where people are likely to walk or drive across them.
- Bundles should not be stacked more than 4 high and no other goods should be stored on top of stacks or individual sheets.

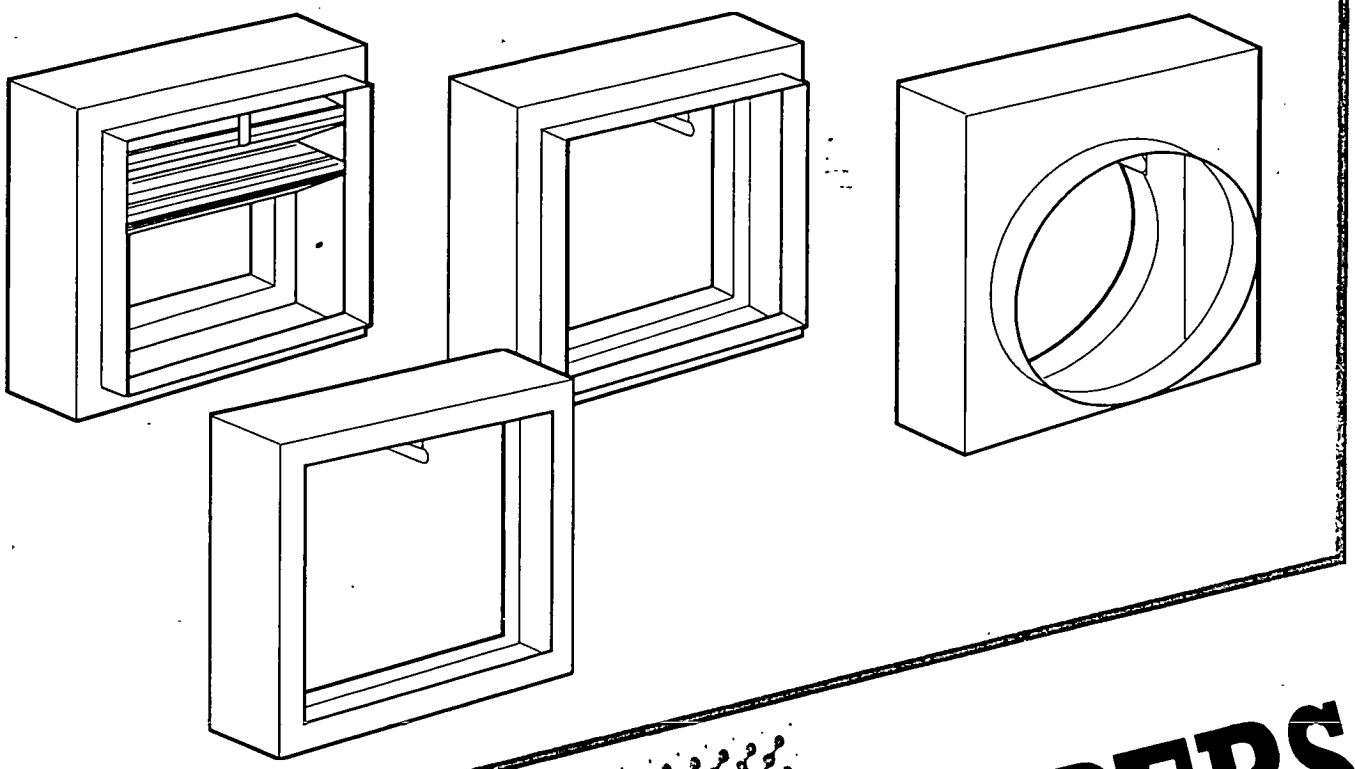
Laying and Fixing

Note: Except where fixing is by RLSD the customer is responsible for the safe laying and fixing of decking but in any event should note and ensure that all users and persons working in proximity to the decking are advised of the following:

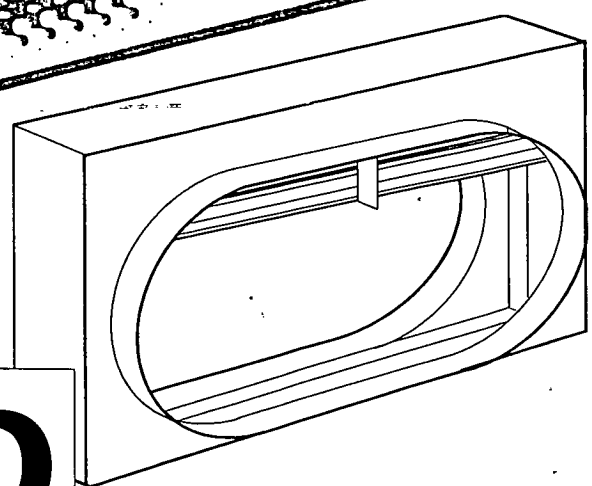
Fixing and Securing

The decking **MUST** be suitably secured to avoid excessive deflection or dislodgement during construction. In the case of steel frame support structures, shot fired pins or self tapping screws can be used through the decking directly to the steelwork provided that pins are at a maximum spacing of 300mm at panel ends and 600mm at intermediate supports. Welding may be carried out but care should be taken to avoid and prevent "burn through". Steelwork must be stable and adequately restrained with support for the deck around columns, stub columns, openings or any other penetrations.
Brickwork, blockwork and concrete supports must be adequately cured, sound and fit to receive decking panels. Decking **MUST** be secured by adequate masonry fixings at a maximum spacing of 300mm at panel ends and 600mm at intermediate supports.

FIRE DAMPERS



DAMPERS



FD SERIES

Introduction

The FD Series Steel Curtain Fire Damper is designed to stop the spread of fire through ducts, walls, floors and ceilings.

The product range has many features and options to meet the requirements of specifiers, contractors, local and national authorities. There are five casing variants with infinite sizing capability within minimum/ maximum dimensions. All are suitable for either low/medium or high velocity applications.

Features

- Low/medium and high velocity models
- Galvanised or stainless steel blades and casings
- Factory fitted HEVAC/HVCA approved installation frame (if required)
- Fully welded construction
- Infinite sizing capability
- Comprehensive control options
- Comprehensive status options
- Tested for a duration of four hours

Specifications and Testing

- Fire tested to BS 476

  Warrington Report WFRC C43264 (Stainless steel blades)

  Warrington Report WFRC C43265 (Galvanised steel blades)

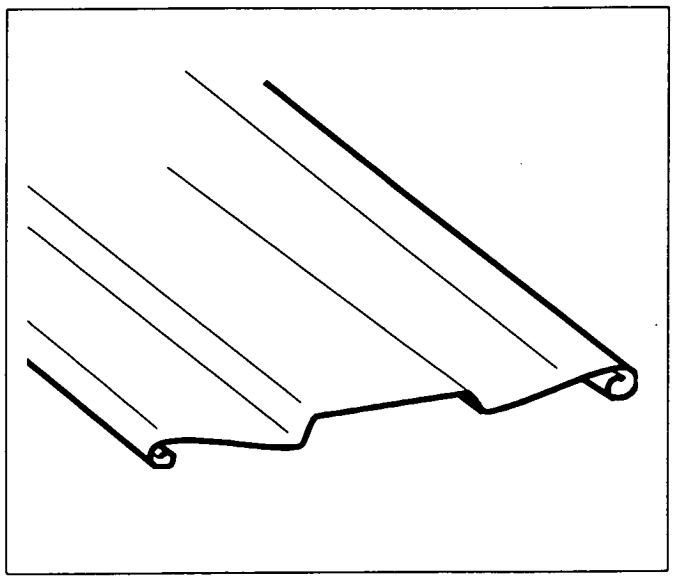
- 28 day salt corrosion test. Chatfield Report C7217 and C7218 refer

- Conformance to DW142 and Eurovent 2/2 as relevant

Blades

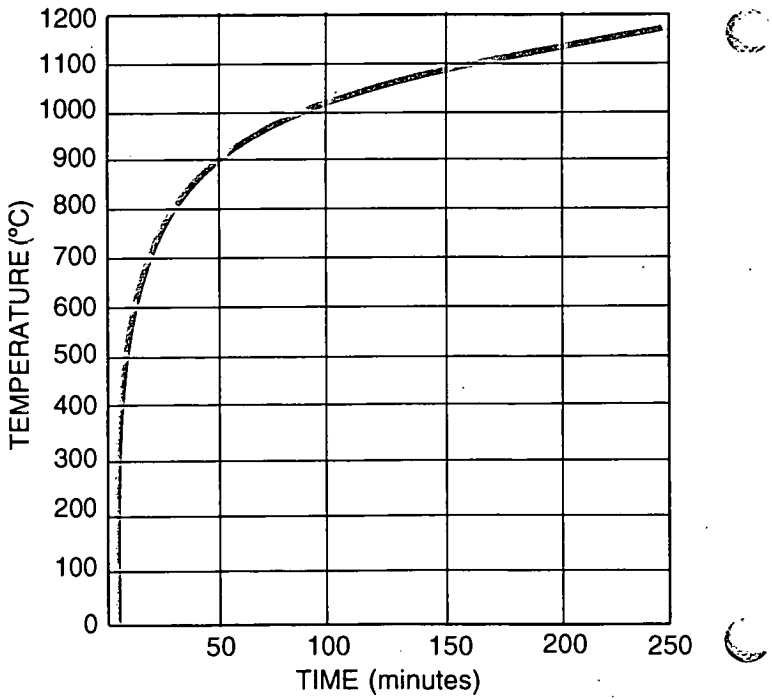
The roll-formed interlocked steel curtain section is available in either cold reduced hot dipped galvanised mild steel or stainless steel.

Formed within the full length of the blade are dual swages which provides additional strength and rigidity.



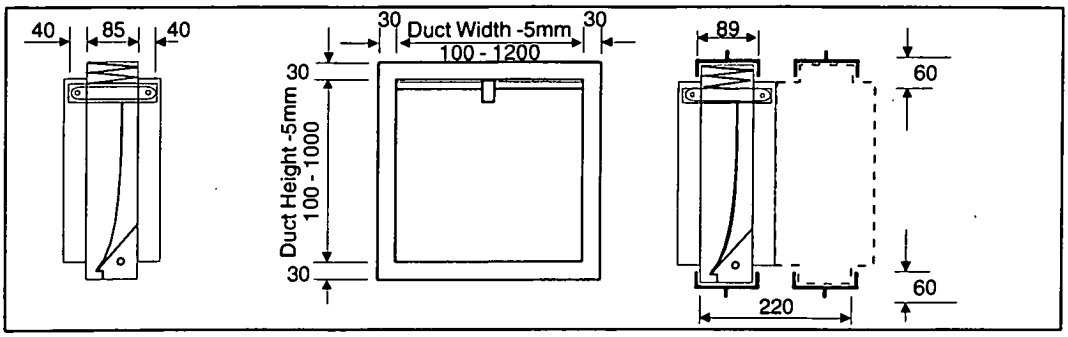
Fire Test

British Standard 476, Time Temperature Curve

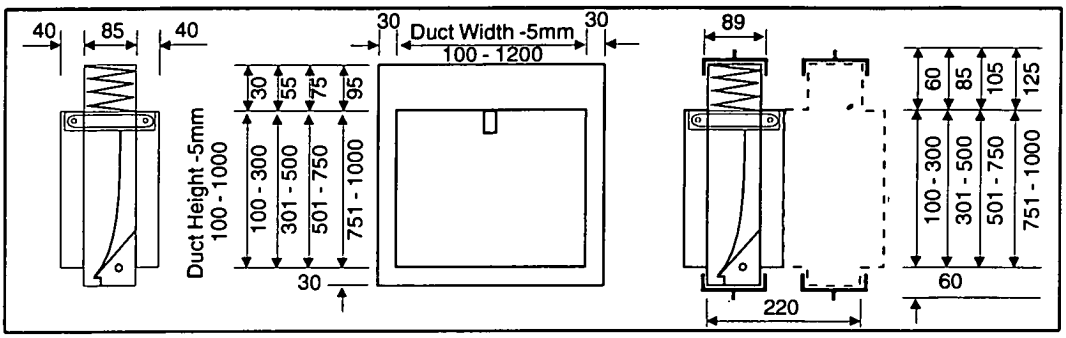


Dimensions

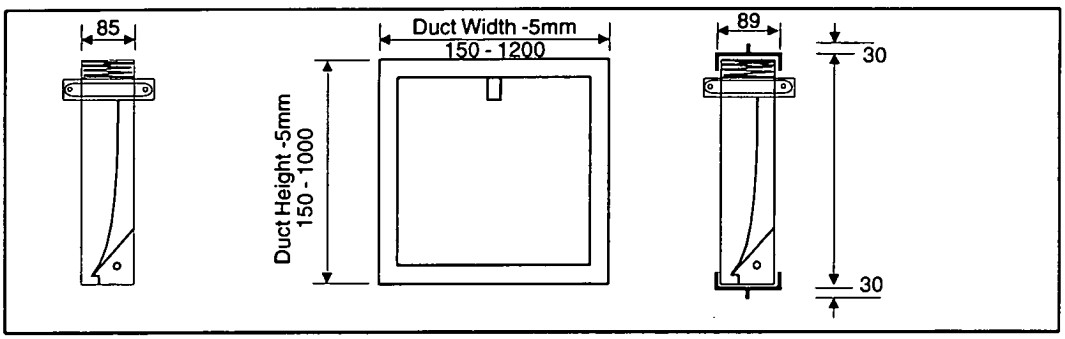
Type A Square/ Rectangular Spigot
(Blades partially in Airstream)



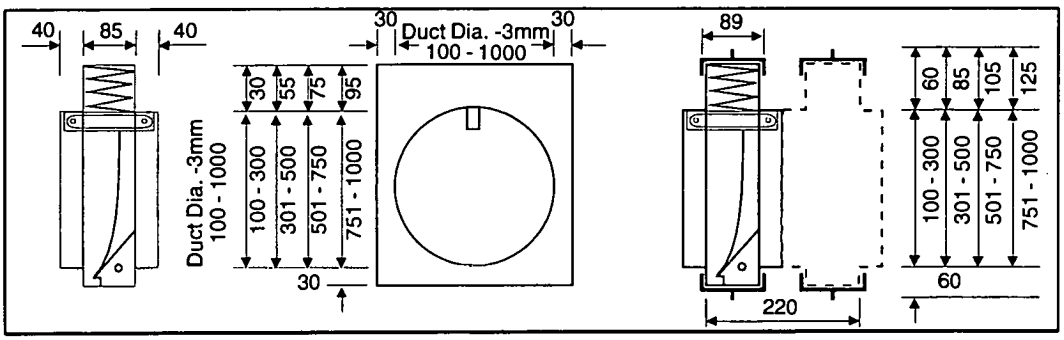
Type B Square/ Rectangular Spigot
(Blades out of Airstream)



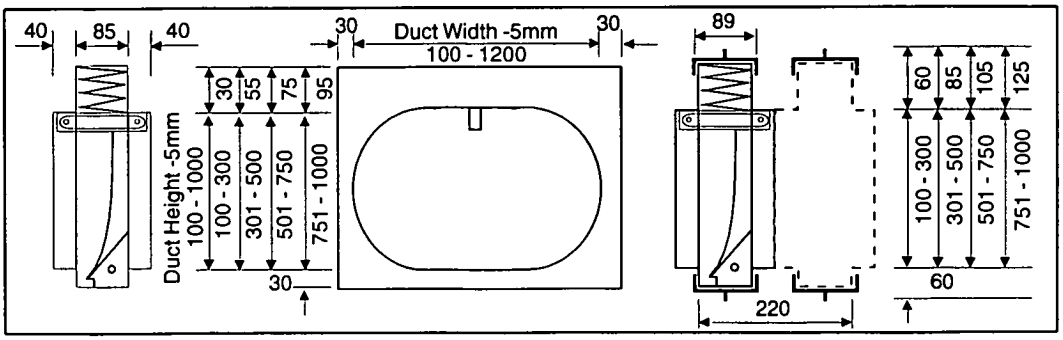
Type I Square/ Rectangular Case "Induct"
(Blades partially in Airstream)



Type C Circular Spigot
(Blades out of Airstream)



Type O Flat Oval Spigot
(Blades out of Airstream)



Notes: 1. All dimensions are in mm
2. Spigoted Models are supplied with actual spigot dimensions nominal less 5mm ± 1mm
3. For sizes greater than detailed maximum sizes, multiple section units would be supplied

HEVAC/HVCA Frames

The HEVAC/HVCA approved factory fitted Installation Frame is designed to allow expansion of the damper under fire conditions, without affecting its integrity or the construction it is installed within.

One Piece Corner Bracket

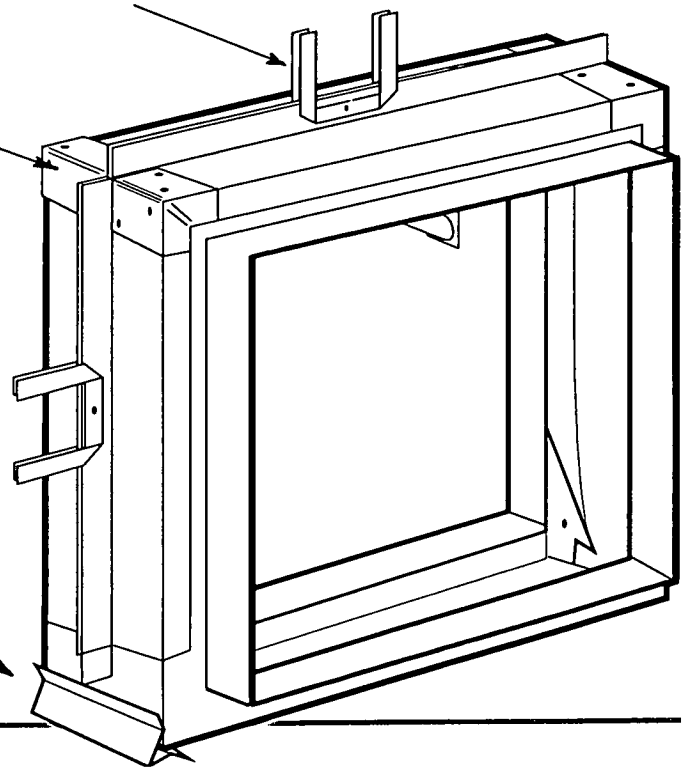
The one piece pressed corner bracket is riveted (using aluminium rivets) to the "Z" Section which makes the frame. This bracket allows the frame to expand under fire conditions without affecting the integrity of the construction it is installed within.

Expansion Corners

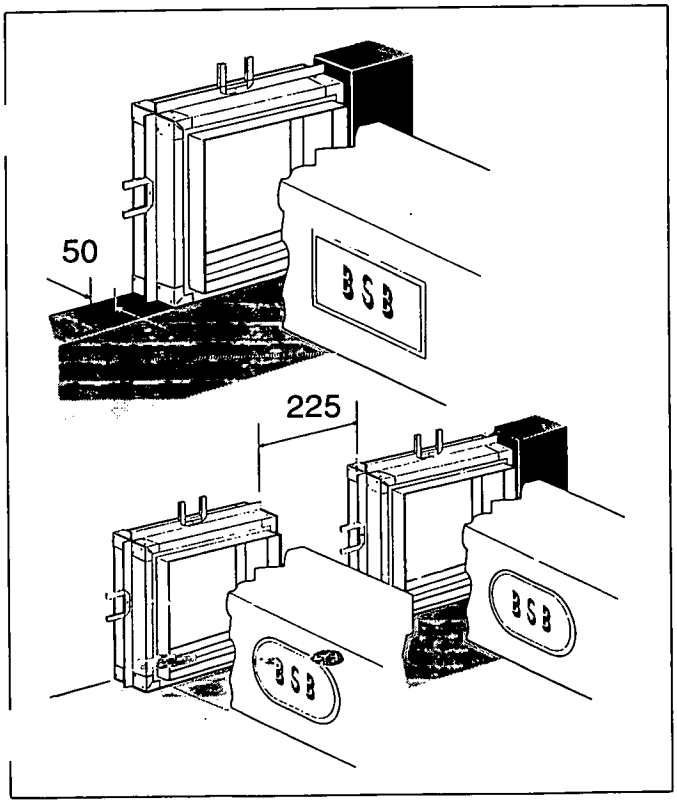
These pressed corners are fitted into each corner to permit expansion of the fire damper within the construction of the frame.

Fixing Tie Tabs

For securing the assembly into the builders work structure as specified by the specifying/ authorising authority.



Installation Codes of Practice



The frame should be installed centrally within the thickness of the surrounding wall or floor. Or, in the case of thick walls or floors, the centre line of the frame should be at least 50mm away from the nearest face.

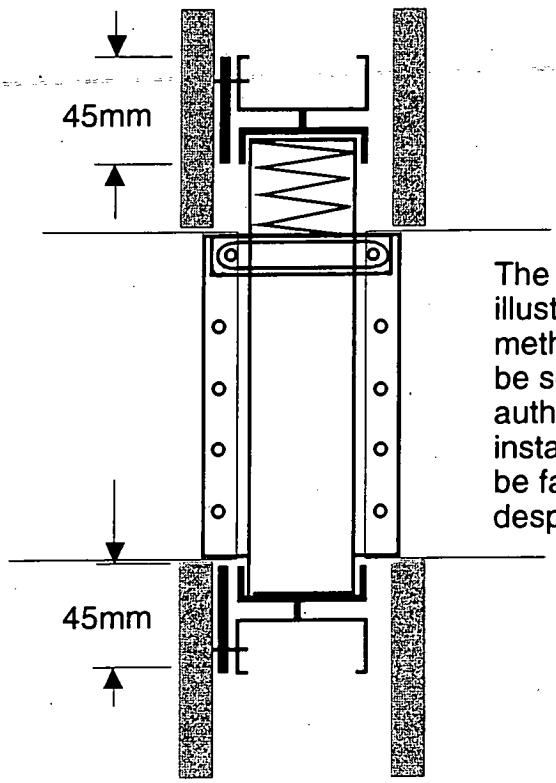
Where more than one duct penetrates a wall or floor, adjacent fire damper assemblies should be separated by builder's work of a minimum thickness of 225mm. During installation, all fixing tabs should be bent out and built into the surrounding structure so as to ensure "positive fixing into the surrounding builder's work".

The illustrated detail on this page is BSB's interpretation of the HEVAC/HVCA Installation Frame specification. For additional details, contact our sales office.

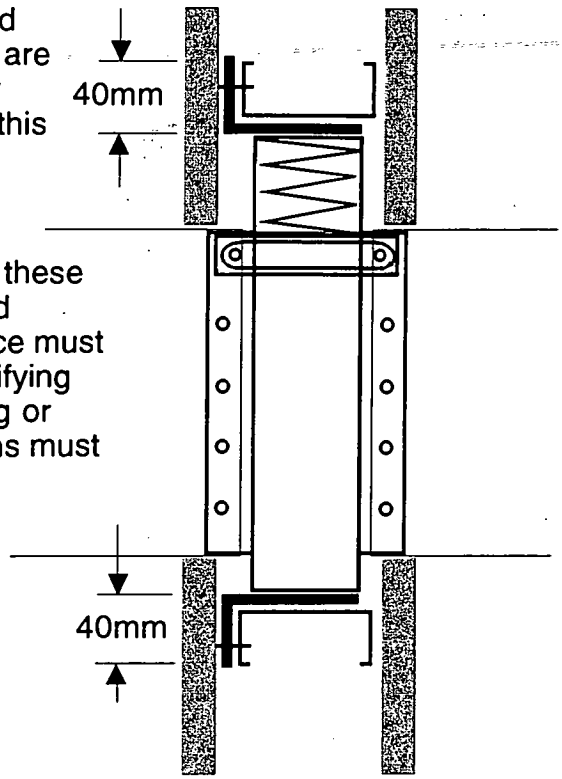
Special Note:
All fire damper installations should be carried out to the satisfaction of the appropriate district surveyor, fire officer and/or specifying authority as other approved methods of installation may well be used.

Other Methods of Installation

Dry Wall Partition



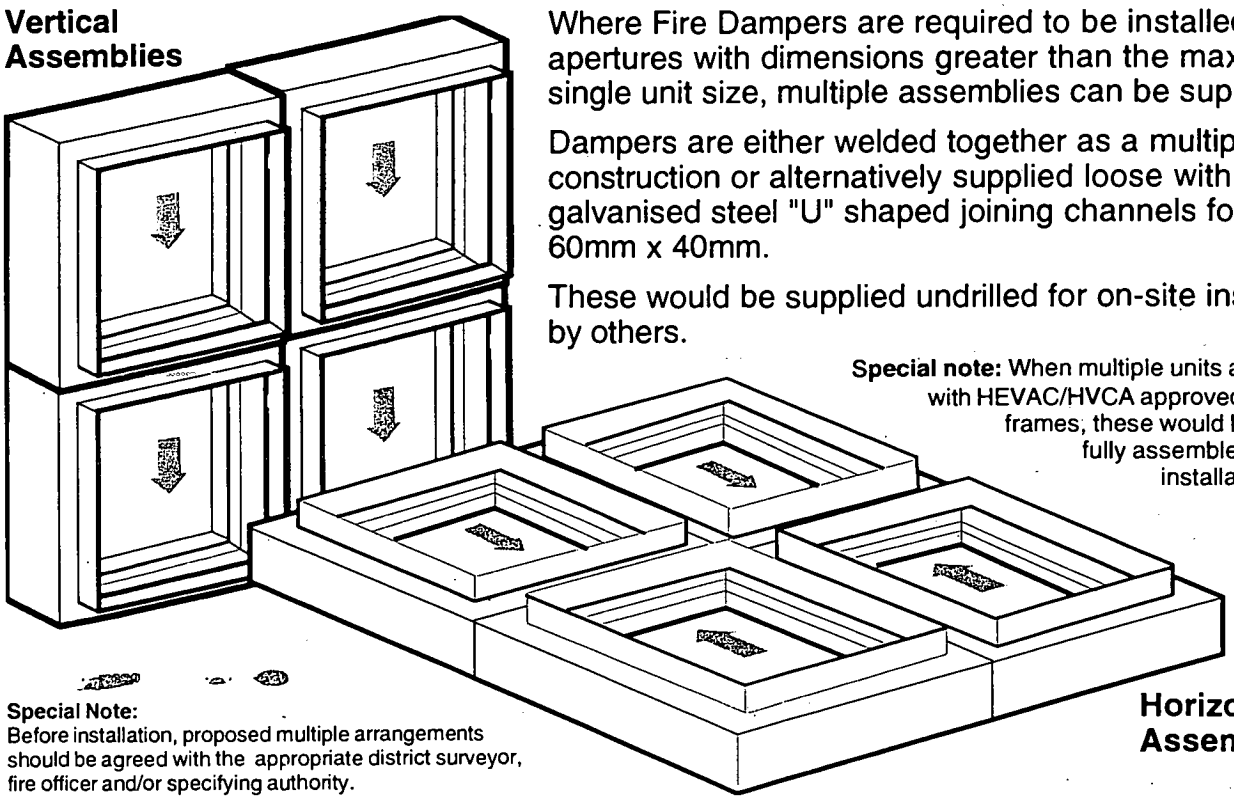
It is recommended that slotted holes are inserted for linear expansion within this "L" formed frame



The methods detailed in these illustrations are proposed methods only. Acceptance must be sought from the specifying authority prior to ordering or installation. These options must be factory fitted prior to despatch

Multiple Assemblies

Vertical Assemblies



Where Fire Dampers are required to be installed in apertures with dimensions greater than the maximum single unit size, multiple assemblies can be supplied.

Dampers are either welded together as a multiple construction or alternatively supplied loose with 1.6mm galvanised steel "U" shaped joining channels formed 60mm x 40mm.

These would be supplied undrilled for on-site installation by others.

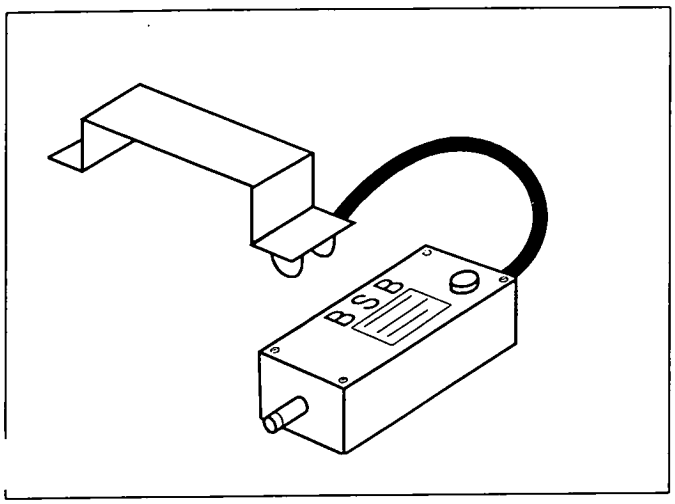
Special note: When multiple units are ordered with HEVAC/HVCA approved installation frames, these would be supplied fully assembled with the installation frame fitted

Special Note:
Before installation, proposed multiple arrangements should be agreed with the appropriate district surveyor, fire officer and/or specifying authority.

Horizontal Assemblies

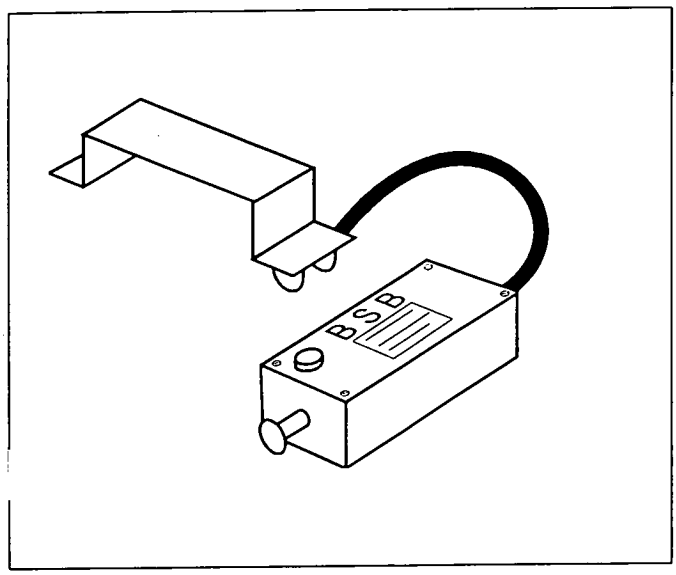
Control Options

Solenoid (De-energised)



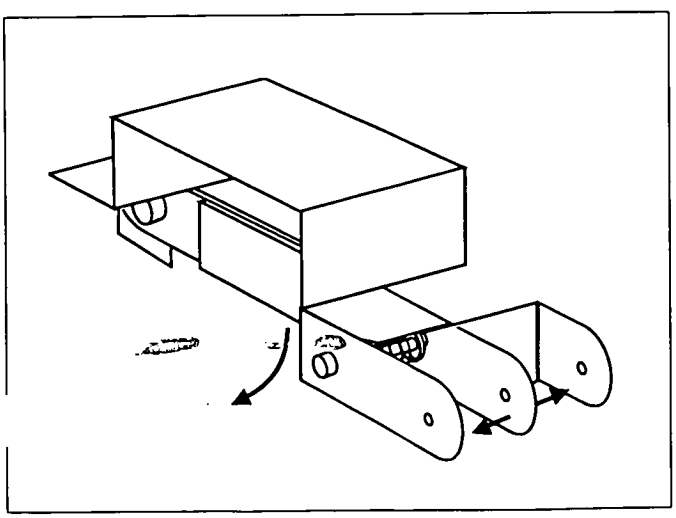
The BSB Solenoid is de-energised and is activated by receipt of an electrical signal.
The solenoid is fitted within a control box mounted to the ductwork and connected to the fusible link holding bracket by a cable that releases the fusible link upon receipt of an electrical supply. The cable is nominally 1 metre long with other lengths available to order.
When activated, the **Red** light will illuminate to report actuation.
240VAC 50Hz solenoids supplied as standard, other voltages available to order.
Available for sizes from 150 x 150mm to 1200 x 1000mm and 150 to 1000mm diameter.

Electro-Magnet (Energised)



The BSB Electro-Magnet is energised providing a continuous current is received. On termination of the electrical supply, the electro-magnet will activate.
The electro-magnet is fitted within a control box mounted to the ductwork and connected to the fusible link holding bracket by a cable that releases the fusible link upon termination of current. The cable is nominally 1 metre long with other lengths available to order.
When energised, the **Green** light will illuminate to report non-actuation.
24VDC 50Hz electro-magnets supplied as standard, other voltages available to order.
Available for sizes from 150 x 150mm to 1200 x 1000mm and 150 to 1000mm diameter.

Universal Cassette



Providing a dual-operation feature, this self-locating and easily resettable cassette can be used with either the solenoid or electro-magnet controls - or, as a standard component to assist the engineer in the resetting of the fire damper during regular inspection and maintenance procedures.

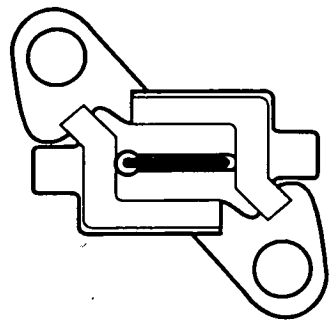
Control Options

Quartzoid Bulb Link

Manufactured from brass pressings and zinc coated, with the fast-response bulbs mounted in stainless steel seats.

Available in temperatures from:

57°C, 68°C, 79°C, 93°C, 141°C, 182°C to 227°C.

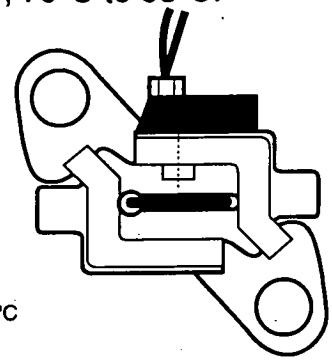


Thermo-Electric Quartzoid Bulb Link

As the standard link but with the addition of being electrically activated via a control panel for automatic response. available in temperatures from 68°C, 79°C to 93°C.

Electrical Specification:

Resistance:	0.9 - 1.6 ohms
Max. Monitoring Current:	0.01 Amp
Min. Operating Current:	1.0 Amp
Max. Operating Current:	5.0 Amp
Operating Time at Operating Current:	10 ms
Working Temperature Rating:	-40°C to +100°C

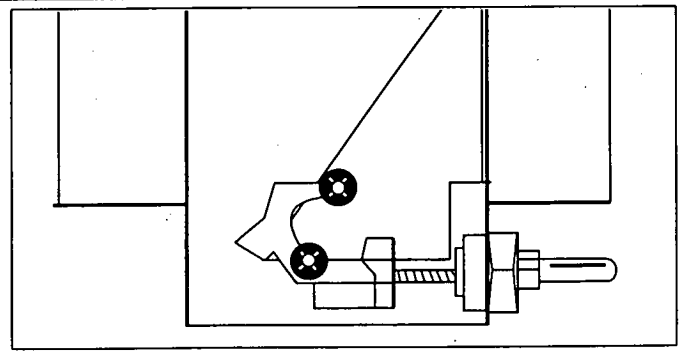


Blade Status Options

Mechanical Visual Indicator

To indicate local indication outside of the casing as to the blade status.

When the indicator appears in the bulb, this shows that the blades have closed.

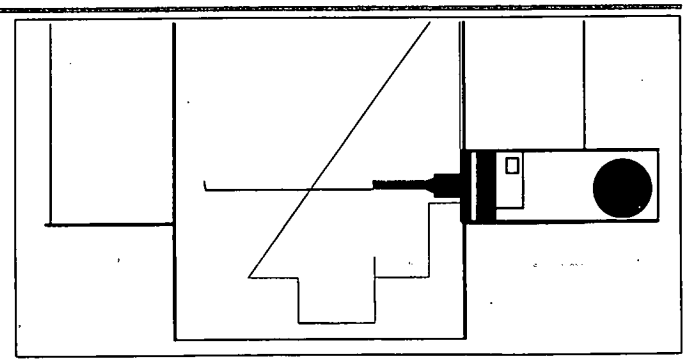


Single Pole Microswitch

To indicate remote indication outside of the casing as to the blade status. As the leading blade travels to the locking ramp, it contacts the arm and operates the switch.

Red = Common
Blue = Normally Open
Yellow = Normally Closed

Factory fitted.



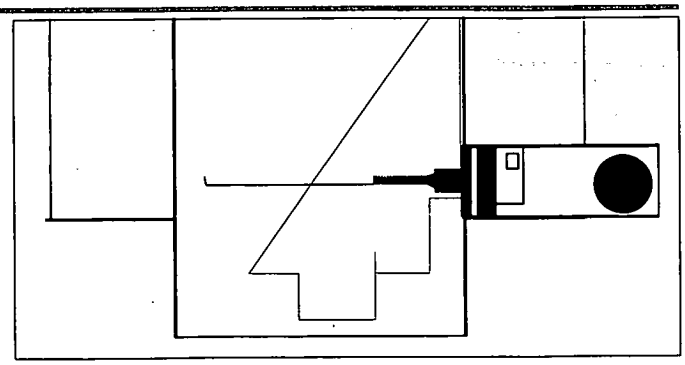
Double Pole Microswitch

Operates as above but with two switches for double pole operation. Provides a signal to a control panel enabling isolation of plant in case of fire.

Pole 1 and Pole 2

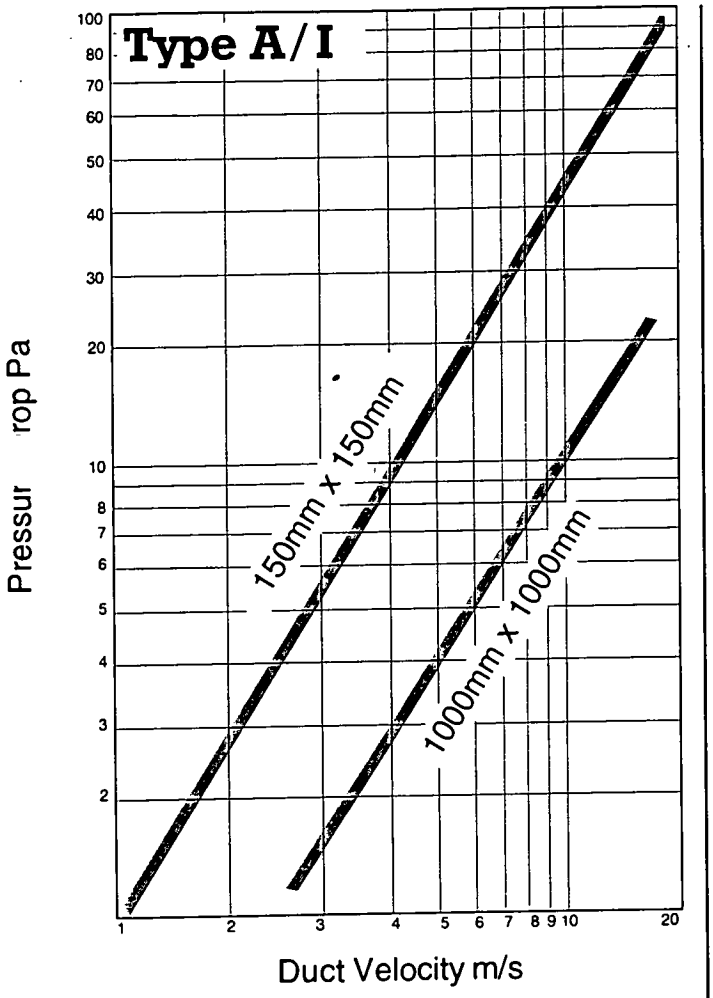
Red = Common
Blue = Normally Open
Yellow = Normally Closed

Factory fitted.

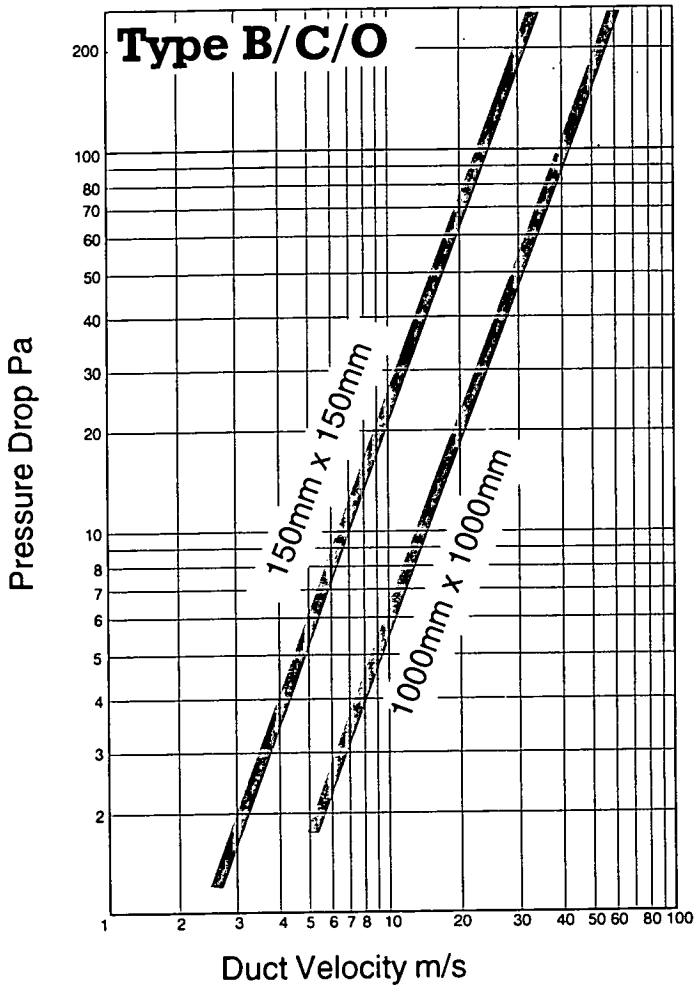


Performance Characteristics

Pressure Drop Graphs



Minimum free area = 91%
velocity range 0 to 12.5m/s



Maximum unrestricted airflow
velocity range 0 to 30m/s

Weight Chart (Kg) Models A and B

Damper Height (mm)	Width (mm)									
	100	200	300	400	500	600	700	800	900	1000
100	2.0	3.0	4.0	5.0	6.5	7.0	8.0	9.0	9.5	10.0
200	3.0	3.5	4.0	5.0	7.0	8.0	9.0	10.0	11.0	12.0
300	3.5	4.0	4.5	5.5	7.0	9.0	9.5	10.5	12.0	13.0
400	4.0	5.0	5.5	6.0	7.5	10.0	11.0	12.0	13.0	14.0
500	5.0	6.0	7.0	7.5	8.5	11.0	12.0	13.0	15.0	16.0
600	6.0	7.0	8.0	8.0	9.5	12.0	13.0	14.0	16.0	17.0
700	7.0	8.0	9.0	9.5	10.5	13.0	14.0	15.0	17.0	18.0
800	8.0	9.0	10.0	10.0	12.0	14.0	15.0	16.0	18.0	19.0
0	9.0	10.0	11.5	12.0	14.0	15.0	15.5	17.0	18.0	20.0
1000	10.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	20.0	22.0

FOR CIRCULAR AND FLAT OVAL MODELS ADD 25% TO THESE VALUES

For models with HEVAC/ HVCA Installation Frame, add a further 25%. These values have been rounded to whole numbers and are illustrated for estimation purposes only.

Engineering Specification

Casing

Formed to provide two continuous internal flanges not less than 25.4mm (1"). Casing and components not less than 1.6mm (16swg) thick cold reduced hot dipped galvanised mild steel to BS EN 10142 1991. Coating Class FE P02b Z275 NA.

Blades

Formed to provide a continuous interlocking hinge extending the full length with dual swages providing maximum strength and rigidity. Not less than 0.7mm (22swg) thick cold reduced hot dipped galvanised mild steel to BS EN 10142 1991. Coating Class FE P02b Z275 NA or Grade 430 stainless steel to BS 1449 Part 2 1983 S172B.

Fusible Link

Blades are held in the open position by a straight bar link rated at 72°C (169°F) with a formed reinforcing swage and two location holes. The fusing alloy is to BS 219. The brass is to BS 2870 and is electro-tinned and soldered following this process.

BSB can supply the FD Series Fire Damper with the alternative rated fusible links for higher temperature applications as follows:

95°C(202°F), 124°C(260°F), 145°C(286°F), 182°C(360°F)

Springs

Dampers are supplied with two constant force coil springs exerting a pull of not less than 35N, with one end fixed to the leading blade by rivets and the coil fitted onto the spindle of the locking ramp. The spring is manufactured from Grade 302 stainless steel to BS 5770, 4 hard.

Paint

All welds, seams and joints are sprayed with commercial grade zinc based paint.

Sealant

Where applicable, sealant conforms to DW142.

HEVAC/HVCA Installation Frame

The installation frame is factory fitted around the Fire Damper to allow expansion without either distorting or exerting severe stresses within the surrounding structure within which the assembly is installed.

The frame is formed with a "Z" section using galvanised mild steel 1.6mm (16swg) to BS EN 10142 1991. Coating Class FE P02b Z275 NA.

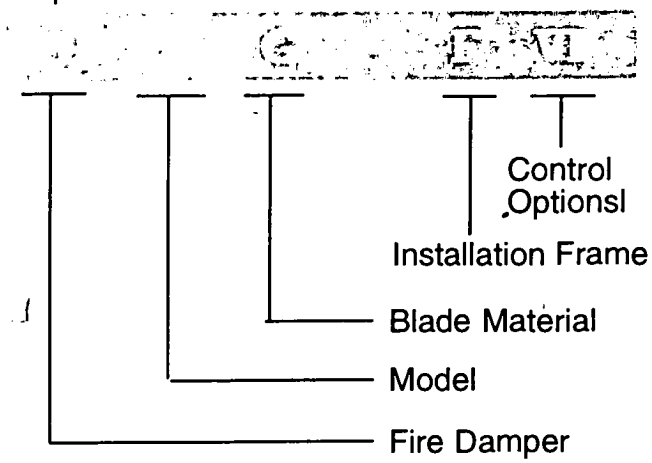
Corner brackets manufactured from 1.6mm galvanised mild steel are fixed to the "Z" section by four 5mm (3/16") diameter aluminium rivets.

A number of fixing tie tabs are positioned equally along each side of the frame, (as indicated below) for positive fixing into the surrounding builder's work to maintain structural integrity.

Duct Dimension (mm)	No. of equally spaced fixing points per side
Up to 508	1 MIN.
509 to 1016	2 MIN.
1017 to 1524	3 MIN.

Ordering Codes

Example:



FD Fire Damper

Model:

A Low/Medium Velocity
B High Velocity
I In Duct - Low/Medium Velocity
C Circular - High Velocity
O Flat Oval - High Velocity

Blade Material:

G Galvanised Mild Steel Airfoil Blades
S Stainless Steel Airfoil Blades (state grade)

Installation Frames:

F Fitted with HEVAC/HVCA Installation Frame

Control Options:

SL Solenoid (state voltage)
EM Electro-Magnet (state voltage)
QB Quartzoid Bulb
ETL Thermo-Electric Quartzoid Bulb
VI Visual Indicator
MS Micro-Switch Fitted (state single or double pole)

BSB Product Range

AD Series Access Doors
CB Series Circular Blade Fire Damper
DD Series Duct Damper
FD Series Fire Damper
FS Series Fire/Smoke Damper
HD Series Heavy Duty Control Damper
PR Series Pressure Relief Damper
SC Series Smoke Control Damper

Authorised Agent:

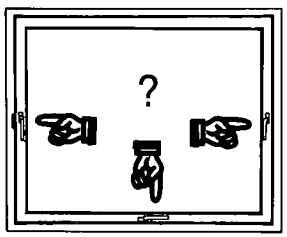
BSBFD. Feb. 1996

Designed and Produced by Deenside Twink Limited.

2 Window handles Always fully turn handles when operated.

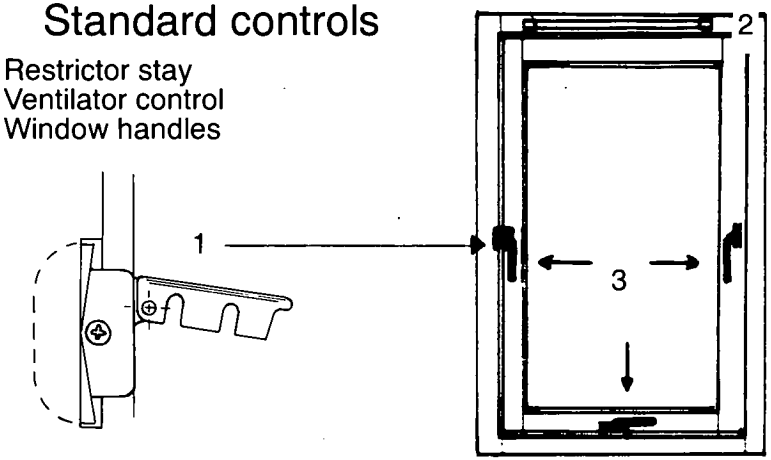
3

Handles can be operated one at a time - no need to stretch out!

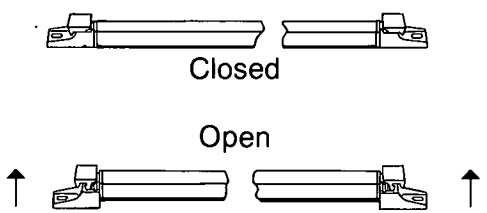


4 Standard controls

1. Restrictor stay
2. Ventilator control
3. Window handles



5 Ventilator control (trickle vent)



'Flick' out either or both ends for half or full trickle airflow.

Push in to close.

In severe storms it is possible a bit of rain can get through, if this happens simply close the vent.

6 Nor-Dan Tilt & Turn - principles

Nor-Dan Tilt & Turn windows do not operate quite the same as windows which you are probably used to. While there are other types of tilt & turn on the market, Nor-Dan is in a class of its own.

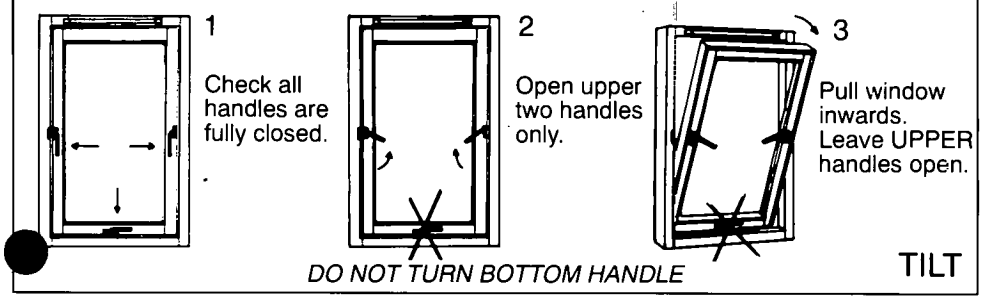
To gain full benefit of the Nor-Dan system, all you need to do is READ ALL THIS BOOKLET *BEFORE* operating Nor-Dan for the first time. The booklet not only describes HOW to use the windows, but also WHY.

Tilt & Turn operates 2 quite different ways -

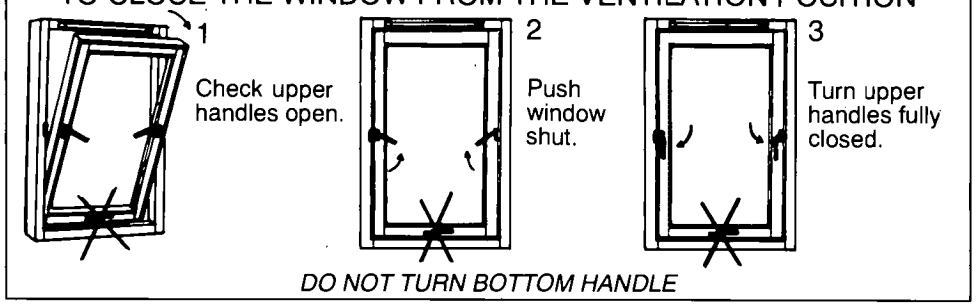
TILT is designed for everyday use, it is the way to gain ventilation for any room. It is important that for *everyday use* ONLY THE TILT position is used.

TURN is for cleaning. The turn position should NEVER be used for ventilation. For safety reasons the turn position does not have any form of catch or restrictor stay provided.

HOW TO OPEN THE WINDOW TO THE VENTILATION POSITION

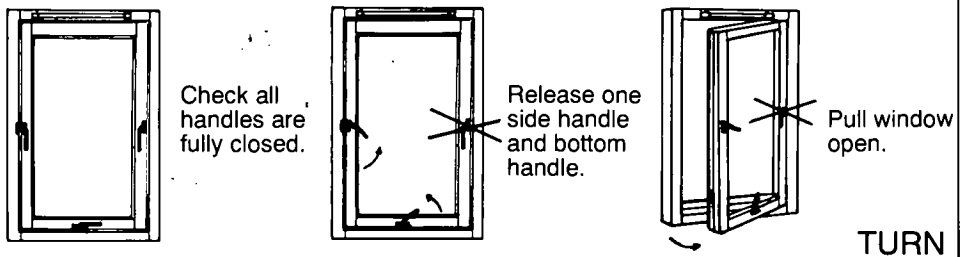


TO CLOSE THE WINDOW FROM THE VENTILATION POSITION



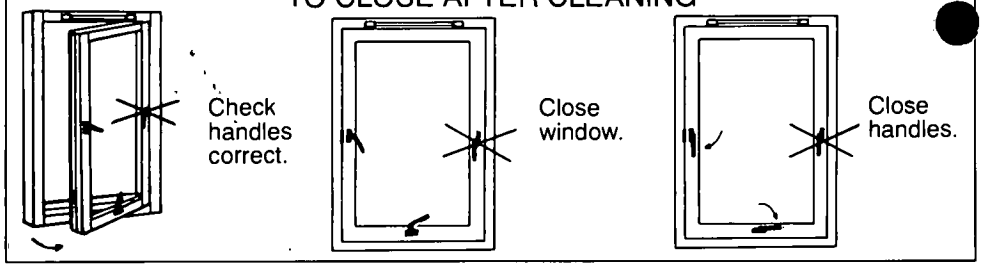
FOR EVERYDAY USE, ONLY THE TWO UPPER HANDLES ARE USED

7 Cleaning position



Note: Windows are either left hung or right hung. See Section 8 before opening for cleaning.

TO CLOSE AFTER CLEANING



SAFETY 1ST **WARNING** **SAFETY 1ST**

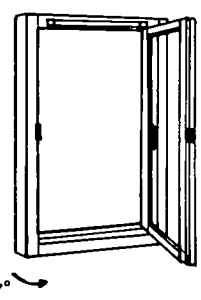
Whether you live on a first floor or in high rise, there are some simple rules to follow to avoid accidents which are common to ANY type of window.

BEFORE CLEANING ENSURE THESE SIMPLE PRECAUTIONS ARE OBSERVED AT ALL TIMES.

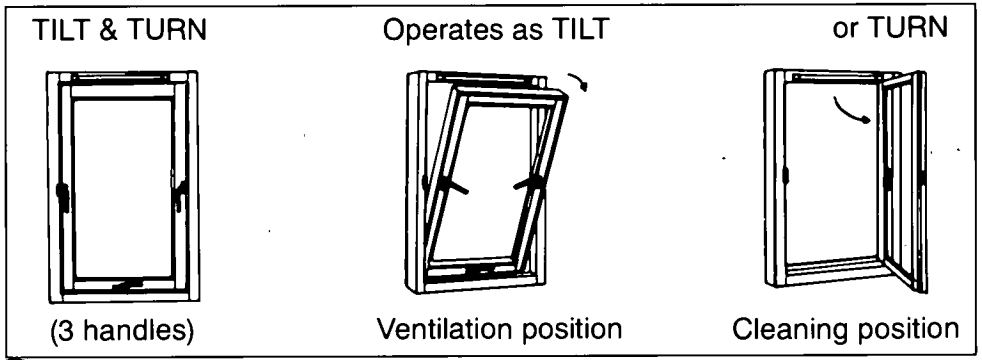
- Always choose a calm day to turn the windows for cleaning.
- Never clean with children/toddlers around.
- Remember - for cleaning - OPEN-CLEAN-CLOSE - in one operation and without interruption.

CLEANING POSITION

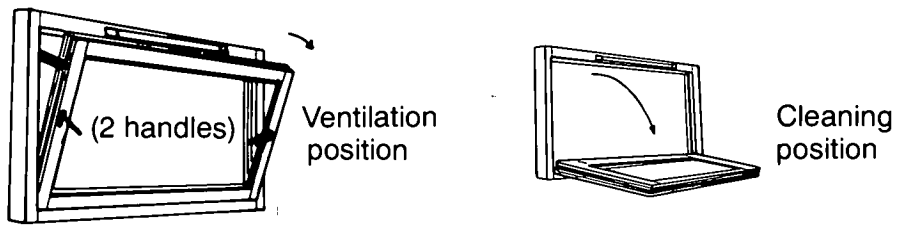
Maximum opening is about 67° — more than adequate to clean the outside — while standing safely inside.



1 Identify the type of windows in your home

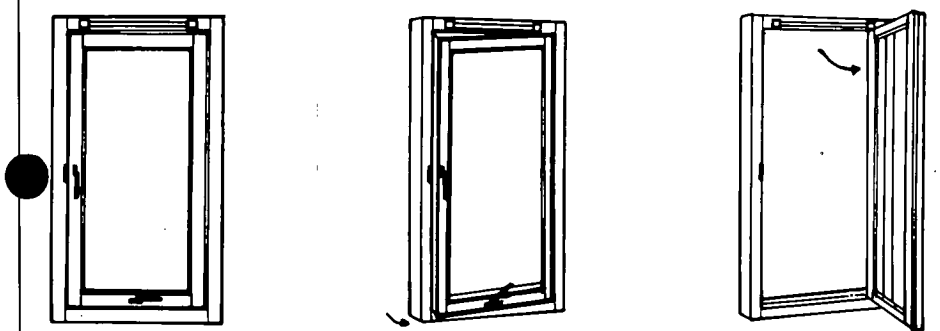


BOTTOM HUNG
Operates as Tilt for Ventilation and lowers down for Cleaning



NOTE: THE RESTRICTOR STAY ON BOTTOM HUNG NEEDS RELEASING TO LOWER DOWN FOR CLEANING

SIDE HUNG
Operates as Turn for Ventilation and opens wide for Cleaning



NOTE: THE RESTRICTOR STAY ON SIDE HUNG IS THE SAME AS TILT & TURN

Note: All windows shown open INWARDLY.

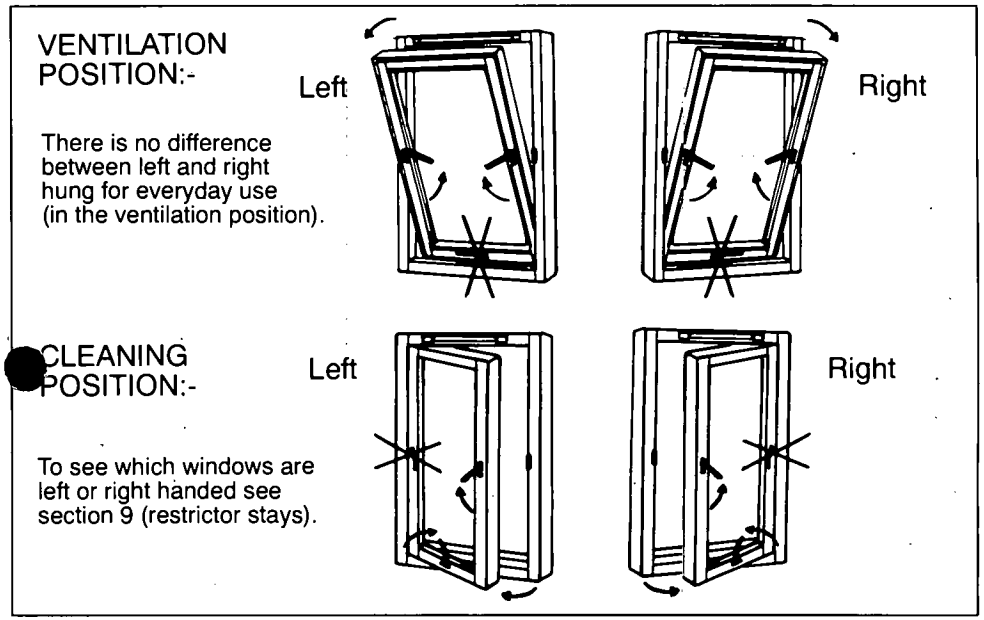
Please read ALL this booklet BEFORE using Nor-Dan windows for the first time.

Welcome to **Nor-Dan** windows!

Please read ALL this booklet before using your windows for the first time. Especially the SAFETY SECTION.

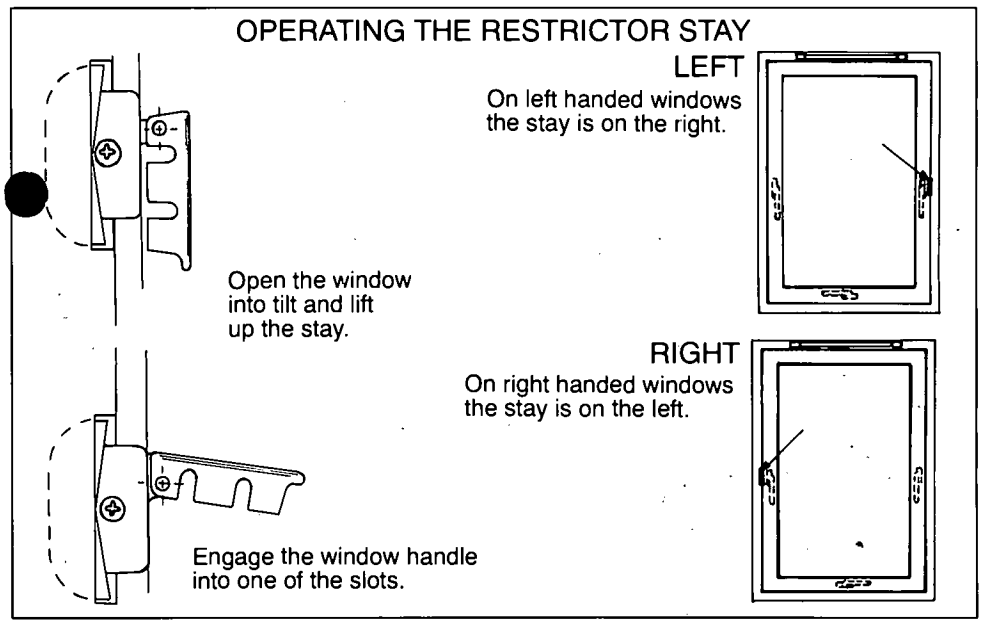
Nor-Dan windows are simple, reliable and genuine high performance products. Tilt & Turn are 30 years old and over 3,000,000 are in daily use. This design has developed over the years to give you the very best a window can offer.

8 Left and right handed Tilt & Turn



9 Restrictor stays

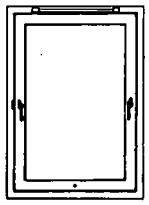
Restrictor stays are designed for use in the tilt position ONLY. Using the stay enables the window to be held in 3 different positions when open. It is recommended to ALWAYS USE the restrictor stay when the window is open because it stops the window moving on its own on windy days.



10 Removable handles

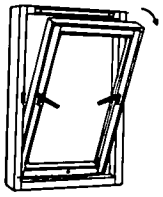
Some Tilt & Turn windows have a removable handle which is usually provided in the bottom position (as shown on diagram). Its purpose is to improve safety, by restricting daily use to the ventilation position ONLY. Which generally improves safety standards when there are children about.

Handle removable.

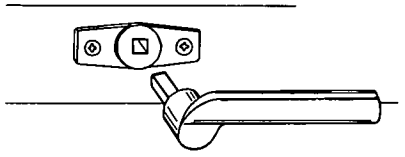


No handle

Safe to leave with children about.



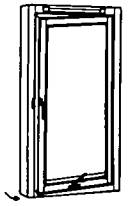
Insert the handle to turn the window into its cleaning position. (see section 7).



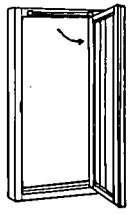
STORE YOUR REMOVABLE HANDLE IN A SAFE PLACE, OUT OF REACH OF CHILDREN.

11 Side hung

VENTILATION POSITION



CLEANING POSITION

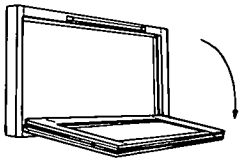


Treat as Tilt & Turn. Use the restrictor stay only for day to day ventilation. For cleaning - simply open wide for access, then close the window afterwards.

Bottom hung

Use the restrictor stay for daily use.

When cleaning, release the restrictor stay and gently lower the window down without letting go.

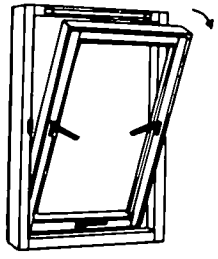


TIPS TIPS TIPS TIPS TIPS TIPS

Ventilator: Always leave the ventilator open, it helps keep damp away and provides limi fresh air without draughts (see section 5).

Curtains: Hang curtains across the wall, not inside on the window.

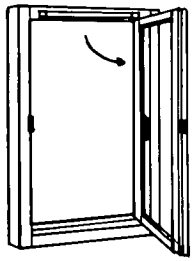
Hot summer days: Keep curtains drawn in bedrooms to keep rooms cooler. Roller blinds, (transparent or otherwise) are very good at keeping temperatures inside under control.



In practical terms the amount of ventilation available between Tilt and Turn is the same.

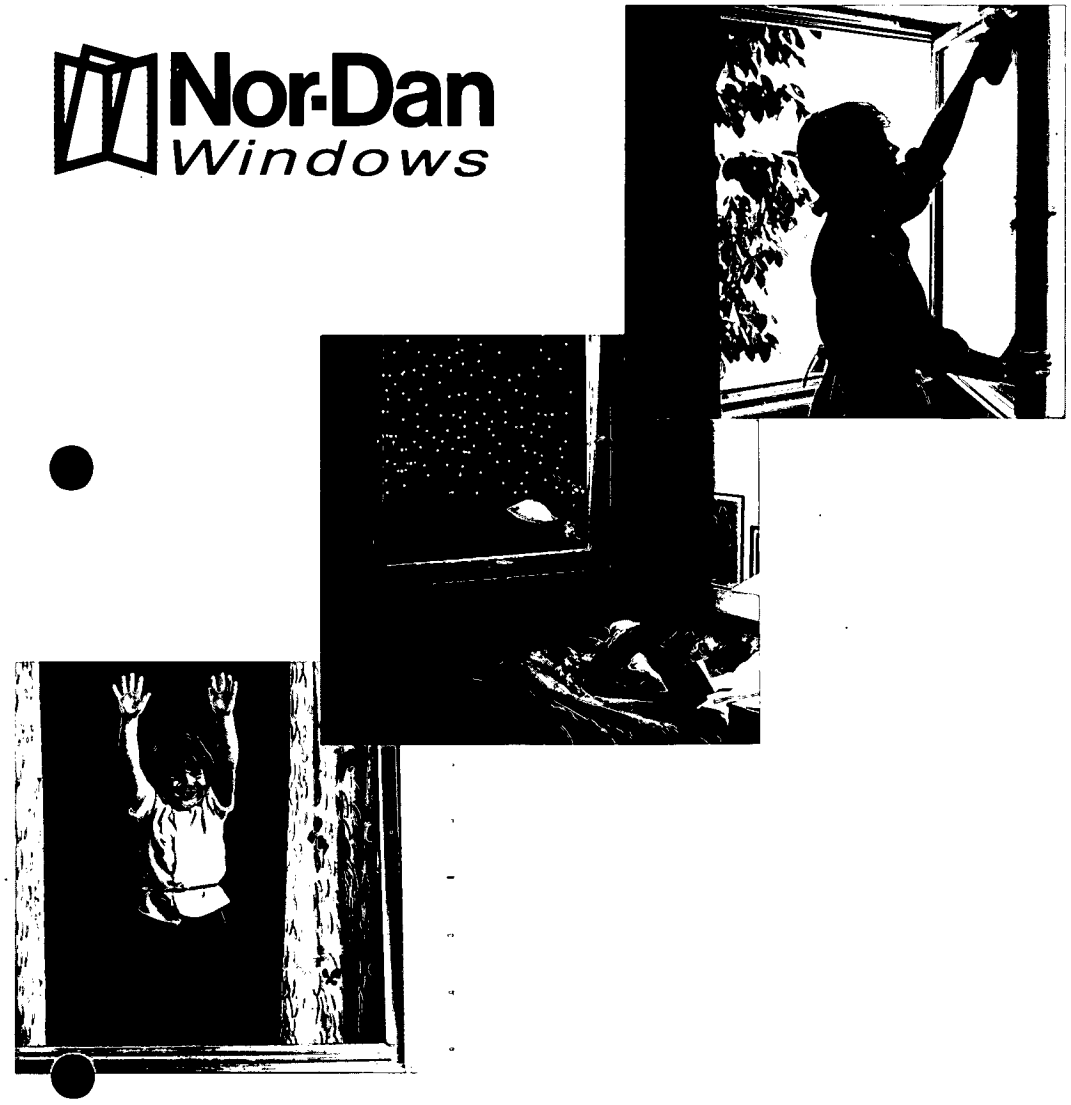
Tilt

Turn



ONLY USE TILT FOR VENTILATION

Nor-Dan Windows



OPERATORS' MANUAL
WITH
SAFETY GUIDELINES

PLEASE PRESERVE THIS WINDOW BOOKLET AND PASS ON TO NEW HOUSEHOLDERS IF YOU MOVE AWAY

22/05/02

CAIRNGORM FUNICULAR

BOTTOM STATION

NOR-DAN WINDOW AND SCREEN SUPPLY INFORMATION

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Factory Acknowledgements – 15 pages

Operators Manual with Safety Guidelines

Nor-Dan Window and Door Book

STRUCTURAL REPORT

CAIRNGORM FUNICULAR
BOTTOM STATION.

McBrides
Consulting Engineers
67 East Main Street
Whitburn
West Lothian
EH47 0RF
01501 740620

Cairngorm Funicular, Bottom Station.

1.0 Introduction.

1.1 At the request of Aberdeen Window and Door Systems Limited, an appraisal of the structural requirements for the installation of the proposed windows and screens was undertaken to ensure compliance with the appropriate Codes of Practice, British Standards and the wind loading as detailed by the Client.

2.0 Structural Assessment.

Window W10.

2.1 The main structure of the building has 139.7 mm diameter x 5 mm wall thickness circular hollow section columns which are understood to be located at every mullion. These columns should be used to provide support for the frames by welding a 150 x 10 thick Grade 43 steel plate x 6 mm fillet welds to the column and the length of the fin will be dependent on the distance from the frame but should give a penetration of 70 mm and be holed to allow for the passage of an M8 bolt through the adjacent jambs and through the plate to provide the necessary support. These fins should be located 250 mm from the top and bottom of the frame and at 500 centres thereafter to give four fins and four fixings.

2.2 The horizontal joint between the top and bottom frames should be strengthened by the provision of a 150 x 90 x 10 rolled steel angle Grade 43 steel fixed to each column by bolting with an M12 bolt or alternatively by site welding. Where the long leg passes between the two horizontal frames, the frames should be bolted to the steel angle with an M12 bolt at the centre point of each frame to provide the necessary support.

2.3 At the sides of the screen the jambs should be fixed to the blockwork using Philips Redhead nylon frame plugs NFP 10115 length 135 mm, 10 diameter at 400 centres up the sides. Similarly two fixings should be located through the cill of each frame into the blockwork below. Where a packer is installed between the frame and the blockwork then the packer should be fixed as described above and the frame fixed to the packer using 12 gauge wood screws at 300 centres, length sufficient to give minimum 45 mm penetration into the packer.

Window W1

2.4 Because of the height of this variable screen, the jambs require to be strengthened to provide the necessary support. This additional support should be provided by a steel plate 80 mm wide, 10 mm thick, the full length of the appropriate jamb and both the jambs and the steel plate should be drilled commencing 150 from the top and bottom of the jamb and thereafter be located at 400 mm centres to take 8 mm bolts counter sunk to the frame.

2.5 Where the jambs are located at the side against the blockwork, they should be fixed to the blockwork using Philips Redhead nylon plugs NFP 10115 length 135 mm, 10 diameter and these should be located at 400 mm centres, with minimum embedment into the concrete block of 70 mm.

2.6 The head and cill should also be fixed with similar fixings and these should be 2 Nr. per frame.

Window W5.

2.7 The vertical jambs between the two frames of window 5 should be screwed together using 12 gauge wood screws at 200 centres and minimum length 70 mm.

2.8 The jambs to the side should be fixed to the blockwork using Philips Redhead nylon frame plugs NFP 10115 length 135 mm, 10 diameter at 400 mm centres. There should therefore be three fixings on the upper part of the frame and two below on the insulated panels.

2.9 At the head and cill a minimum of two fixings as described above should be used on each frame giving four in total.

2.10 At the horizontal joint between the top frames and the bottom insulated frames a steel angle should be fixed to the face of the concrete floor using a 100 x 100 x 10 steel angle Grade 43 steel bolted to the floor with M12 bolts at 600 centres with minimum 75 penetration into the concrete. thereafter the two horizontal frames should be fixed through the steel angle using M8 bolts 2 Nr. on each frame.

Window W6.

2.11 The fixings for the cill, head and side jambs should be by Philips Redhead nylon frame plugs NFP 10115 length 135 mm, 10 diameter at 400 centres up the jambs and 2 per frame on head and cill.

2.12 The jamb to jamb connections between the first four or taller frames should be strengthened by an 80 x 10 mm Grade 43 steel plate placed between them and holes drilled to take M8 bolts at 400 mm centres commencing 150 from the top and bottom of each frame. The head and the nut should be counter sunk. The two remaining jamb to jamb connections should be effected using 12 gauge wood screws 70 long at 200 centres.

Signed... Personal Data Redacted

Date.....11-10-2000.....

McBrides
Consulting Engineers
67 East Main Street
Whitburn
West Lothian
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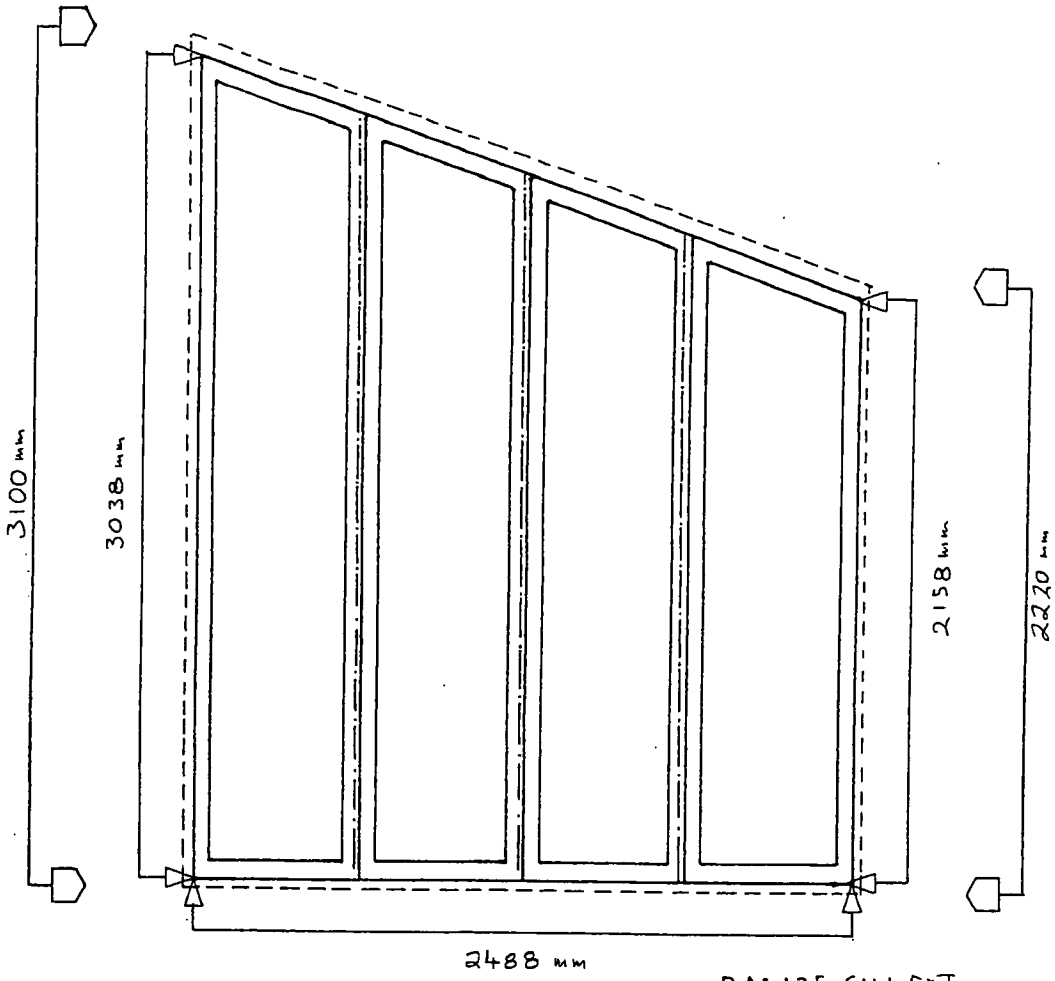
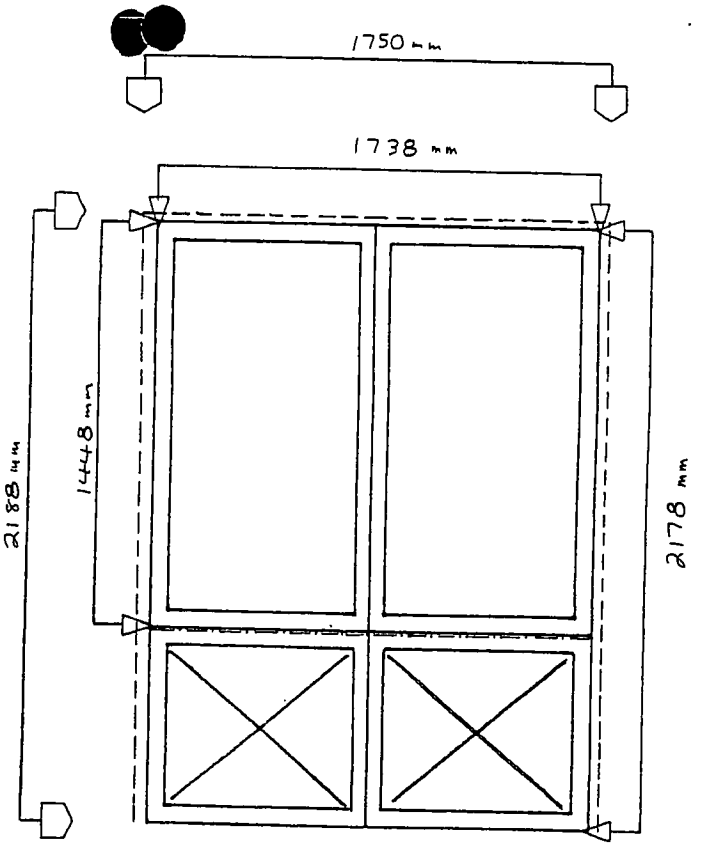
01501 740620



RAS125 SILL EXT.

W1.



W5.

RAS305 HORIZONTAL COUPLING FLASHING FOR JOINT BETWEEN W5 AND EXTERNAL DOORSET D3.

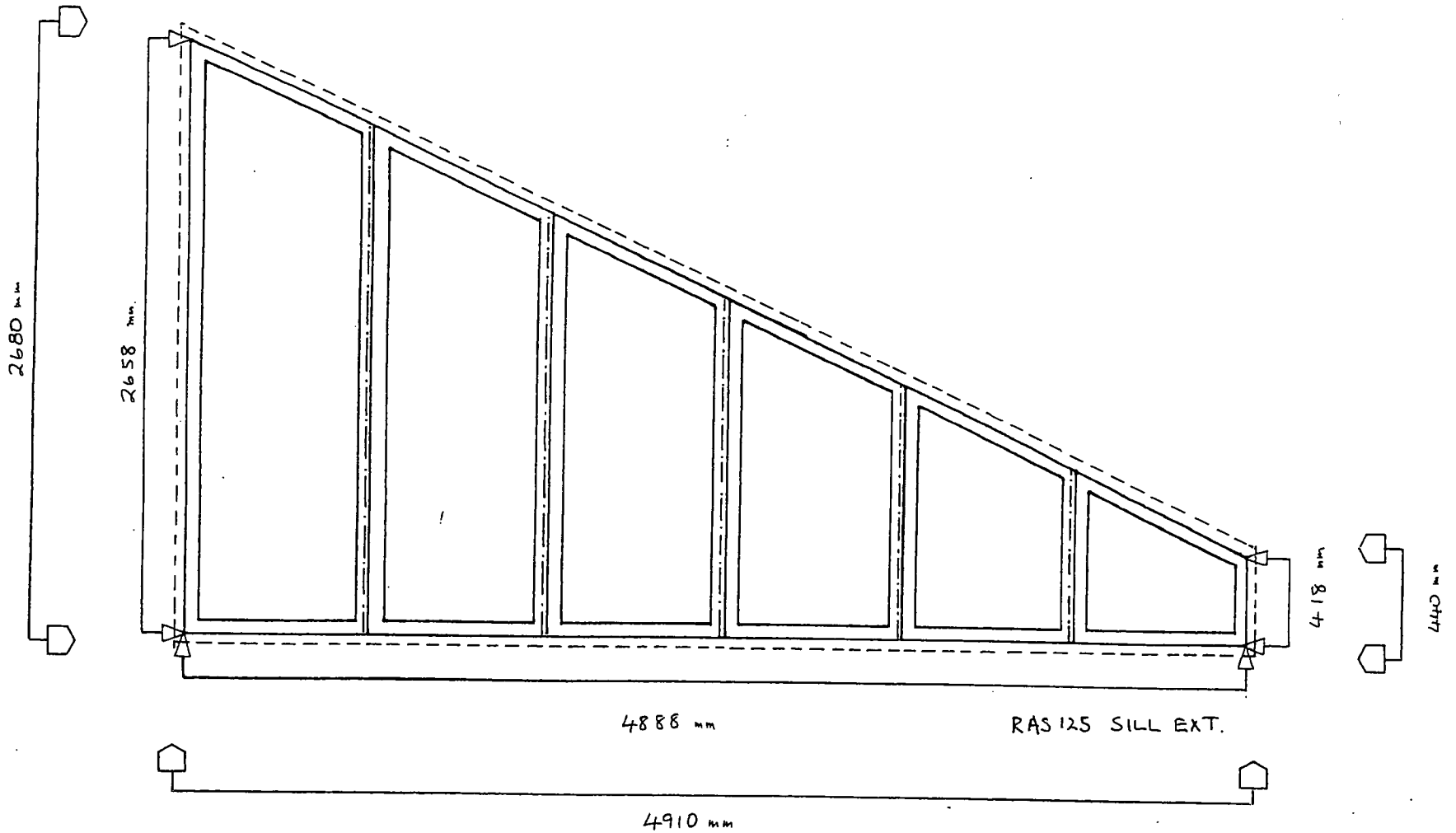
15/09/00

A.W.D.S.

CAIRNGORM FUNICULAR

BOTTOM STATION

SCREENS W1 + W5



PAGE 6.

A.W.D.S. 15/09/00

CAIRNGORM FUNICULAR

BOTTOM STATION

SCREEN W6