

Stud rails: prefabricated punching shear reinforcement

The loads on a concrete slab supported on a concrete column induce shear stresses in the slab. Where additional reinforcement is not provided, this stress could result in the column ‘punching’ through the slab. Although this punching shear stress can be relieved by localised thickening of the concrete, such as downstand beams or enlarged column heads, the construction of a flat slab is often preferred. A consistent head space, a reduction in overall building height and significant savings in both time and materials are the main advantages of flat slab construction.

PAUL EVANS, ANCON BUILDING PRODUCTS

Stud rails can be located around a column head or base to reinforce a flat slab against punching shear. The shear load from the slab is transferred through the studs and into the column.

A stud rail system comprises a number of stud and rail units, which have been factory produced to suit the specific requirements of a particular column. Each unit comprises double-headed studs, hot forged to three times the diameter of the bar, welded to a flat steel carrier rail. The rails are located around the column in the required layout.

The quantity and dimensions of both studs and rails, the spacing and the layout are all determined by calculation. To simplify system design, stud rail manufacturers provide free calculation software and other technical support such as faxback design sheets.

The rails perform no structural function. They simply ensure stud alignment, spacing and vertical positioning within the slab. Studs are manufactured in a variety of diameters and in virtually any length to suit the load and depth of the slab. Rails with a gap along the length allow for the passage of concrete during pouring.

Stud rail design

A stud rail reinforcement system is designed by calculating the stress at concentric perimeters around a column, in accordance with BS 8110⁽¹⁾. First, the shear stress is checked at a perimeter $1.5d$ (d = effective slab thickness) from the face of the column (u_0). Further checks are carried out at successive intervals of $0.75d$ (u_1 , u_2 , etc) until a perimeter is reached that does not require shear reinforcement (u_n).

The first stud is positioned $0.5d$ from the face of the column, with the spacing between individual studs taken as $0.75d$. Rail layouts can be radial or orthogonal.

Stud rail manufacturers provide free calculation software, which simplifies this design process.

A stud rail system can be designed for all column shapes (rectangular, circular, L-shaped, etc) and locations (edge, corner, interior, etc). They can be installed either top down or bottom up – selection is based on user preference. When installed top down, the studs are installed after all other reinforcement. The rail rests on the top layer of reinforcement and is securely tied in position. Bottom-up installation takes place before all other reinforcement. The rails are tied to spacers before being located around the column and nailed to the formwork.

Comparison with shear links

Loose shear links, formed on-site from short lengths of reinforcement bar, can be used to reinforce a slab against



Figure 1 left: Ancon Shearfix stud, welded to a flat rail, tied to main reinforcement.

Figure 2 below: Rails simplify the accurate positioning of studs in the slab.



Photos: Ancon Building Products

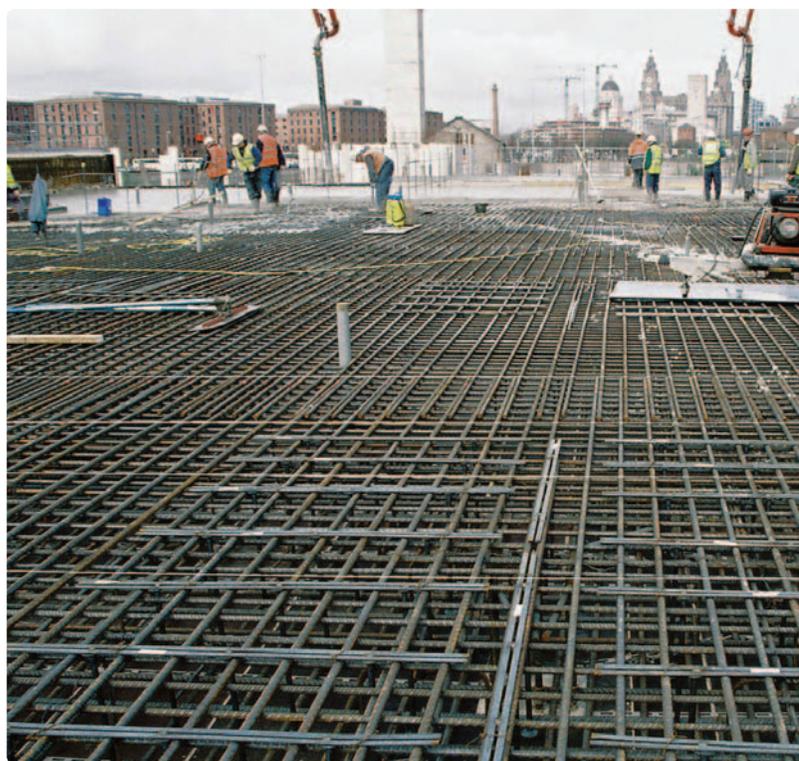
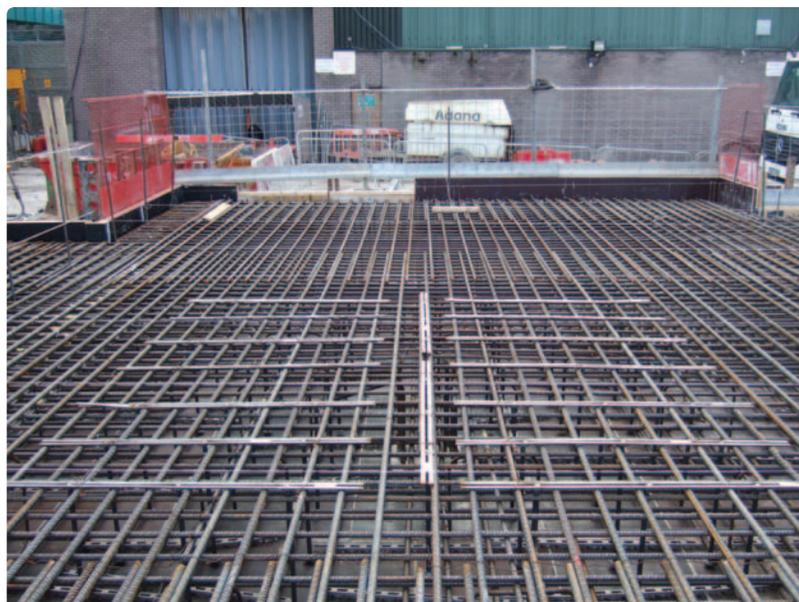
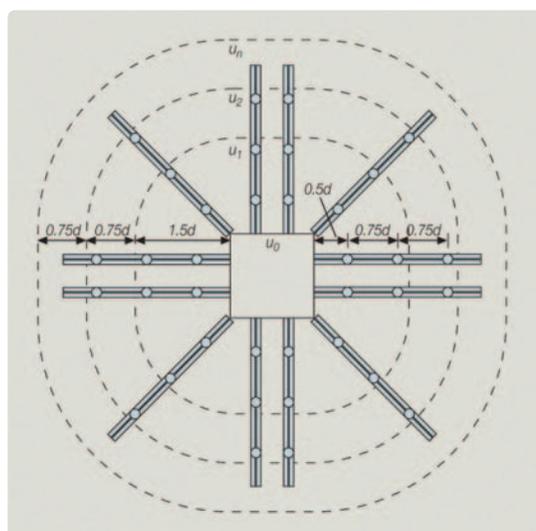


Figure 3 top: Stud rails arranged around a column head.

Figure 4 above: Kings Dock Mill, Liverpool.

Figure 5 right: Example radial rail layout.

Figure 6 far right: Example orthogonal rail layout.



punching shear. They are hooked around the top and bottom reinforcement, where calculated by the project engineer. When compared to loose shear links, the use of stud rails can accelerate both the design and the construction process.

With reinforcement being on the critical path to completing the structural frame, time savings are the major benefit of using stud rails. Research shows that the savings made from the significantly reduced fixing time far outweigh any additional material costs. A British Cement Association best practice guide⁽²⁾ claims prefabricated solutions can be up to ten times quicker to install than loose shear links. Stud rails are supplied to rails at the appropriate spacing, so a number of studs are installed simultaneously – unlike shear links, which are formed on-site and installed individually.

The software provided by stud rail manufacturers not only calculates the stud dimensions and spacing, it also generates a DXF file of the rail layout for each column, which is then easily inserted into floor plans.

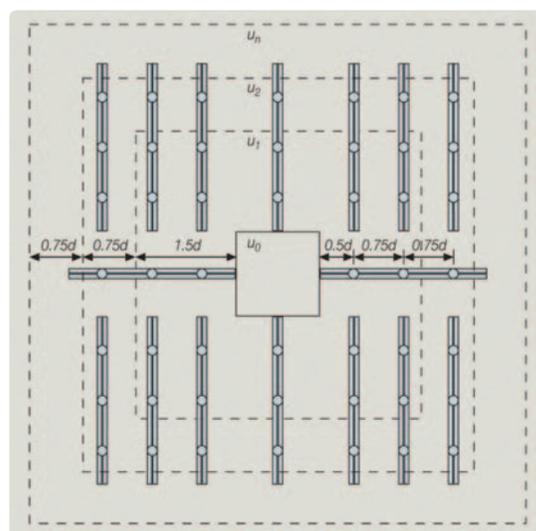
Although stud rails are manufactured to order, they are available on a short lead-time. Even sizeable stud rail systems are normally despatched one working week from receipt of order. To enhance installation times further, pallets can be packed in priority order, eg, by pour number, and each rail is labelled with the particular column reference and product code. Codes normally comprise: stud diameter, number of studs on rail, stud length and rail length, and correspond directly with the layout drawing.

Kings Dock Mill, Liverpool

A significantly reduced fixing time when compared to shear links is the main reason Ancon Shearfix stud rails are currently being installed by Adana Construction on the Kings Dock Mill Development in Liverpool's Baltic Triangle.

The site manager for Adana says, "Our priority is the project schedule. The Shearfix rails took just two people one day to place and secure on this whole floor. If we had used loose shear links they would have taken a team of people a week to install. Site conditions are good today and we need to capitalise on periods of good weather. The concrete pour is going ahead on schedule."

In some locations on this multi-storey, mixed-use development, the floor slabs are 700mm thick. Shear links of this length may have been particularly problematic to install and would have significantly increased congestion in an already heavily reinforced slab.



Concluding remarks

Stud rails are an effective means of reinforcing flat concrete slabs against punching shear at column locations. They offer considerably reduced fixing times when compared to loose shear links and are designed using free calculation software available from stud rail manufacturers. Double-headed steel studs are supplied welded to flat steel rails, at the designed centres. The rails ensure stud alignment and the accurate vertical positioning of the studs within the slab.

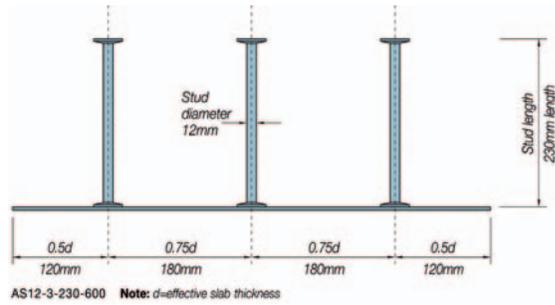


Figure 7: Stud spacing.

References:

1. BRITISH STANDARDS INSTITUTION, BS 8110. *Structural use of concrete. Part 1 – Code of practice for design and construction*. BSI, 1997.
2. BRITISH CEMENT ASSOCIATION. *Prefabricated punching shear reinforcement for reinforced concrete flat slabs*. BCA, Camberley, 2001.

Spacers that pass the flavour test

Keeping our water uncontaminated is a prime consideration when deciding on the use of any product during construction of potable water retaining structures. Even the smallest source of contamination can have a potentially devastating effect upon public health.

DAVID WILSON, MAX FRANK

When it comes to ensuring the quality of our drinking water supply, it is increasingly important to ensure that all possible safeguards are in place. Outbreaks of cryptosporidium and similar have heightened public awareness of the need for vigilance. It is therefore partly beholden on the construction industry to ensure that the public is protected at all times and in every way possible.

Standards

Standards for components that can potentially come in contact with potable water have been developed but these have not been applied to most traditional products in use for many years or for those offering a small surface area to the water. These have been automatically permitted without testing. This is changing and for public safety it should be an imperative that all permanent products in the works, no matter how small, nor for how long they have previously been in use, should prove their suitability for potable water applications.

Materials used in contact with drinking water, whether within structures or in the water supply system, require testing and approval to show that they will not adversely affect water quality. For a product that only has a small contact surface, the only testing required for non-metallic materials used in contact with drinking water is Water Regulations Advisory Scheme (WRAS)/BS 6920⁽¹⁾. The more rigorous approval to DWI CPP Regulation 31, for *Products and Processes for use in Public Water Supply*⁽²⁾,



Photos: Max Frank Ltd.



Figure 1 above: Extruded fibre concrete spacers have a tested and proven watertight bond to concrete.

Figure 2 left: Extruded fibre concrete distance tubes ensure that there are no preferential water flow paths along the tube-concrete interface.