Uniclass L333: P41	EPIC C33: X412
CI/SfB (29) Xh2 (X7)	

April 2010

Shearail® | punching shear reinforcement to BS 8110

Certificate No: 136/07

Technologies for the construction industry

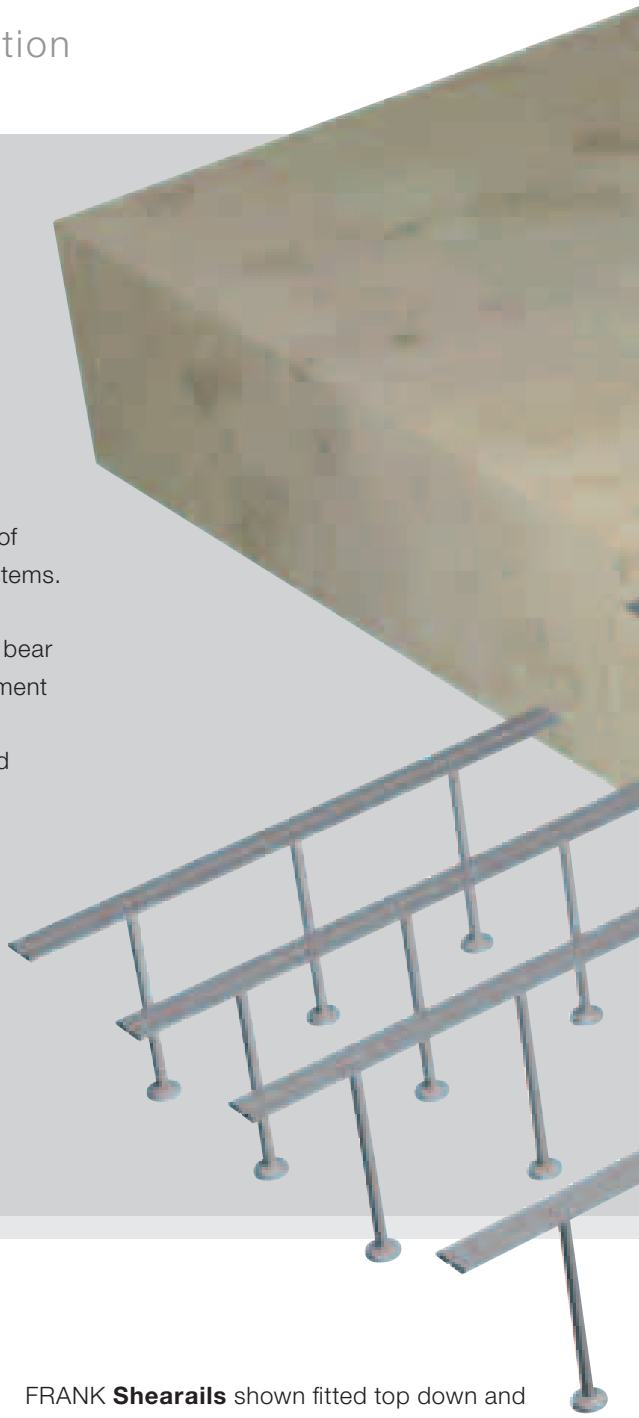
FRANK®

From groundbeams and pile caps to slabs and circular columns, more and more aspects of the construction process are benefiting from the use of components that are prefabricated and tailored to suit the requirements of each specific project.

This move towards off-site engineering is widely recognised as helping to speed construction, improve build quality, reduce dependency on skilled labour and – through reduced construction times – deliver significant cost reductions too.

The FRANK Group has been at the forefront of this revolution from the outset, developing technologies such as the renowned Pecafil® and Stremaform® systems and introducing a range of other innovative products and systems.

Today this expertise is brought to bear on another area with the development of the **Shearail** punching shear reinforcement system for flat, piled and post-tensioned slabs.



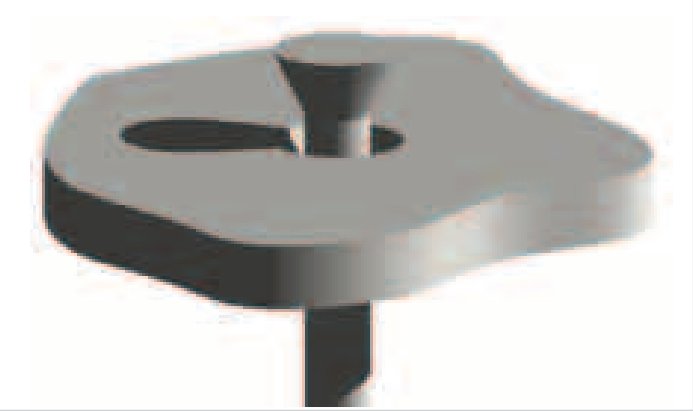
FRANK **Shearails** shown fitted top down and arranged in an orthogonal pattern around a square supporting column. Although shown here in plain bar, **Shearail** is also available in ribbed bar upon request.

Certificate No: 136/07

Shearail from Max Frank Limited is the only punching shear solution approved by BRE, providing Consultant Engineers, Contractors and Local Authorities with the assurance that the material is from a traceable source and has been independently tested and verified for use in concrete floors in accordance with BS 8110 and BS EN 1992-1-1 (EC2). As a BRE accredited product, Shearail is unique to competitor products. It provides Max Frank customers with confidence about its performance and ensures peace of mind.

A proven solution - prefabricated

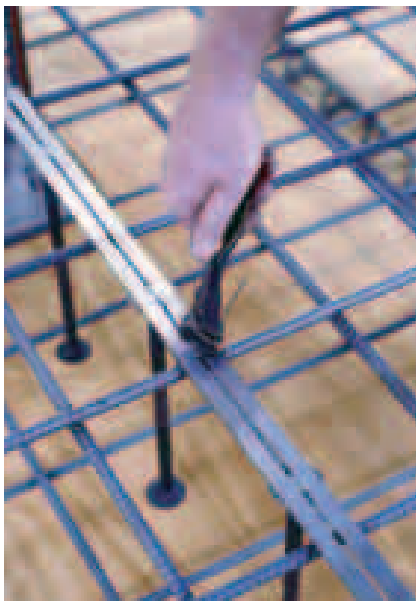
Flat slab construction is among the most efficient methods of construction, enabling a consistent head space (i.e. a flat soffit) to be achieved across the entire floor with the resulting benefits of easier layout of services and reduced overall floor-to-floor heights.



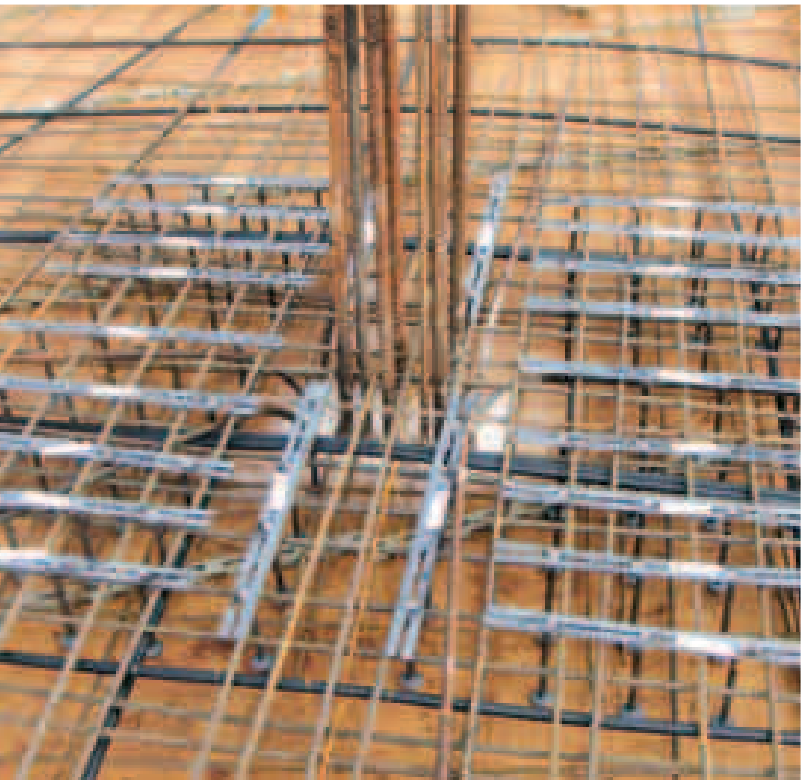
The challenge faced by engineers is that the weight of the slab supported directly on a column creates concentrated localised shear stresses which, without the necessary reinforcement, could result in the slab “punching” through the column.

One way to overcome this is through the use of enlarged columns, column heads or a localised increase in slab thickness. However, these approaches not only disrupt the otherwise flat soffit and reduce floor space, but can also require complicated formwork. This minimises the benefits of this form of construction.

The usual solution therefore is to install shear links within the slab around the top of the column, which locally increases the shear resistance of the slab and safely transfers the shear load from the slab into the column. While effective, these are extremely time-consuming to install and can also be difficult to check for position and quality.

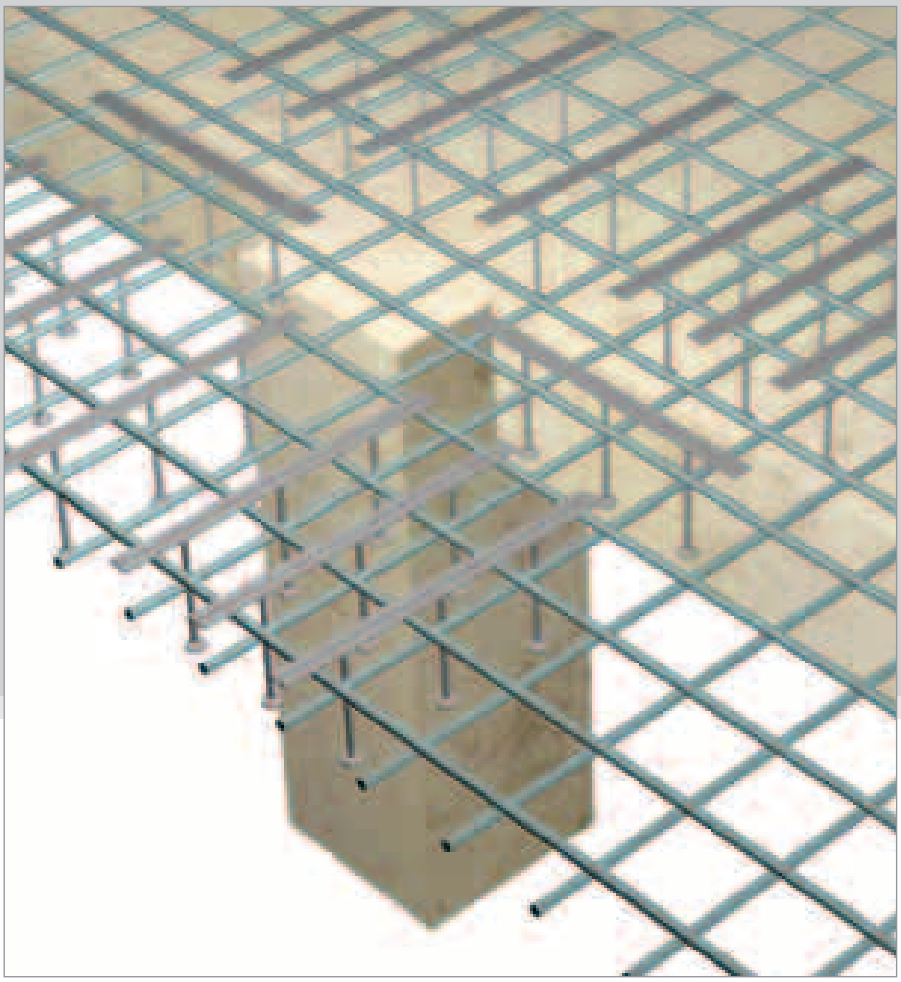


The Shearail prefabricated punching shear reinforcement system from Max Frank is an effective solution, allowing the fixing to be carried out far more efficiently, and in a fraction of the time.



Shearail® – faster, easier and more efficient flat slab construction

Shearail combines a superior performance to traditional shear links, providing improved anchorage with the convenience, speed and quality assurance of a prefabricated system. The design of the system is in accordance with BS 8110. This means that the link arrangements you currently use can be converted directly into a **Shearail** system.



"The additional material costs of prefabricated systems are generally far outweighed by savings resulting from reduced fixing time."

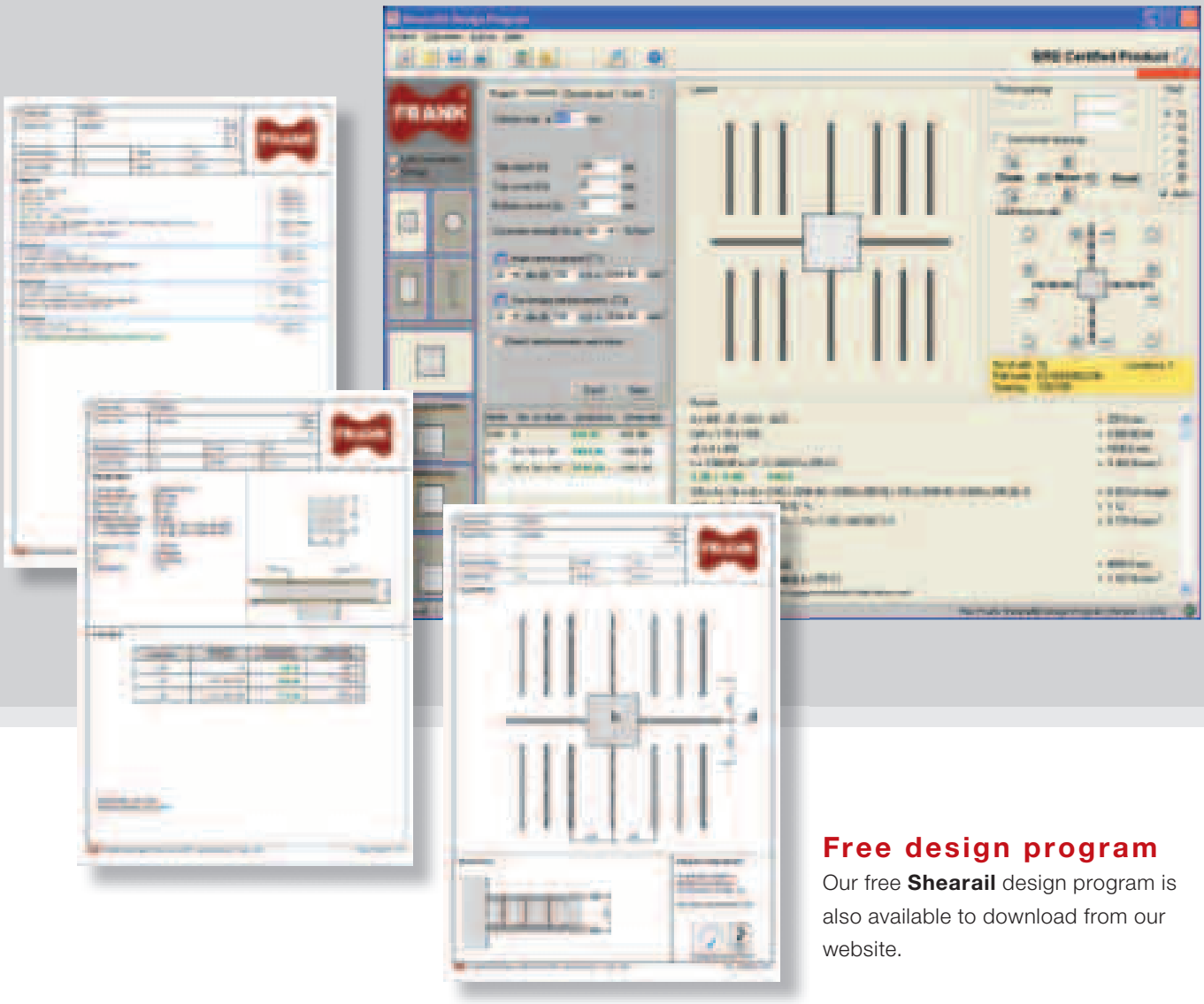
Best Practice Guides, European Concrete Building Project

So instead of having to install hundreds if not thousands of individual shear links on a project, you can take delivery of ready-made "rails" of studs, each designed and fabricated to create the overall shear reinforcement required.

Each **Shearail** rail consists of a number of double-headed studs – of variable diameter and length according to the specification – welded to the carrier rail at spacings in accordance with BS 8110. The rails can either be fitted into position before placing the main reinforcement (bottom up) or installed "into" the reinforcement (top down). Either way, installation times are dramatically reduced and checking is simple, as all studs are already spaced and positioned correctly.

While reinforced concrete flat slabs are the most widely used application for prefabricated punching shear reinforcement, **Shearail** can be employed in piled slabs, post-tensioned slabs, shear walls and other shear applications.

Shearail is available in a range of stud diameters and spacings and each rail is tailormade to the specific requirements of a particular installation.



Free design service

To assist in the design and detailing of **Shearail** into your project we provide a free design service.

Upon completion we will supply you with full calculation sheets for your approval and can also supply DXFs for inclusion in your CAD drawings.

To enable us to proceed with a design we would require the following information:

- G.A/Layout of the floor being considered and the floor below
- Top reinforcement drawings (Bottom if transfer situation)
- Any drawings showing voids not detailed on G.A/Layouts
- Any applicable sections (steps etc)
- Shear loads (kN) and any moments to be considered (kNm), (factors from the code will be applied if only shear loads supplied)

Alternatively for an even faster turnaround please fill in the **Shearail** design request sheet provided separately within this brochure or from our website.

Free design program

Our free **Shearail** design program is also available to download from our website.

This enables you to design **Shearail** layouts to BS 8110 easily and simply. It also allows you to convert existing link designs to an equivalent **Shearail** layout.

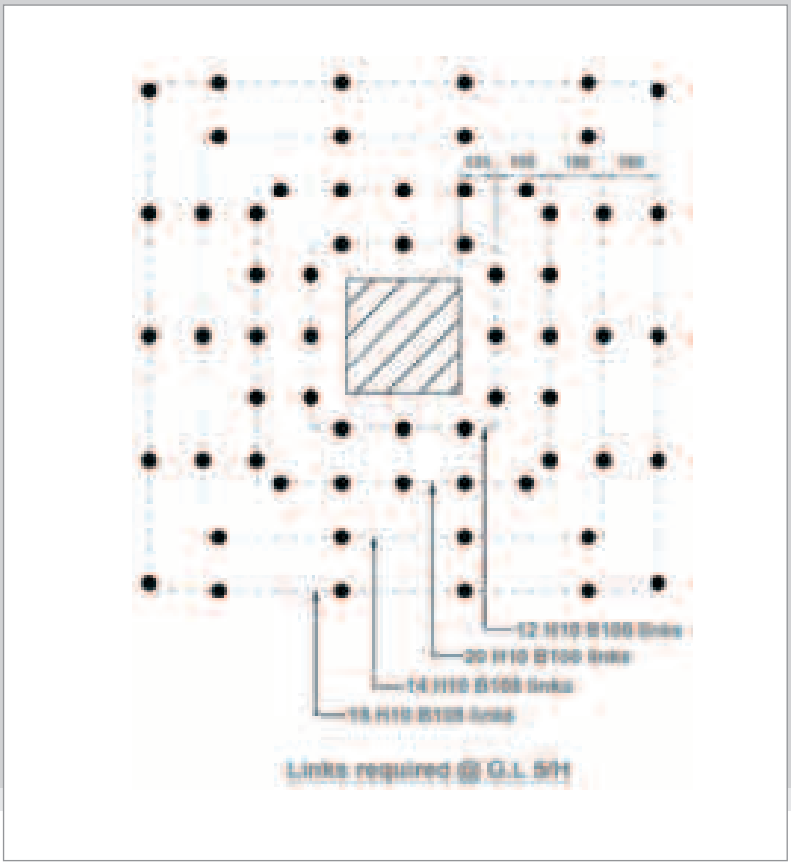
The program provides you with fully checkable calculations/conversions and a DXF out facility so the layouts created can easily be included in your drawings.

To download a copy of the program please visit www.maxfrank.co.uk

Alternatively contact us via technical@maxfrank.co.uk or phone to request a CD version.

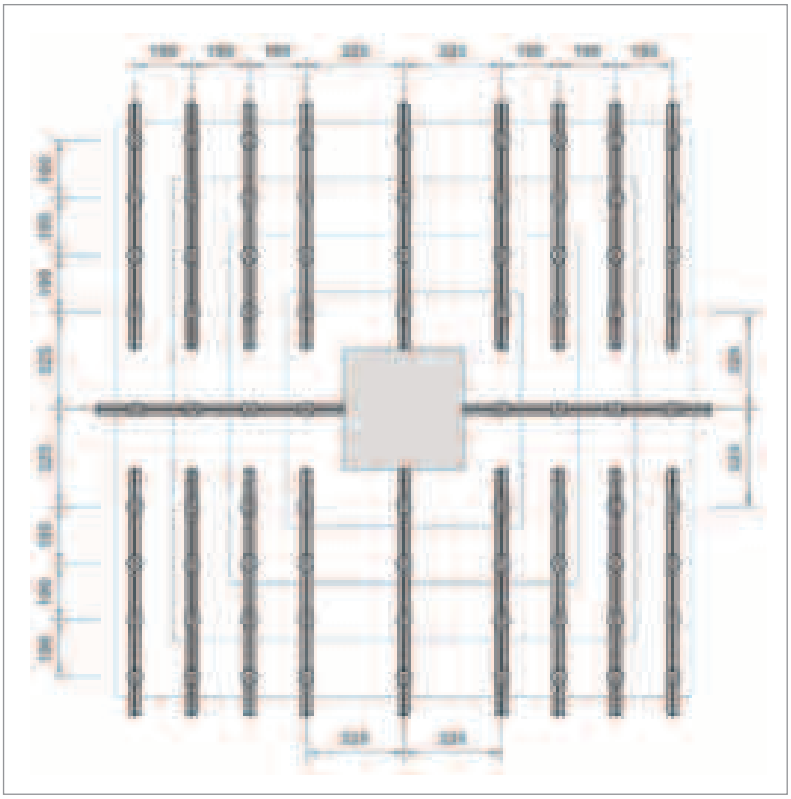
Links which have already been designed can be quickly and easily converted to comply with the original design.

As the design procedures for both are identical, you can use our design program to create conversions easily on a like-for-like area basis. The areas provided in each perimeter with **Shearail** will be at least the area provided by the links. These conversions can be carried out either by using the link drawings or using the output from the RCC spreadsheets.



Double headed shear studs are now a generic method, being used for ten years in the UK and over thirty years in Europe.

Numerous independent tests have demonstrated the stud heads form positive end anchorage flush with the top layer of tension reinforcement. Whereas the anchorage of the links is based mainly on bond, this improved end anchorage controls the shear cracks and enhances the aggregate interlock.



Equivalent arrangement using 20 No. 14mm diameter, 4 stud **Shearail** rails.

Design procedure & method

If a full design is required then **Shearail** can be designed into the slab using the same design principles as for shear links. All design methods are in accordance with BS 8110 part 1.

The concrete is first checked for shear at the column face against allowable limits from the code and is then checked along a perimeter at a distance of 1.5d from the column face. If shear reinforcement is not required, then no further checks are necessary. If shear reinforcement is required then the concrete is checked along subsequent further perimeters 0.75d apart until no further shear reinforcement is necessary.

The area of reinforcement required at the first perimeter (1.5d) is then split by placing at least 40% at 0.5d from the column face and 60% at 1.25d from the column face. If subsequent areas of reinforcement are required, these are spaced at 0.75d from the last perimeter of reinforcement.

Two perimeters of studs are used for the calculation of the area required.

Condition	No moment being considered	Moment being considered
Internal	$1.15V_t$	$V_t\left(1+\frac{1.5M_t}{V_t x}\right)$
Edge (Bending about an axis parallel to the free edge)	$1.25V_t$	$1.25V_t$
Edge (Bending about an axis perpendicular to the free edge)	$1.4V_t$	$V_t\left(1.25+\frac{1.5M_t}{V_t x}\right)$
Corner	$1.25V_t$	$1.25V_t$

Design steps

1. Design at the Column Face

a. Calculate Design Effective Shear (V_{eff})

When calculating V_{eff} the factors shown in the table opposite are applied to design shear load (V_t)

Please note – When considering moments, both axes of the column should be checked and the worst case V_{eff} used

b. Calculate Maximum Design Shear Capacity (v_{max})

$$v_{max} = \frac{V_{eff}}{u_0 d}$$

This should not exceed a maximum value of $0.8\sqrt{f_{cu}}$ or 5 N/mm^2, whichever is the lower.

2. Design at the Perimeters

a. Calculate Design Concrete Shear Stress (v_c)

$$v_c = 0.79 \frac{\left(\frac{100A_s}{(b_v d)}\right)^{\frac{1}{3}}\left(\frac{400}{d}\right)^{\frac{1}{4}}\left(\frac{f_{cu}}{25}\right)^{\frac{1}{3}}}{1.25}$$

Where $\left(\frac{100A_s}{(b_v d)}\right)^{\frac{1}{3}}$ not to be taken greater than 3

$\left(\frac{400}{d}\right)^{\frac{1}{4}}$ not less than 0.67 or less than 1 for slabs greater than 400mm deep

$f_{cu} \leq 40$ N/mm^2

b. Check Design Shear Stress (v) at First Perimeter (1.5d)

$$v = \frac{V_{eff}}{u_1 d}$$

If $v \leq v_c$ no punching shear reinforcement required

If $v_c < v \leq 2v_c$ punching shear reinforcement required

If $v > 2v_c$ the slab is not sufficient. Adjust slab/column parameters

c. Calculate the Area of Steel Required (A_{sv})

If $v \leq 1.6v_c$ then

$$A_{sv} = \frac{(v - v_c)\, u_1 d}{0.87 f_{yv}}$$

If $1.6v_c < v \leq 2v_c$ then

$$A_{sv} = \frac{5(0.7v - v_c)\, u_1 d}{0.87 f_{yv}}$$

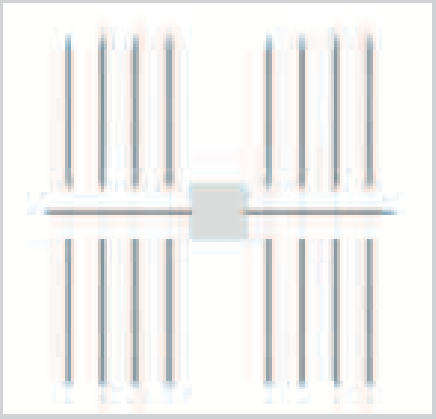
These must not be less than the minimum steel of $\frac{0.4u_1 d}{0.87 f_{yv}}$

$f_{yv} = 500$ N/mm^2

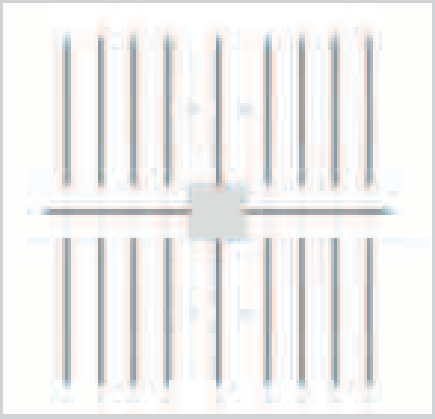
d. Check Subsequent Perimeters

Repeat steps (b) & (c) but using u_2, u_3 etc. until $v \leq v_c$

The first rails are laid out along either side of the column with the front of the rail in line with the face of the column.



Rails are then laid out perpendicularly in line with the studs on the first rails and the column face.

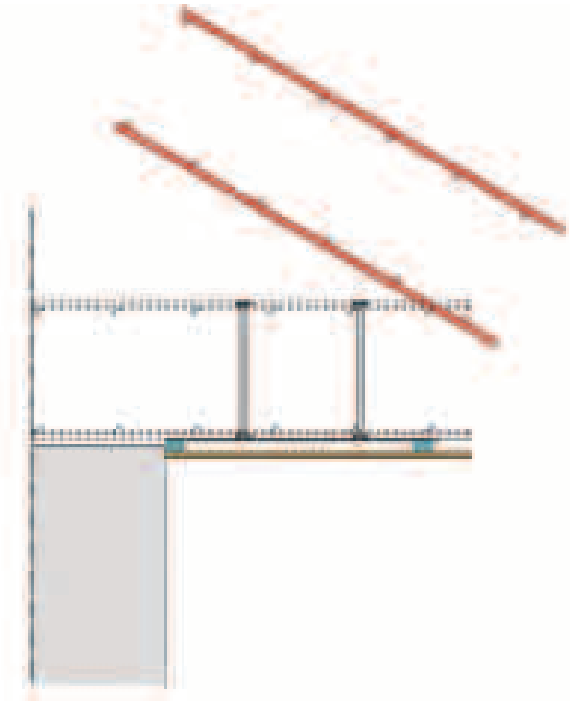


Finally rails are then placed vertically along the top and bottom sides of the column so that there is equal spacing between the rails either side and with the front of the rail in line with the face of the column.

When installing **Shearails** on site, the rails can be fitted as follows:

Bottom up (recommended)

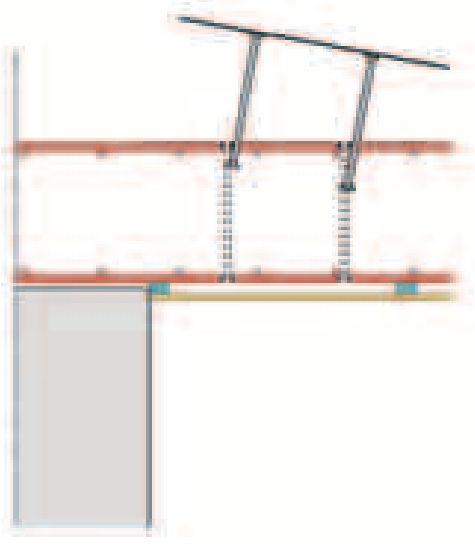
1. Rails are fitted first by spacing the rails off the formwork using concrete spacers and nailing to the formwork through the carrier rail and spacer.
2. The bottom and top rebars are then laid in the usual manner around the **Shearails**.

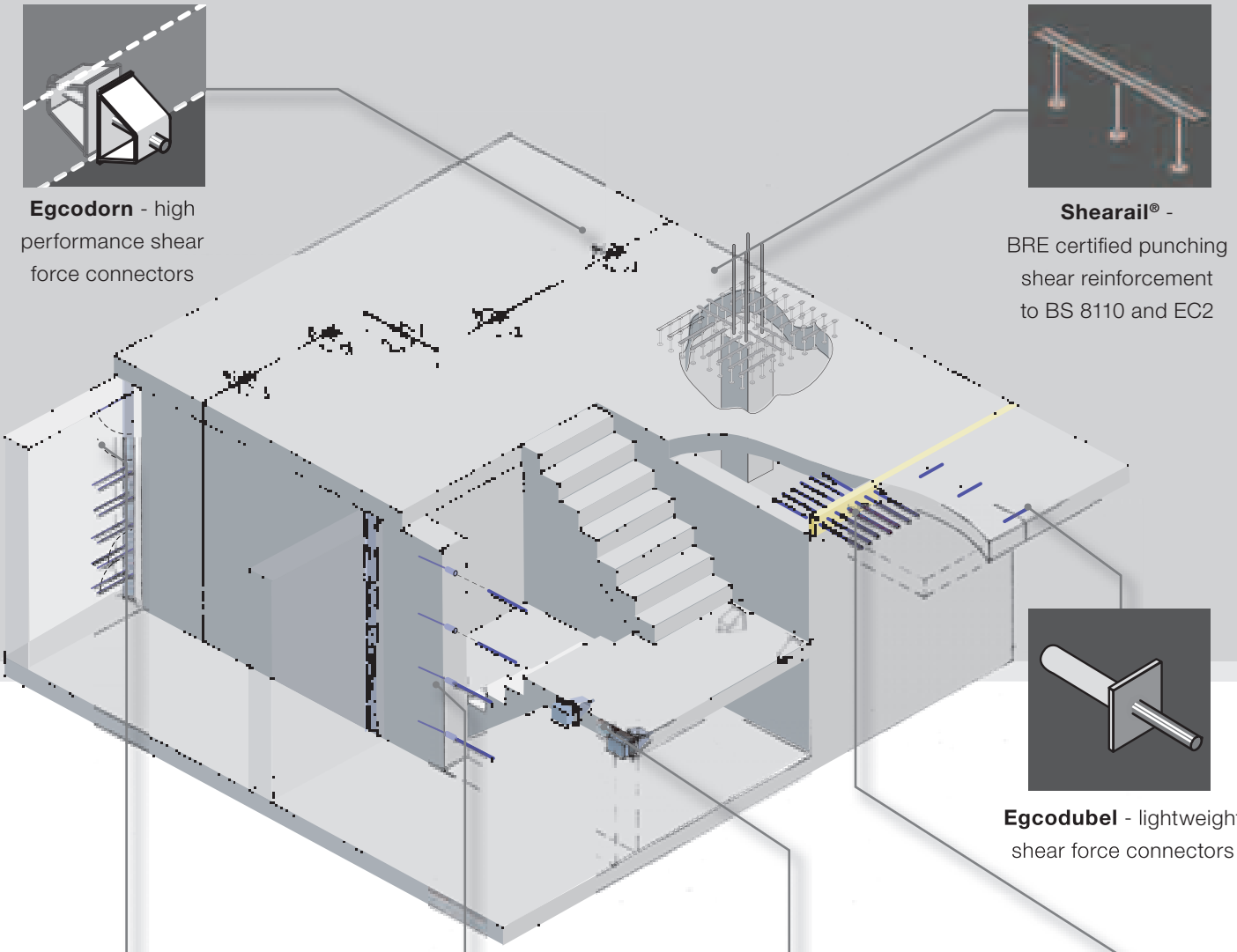


Top down

1. The top and bottom rebar is fitted as per usual.
2. The rails are then placed through the rebar and so the carrier rails sit on top of the T1. These are then securely wire tied to the rebar so that when the concrete is poured, they do not move.

If the rails when fitting sit on the T2 then these need to be spaced up so they are level with the top of the T1. These special **Shearail** supports are available on request.

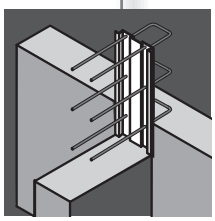




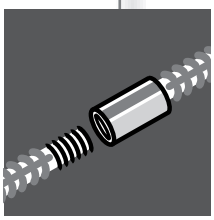
Egcodorn - high performance shear force connectors

Shearail® - BRE certified punching shear reinforcement to BS 8110 and EC2

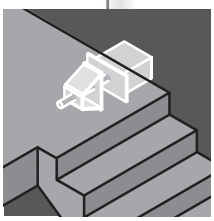
Egcodubel - lightweight shear force connectors



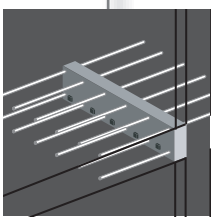
Stabox® - reinforcement continuity system



Threaded couplers



Egcotritt - acoustic shear force connectors



Egcobox® - BBA approved insulated balcony and cantilever connection system

Max Frank GmbH & Co. KG | Technologies for the construction industry

Mitterweg 1
94339 Leiblfing · Germany
Phone +49 (0) 94 27 / 1 89-0 · Fax +49 (0) 94 27 / 15 88
info@maxfrank.com
www.maxfrank.com

Max Frank Limited | Technologies for the construction industry

Whittle Road
Meir
Stoke-on-Trent
ST3 7HF

Phone 01782 598 041
Fax 01782 315 056

info@maxfrank.co.uk
www.maxfrank.co.uk

10047/2-GB-04/2010

www.maxfrank.co.uk