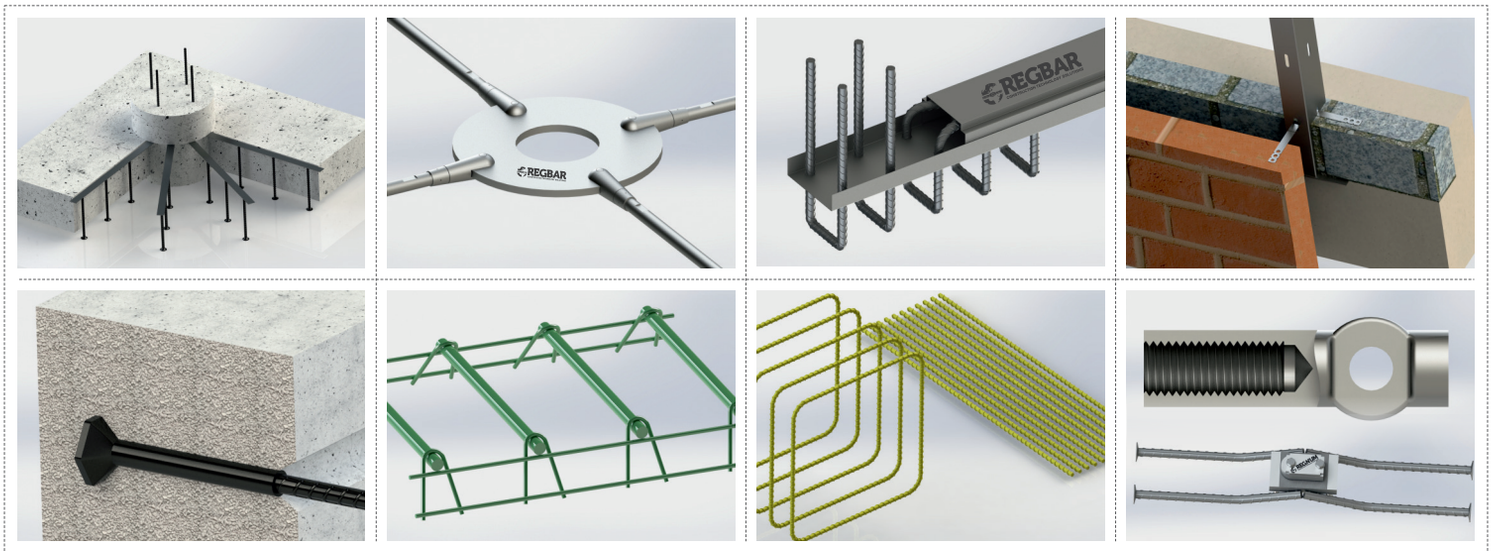
CONSTRUCTION TECHNOLOGY



REGBAR
CONSTRUCTION TECHNOLOGY SOLUTIONS

SHEAR REINFORCEMENT

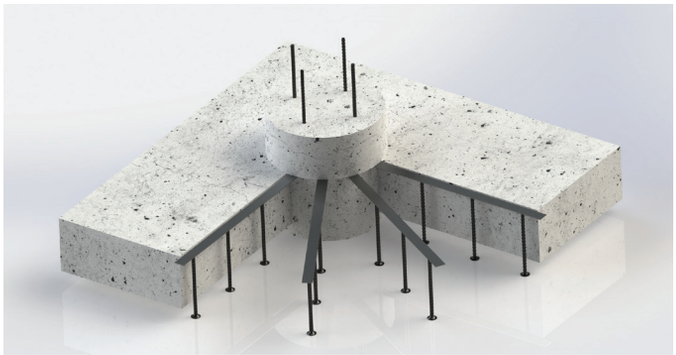
www.regbar.com / info@regbar.com

CONSTRUCTION TECHNOLOGY

SHEAR REINFORCEMENT

Properties

- Higher load bearing capacity than conventional stirrup reinforcements.
- Time saving easy installation from above
- Can be installed easily and fast
- Standardized product range with short delivery times, standard items are available from stock
- Available in sizes 10 mm - 26 mm
- Allows simple visual inspection



Regbar Shear Reinforcement (RSR) is the perfect solution to the design and construction problems associated with the punching shear, used in flat slabs to provide further strengthening by providing additional reinforcement around columns. The system consists of double headed studs welded to mounting rails, positioned around the head or base of the column, transferring the shear load from the slab to the column through the studs.

RSR system is suitable for all column shapes and, depending on user preference, can be easily installed either “top down” or “bottom up.”

The studs are assembled to form reinforcement elements comprising at least two studs. The studs are tack welded or clamped at one end to a non-structural steel rail or reinforcing bars for securing the position of the double headed studs when pouring the concrete.

All studs of one of those reinforcement elements have the same diameter.

The design of punching shear reinforcement is typically carried out in accordance with the recommendations contained in **BS EN 1992 (Eurocode 2), ACI318 or Turkish Seismic Code 2018**. Engineering design service is given by Regbar upon request.

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Defining The Problem: Punching Shear Around Columns

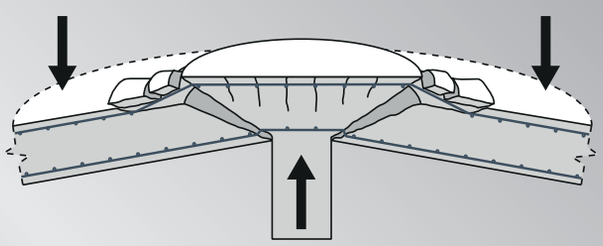
Manufacturing reinforced concrete slabs without any beams and enlarged column heads results in inexpensive manufacturing.

This type of construction allows thinner, lighter and simpler elements, enabling optimum and flexible space use.

Advantages of flat slab manufacturing are:

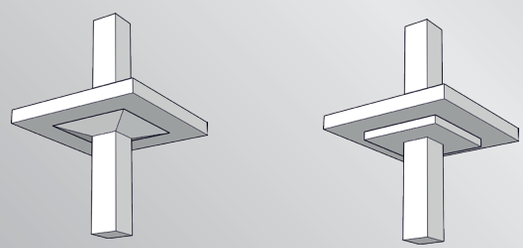
- Less construction time
- Slimmer, lighter and more aesthetical elements
- Easier installation of building utilities under slabs (e.g. auto sprinkler or ventilation ducts)
- Easy constructability with economy in the formwork flexibility for interior fittings
- Plain ceiling surface giving better diffusion of light
- Building height or floor heights can often be reduced

Dealing with the problem - Shear checks:



Load concentration around the column head generally leads to increased stresses that can't be absorbed solely in thin slab thicknesses.

Uneconomical and unfavorable solutions were used to prevent punching shear failure, such as increasing the slab thickness or using extended column heads before. These methods not only extend the construction time, but also reduce the usable height between floors and therefore limit building space.



Uneconomical solutions

Alternatively, it is possible to use stirrups cages as punching shear reinforcement. However, longitudinal slab reinforcement must be enclosed by the stirrups which makes installation complicated and difficult

Determining The Solution: Regbar Shear Reinforcement - RSR

Regbar Shear Reinforcement (RSR) System is most typically used as vertical reinforcement in concrete slabs that is designed and detailed to prevent the development of inclined punching cracks. System consists of two, three or four double headed studs welded onto a spacer bar. System can be positioned from top or from bottom. Individual parts can be added to each other to maintain design requirements.

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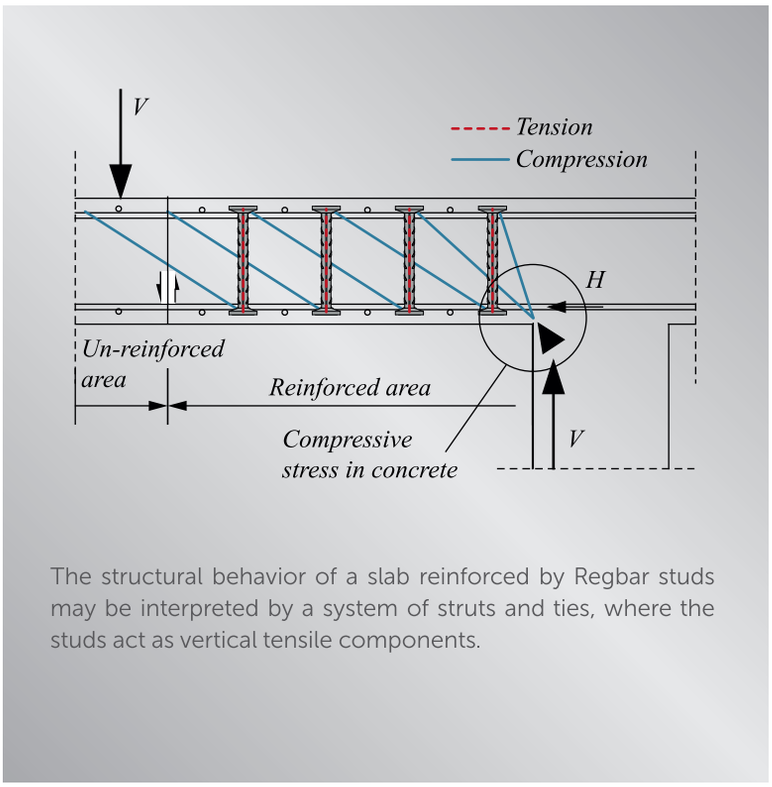

The structural behavior of a slab reinforced by Regbar studs may be interpreted by a system of struts and ties, where the studs act as vertical tensile components.

Designing The Shear Reinforcement

The design methodology is determined by **BS EN 1992-1-1-2004 (EC2) or to BS 8110-1:1997**. Regbar offers in-house designs prepared by qualified engineers.

Design Manual According To EC2

An EC2 design will normally produce a radial or cruciform layout pattern, however square patterns can also be achieved following certain procedures with the basic design principles below being maintained.

Outline design procedures for a suspended slab:

1 The direct shear at the edge of the loaded area (column or pile) is checked and satisfied.

$v_{Ed\,0} \leq v_{Rd.max}$ u_O *perimeter must be calculated in accordance with EC2*

2 The punching shear stress at the control perimeter u1 is determined; if it's within the concrete punching stress resistance, no punching reinforcement is required and no further action is required.

$v_{Ed\,1} \leq v_{Rd.c}$ u_1 *perimeter is 2d from loaded area in accordance with EC2*

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3 If the concrete stress is exceeded, punching shear reinforcement can be added to increase the effective resistance of the slab. If the limit is exceeded the slab properties should be increased accordingly

$$v_{Ed\,1} \leq 2v_{Rd.c}$$

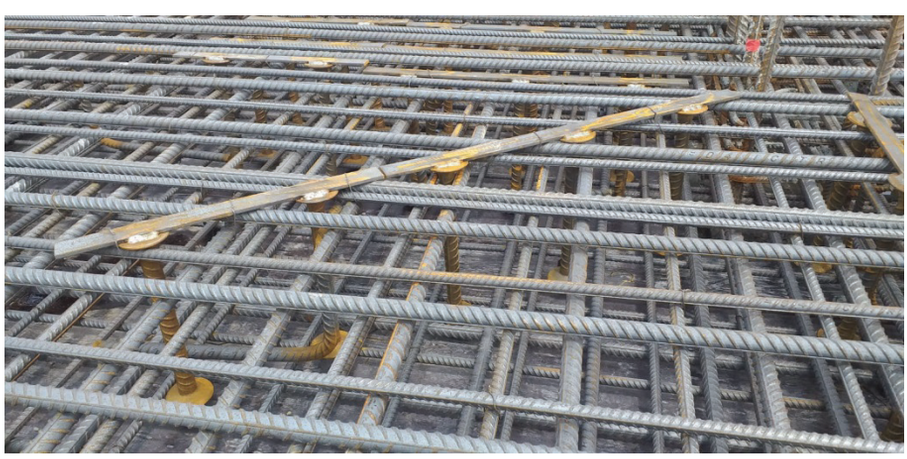
It may be possible to increase this to 2.5 vRd.c established from full scale test plus an independent report. This is at the discretion of the Project Engineer. It is normal practice is to remain within the set limits applied in EC2

4 Perimeters of punching shear reinforcement are required to within kd (1.5 x the effective depth) of where the normal reinforced slab is able to resist the applied shear loads (U_{out}).

$$A_{sw} = ((\, v_{Ed\,0} - 0.75_{vRd.c}\,)\, u_1 s_r / \, 1.5_{fywd.ef}\, x \ number\ of\ studs)$$

or

$$A_{sw.min} = (\, 1.5 \,/\, (s_r s_t)\, x\, (\, 0.08\sqrt{(f_{ck} f_{yk}}\,)$$



The calculated value is for the area of one stud, the reinforcement is projected out to within kd (1.5d) of the U_{out} perimeter.

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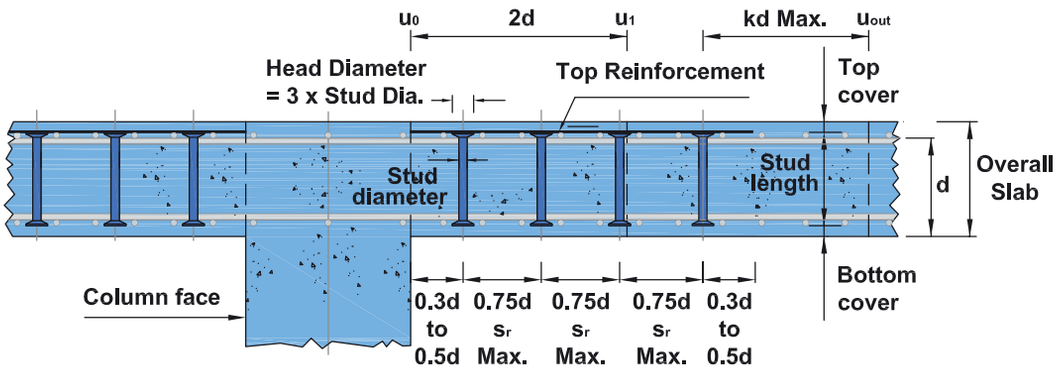
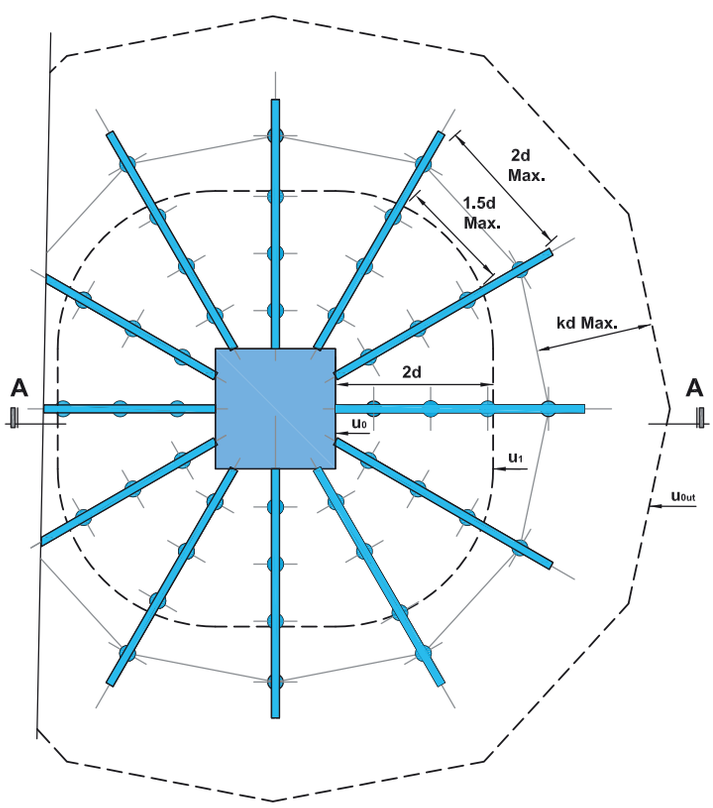
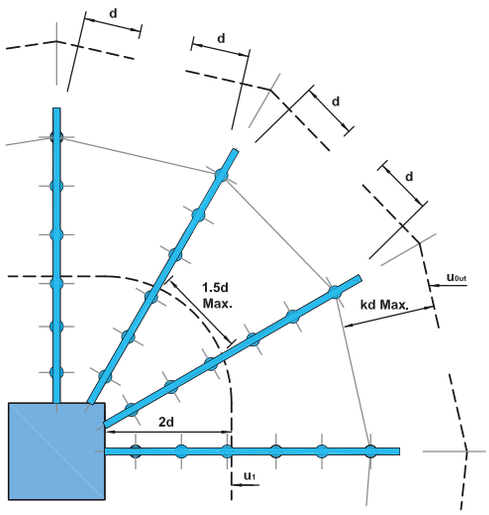


Section A-A

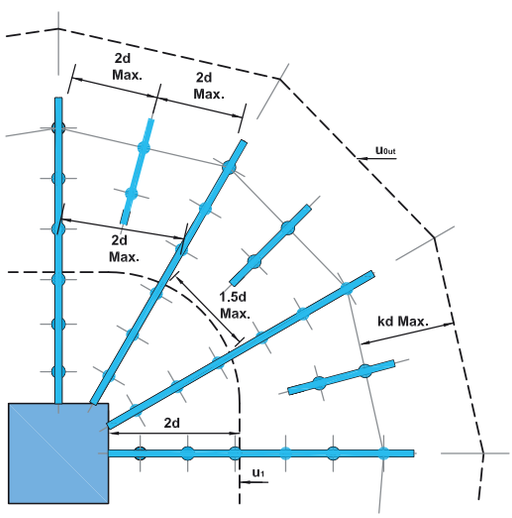


Note: The value of k for use in a Country may be found in the National Annex (Normally 1.5)

Radial Shearail Layout Pattern



Extended Shearails without spacers rails



Extended Shearails with spacers rails

It may be possible to increase stud spacing to 3.5d behind 2d from the column face, this is at the discretion of the Project Engineer established from independent full scale testing, however it is normal practise is to remain within the set limits applied in EC2.

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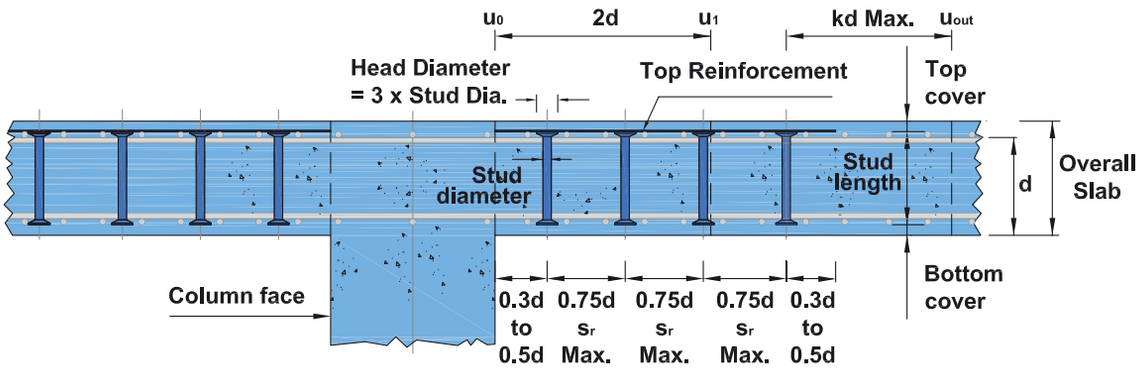
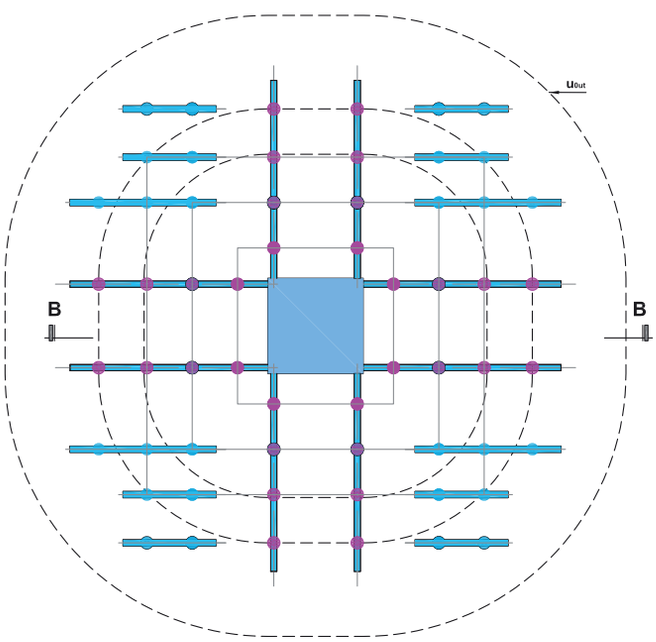


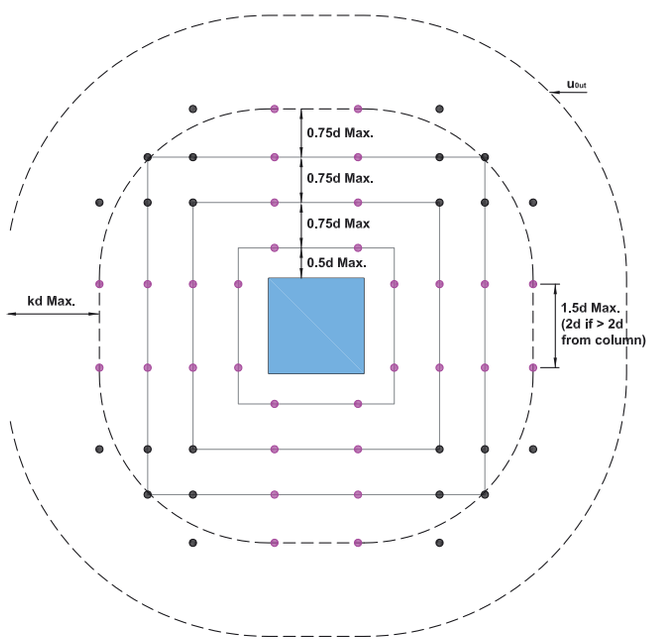
Section B-B



Links are replaced by studs on like for like area basis

Note:
The studs indicated in blue are not used in the punching shear design.

Orthogonal Shearail Leyout Pattern



Traditional link layout as designed by the Project Engineer in accordance to the Concise Eorocode 2, pubilshed by the Concrete Centre,

Note:
The links indicated in black are not used in the punchhing shear design.

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Selecting RSR

RSR is made from two types of steel material, B420C or B500B.

The characteristic values of resistances of individual RSR studs are summarized in Table below:

	Bar Sizes			Head Diameter (*)		Stud Section (*)		Stud Yield Strength	
Product Code	Metric [mm]	US	Canada	[mm]	["]	[mm]	["]	[MPa]	[ksi]
RSR10	10	#3	-	30	1-3/16	78.60	0.12	420 or 500	60 or 75
RSR12	12	#4	10M	36	1-27/64	113.10	0.18		
RSR14	14	-	-	42	1-21/32	154.00	0.24		
RSR16	16	#5	15M	48	1-57/64	201.10	0.31		
RSR20	20	#6	20M	60	2-23/64	314.20	0.49		
RSR26	26	#8	25M	75	2-61/64	531.00	0.82		

		Head Diameter [mm] (*)					
Stud Yield Strength [MPa]		10	12	14	16	18	20
420	Resistance [kN]	33	47.5	64.7	84.4	131.9	223
500		39.3	56.5	77	100.5	157.1	265.5

The resistance of a concrete member reinforced by rsr has to be verified case-by-case for each project. Custom software may be used to design RSR and verify the resistances of concrete members reinforced by RSR.

	Stud Bar Sizes			Head Size		Stud Section		Stud Yield Strength	
Product Code	Metric [mm]	US	Canada	[mm]	["]	[mm]	["]	[MPa]	[ksi]
SRCT10	10	#3	-	30	1-3/16	78.60	0.12	420 or 500	60 or 75
SRCT12	12	#4	10M	36	1-27/64	113.10	0.18		
SRCT14	14	-	-	42	1-21/32	154.00	0.24		
SRCT16	16	#5	15M	48	1-57/64	201.10	0.31		
SRCT20	20	#6	20M	60	2-23/64	314.20	0.49		
SRCT26	26	#8	25M	75	2-61/64	531.00	0.82		

NOTES

- *Dimensions shown in chart are typical..*

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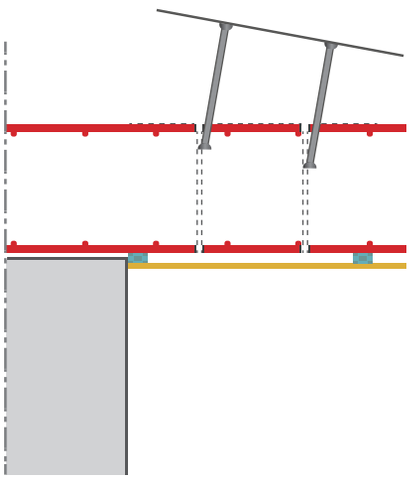
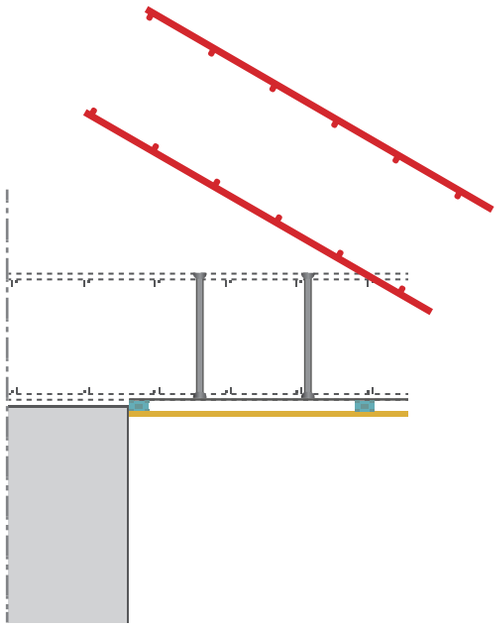
Simple Installation



After installing the upper and lower mesh reinforcement the Regbar shear reinforcement elements are inserted from above through the reinforcement.



Alternatively, Regbar shear reinforcement elements are installed upside-down before installing the upper and lower mesh reinforcement.

Regbar provides a free design service to assist in the design and detailing of RSR into your project.

To benefit from Regbar's RSR design service simply email your drawings to info@regbar.com. Our experienced and dedicated RSR technical department will use their expertise to formulate the optimum concrete reinforcement strategy for your project based on the drawings and information supplied by you.

You will receive a quote prepared by our in-house costing team who will liaise with the design engineer dealing with your enquiry.

Our design service will provide 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:

- General Arrangement (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 unfactored loads are supplied)

Regbar Construction Technology

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