



# TECHNICAL SOLUTIONS

## FOR REINFORCED CONCRETE

Startabox® – Reinforcement Continuity System

Sheartech® – Punching Shear Reinforcement

Rebar Coupler Systems

Sheartech Grid® – Shear Reinforcement

Couplerbox® – Reinforcement Continuity System



# COMPANY OVERVIEW

RFA-TECH designs, manufactures and supplies products for reinforced concrete structures, supplying clients worldwide from a UK location.

The company is based at a manufacturing facility in Sheffield carrying ISO 9001 and ISO 14001 accreditations and RFA-TECH are proud members of the 'Made in Sheffield' registered trademark group. RFA-TECH hold CARES Technical Approvals on many of its products and are members of CONSTRUCT, the concrete structures group.

RFA-TECH has supplied some of the highest profile and most prestigious contracts in the UK and worldwide. A selection of these includes:

- The Shard, London, UK
- Olympic Village, London, UK
- Terminal 2B, Heathrow Airport, UK
- DS3, HQ4 and BP3 Towers, Canary Wharf, London, UK
- Pan Peninsula Tower, Marsh Wall, London, UK
- Beetham Hilton, Manchester, UK
- New Southern General Hospital, Glasgow, UK
- BBC Media City, Salford Quays, UK
- Hilton Hotel, Barbados
- Ras Laffan Industrial City, Qatar
- Third Ring Road Project, Tripoli, Libya



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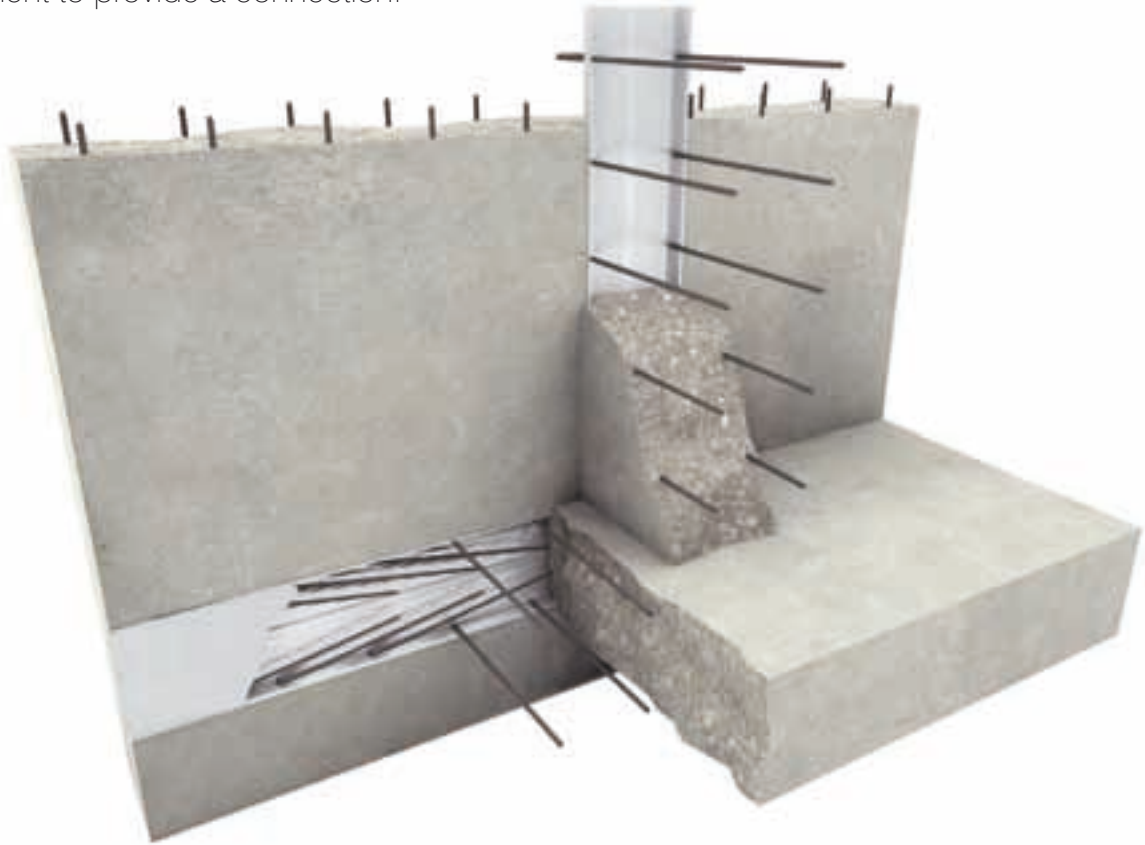
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# STARTABOX®

The concept and use of reinforcement continuity strip systems or 'pull-out bar' systems has been widespread in Europe, and further, over the last 30 years and is a widely accepted means of providing reinforcement continuity across construction joints in concrete. The system utilises the concept of overlapping reinforcement to provide a connection.



RFA-TECH has been involved in manufacturing this product type since its inception and has over 30 years of manufacturing experience. The Startabox system provides a safe and cost effective method with time and labour saving factors. The system is designed and custom made utilising the engineer's original reinforcement detail.

The Startabox system consists of specially selected, high yield reinforcing steel, housed in a fully perforated and hot dip galvanised carrier unit. The unit ends are sealed to prevent the ingress of concrete. The reinforcement used is CARES Approved and cut and bent to conform to BS8666. The system is assembled in a BS EN ISO 9001 factory environment and the full system carries a CARES Technical Approval.

The units are used on site by nailing to formwork, prior to a concrete pour. Alternatively, units can be wire tied to the main reinforcement arrangement. After concrete is poured and the formwork then struck, the lid is removed to provide the connection or overlap bars. The bars are bent out of the case to provide an overlap connection to the main reinforcing steel and next concrete pour.

The case design offers an efficient key and rebate and requires no further joint preparation. The perforated casing ensures that the product remains embedded in the structure when striking the formwork and the concrete and case become a composite material. The case remains in the joint and is filled with concrete on the subsequent concrete pour.

## Applications

Most joints in concrete, on many different types of construction site, have the potential to be formed using Startabox. Startabox has been supplied to high rise commercial, water treatment, hospitals, prisons, Energy from Waste Facilities and many more types of site. Typical joint applications include.

- Walls
- Floor Slabs
- Corbels
- Stair Landings
- Cantilever Slabs
- Launder Channels
- Brick Support Nibs
- Balconies
- Precast Slab Interfaces
- Stairway Applications

## Benefits & Advantages



### Safety

The starter bars are housed within the case until ready for straightening. There are no protruding bars to cause injury and the working space available is enhanced.

Startabox features a tear off plastic lid to reduce the risk associated with using metal lid systems.

The perforated casing negates the need for any further joint preparation using mechanical tools such as scabbling, a time consuming process with Health & Safety concerns.

### Speed

Startabox units are easy to use and quickly nailed to formwork or tied to the main reinforcement.

Formwork designs can be simplified and complicated construction joint designs reduced.

Climbing formwork systems can be used such as Slipform and Jumpform.

### Quality

Only Startabox features a perforated casing to allow free airflow, assisting removal of entrapped air, especially where high pour heights are being achieved.

The perforated casing offers improved shear connection and provides an additional joint rebate when compared to pouring a traditional wall and slab detail.

The Startabox units are fabricated in an ISO 9001:2000 factory environment to ensure all rebar measurements and centres are correctly maintained.

The starter bars remain protected and clean from damage until required for use.

As the formwork is completely sealed with the Startabox unit in place, no grout loss should be incurred at areas where traditional starter bars would have penetrated the formwork materials.

### Cost

Formwork systems do not need to be drilled, damaged or repaired when using the Startabox system, so can be used many times.

Startabox is easy to use and can be installed by non-specialist labour if required.

Simple formwork designs and larger concrete pours enable faster work and more site productivity.



## Rebar Couplers & Couplerbox

Although the Startabox system is generally custom made and very flexible in the design detail that can be achieved, in some instances an alternative needs to be considered.

This occurs generally when the amount of rebar required, either due to bar diameter, lap lengths, element thickness or bar centres, combine to present a situation where the amount of rebar required cannot be accommodated in the Startabox casing.

In these instances, or where larger bar diameters are required RFA-TECH offers a full strength, bar break, parallel thread coupler system which can be produced to replicate the required Startabox design. This system is available to suit bar diameters from 12mm to 40mm.



The ultimate advancement of rebar continuity at construction joints is the Couplerbox, which features the full safety, speed, quality and cost benefits of the Startabox system but is suitable for use where a coupler system is preferred or a Startabox unit is not suitable for manufacture.

In the Couplerbox system larger diameters can be catered for along with the ability to produce short lengths of material for areas such as beam connections. The Couplerbox system also assists greatly with the location and fixing of coupled bars when compared with traditional systems.

See page 19 for more on Rebar Coupler Systems and page 28 for Couplerbox

## Technical Product Data

### Reinforcement

All reinforcement bar used in the Startabox system is of grade B500C conforming to BS4449. Startabox is available containing 8mm to 20mm reinforcement with 12mm and 16mm being the most commonly used sizes. The rebar material is specially selected to be suitable for rebending, a prerequisite of the system, and is cut and bent to meet the requirements of BS8666, specific requirements of CARES Appendix TA2 and in line with the CARES Technical Approval on the Startabox system.

All reinforcement used is tested regularly, both in-house and independently, to ensure it continues to meet the requirements of BS4449 once rebent, offering confidence to detailers and engineers and supported by relevant and recent testing data.



Curved Startabox

### Case

Startabox cases are manufactured from galvanised mild steel sheet rolled to precise dimensions. The cases are fully perforated on all faces to provide an excellent bond to the first concrete pour and provide an efficient key for the subsequent pour. The cases are annealed at specific points along the case to ease nailing when fixing to formwork. A wide range of case sizes are available to suit the rebar detail requirement.



### Lid Cover

The Startabox system is fitted with a plastic tear off lid, to allow easy removal once required. The plastic lid has the advantages of no sharp edges, low weight, minimal concrete adherence and is suitable for recycling. Where necessary or requested, steel lid covers can be fitted.



### End Cap Seal

Startabox cases are fitted with two easily removable plastic end cap seals. These ensure the concrete cannot enter the casing. End cap seals are suitable for recycling once removed.



## Technical Approval & Product Testing

As no specific British Standard is applicable to reinforcement continuity systems, full scale structural testing was undertaken on the Startabox system. The testing was carried out under the supervision and guidance of CARES at Imperial College, London. Several wall to floor, wall to wall and column to beam connections were formed in reinforced concrete including construction joints using the Startabox system. In all wall to slab specimens the continuity reinforcement was 16mm diameter deformed bar, chosen as being the largest bar normally used in the Startabox system and which imposes the greatest stresses on the surrounding concrete and most severe demands on the reinforcement in relation to bending and straightening.

The series of reinforced concrete samples, some of which were cast in a manner to simulate poor concrete compaction, were subject to various loading conditions representing high shear or high bending moment load. The displacements and crack widths were measured in relation to applied load. The ultimate loads were measured. In all cases the samples exceeded the ultimate loads calculated from BS8110.

The structural tests showed that the flexural strength and shear strength of construction joints formed with the Startabox system are no less than those of traditionally formed construction joints.

Full details of testing can be found in the Cares Technical Approval TA2 5007 which can be obtained from the RFA-TECH website or on request.



## Installation

1

A Startabox unit is installed by firstly nailing through the casing to the shutter face. The casing is annealed at points to make this operation easier. Alternatively the Startabox unit can be wire tied to the main reinforcement cage using the anchorage rebar projecting from the rear of the case. The shutter can then be placed against the face of the unit. For steel or sliding formwork systems the method of tying is the usual method.

2

With the Startabox unit securely in place, concrete can be poured and the entire unit will become part of the first pour of the concrete structure. Once formwork is struck, the lid of the Startabox unit will be revealed on the concrete face ready for removal.

3

With the formwork struck, the Startabox lid and endcaps can now be removed and discarded. The lap bars contained inside the case will now be revealed for rebending. Should any grout have stuck to the face of the Startabox lid and need to be removed, a small tap with a hammer will break this material away.

4

With the Startabox case now opened, the lap bars can be bent out using the correct tool and following the rebending procedure. The lap bars may need to be flexed slightly to allow the rebending tool to be fitted correctly. Once all bars are rebent from the Startabox unit the main reinforcement steel can be overlapped creating the connection to the following pour.

1



2



## Straightening of Bars

The overlap bars contained inside the Startabox units should only be rebent using the correct size Startabox rebending tool. This tool is specifically manufactured to fit closely over the ribs on the overlap bars to ensure the bar does not flex within the tool. The tool features a chamfered end to ensure that it can be located on the bar in the correct rebending location at the case interface. The tool is the correct length to ensure that adequate leverage can be obtained to rebend the overlap bars in a single, smooth procedure. Overlap bars should not be rebent multiple times as this can work-harden the bar and affect strength and future performance.

The rebending tool should be fitted to the bar to be rebent and located so the tool end is touching the Startabox case. The tip of the tool should be orientated on the outer bend radii. It is permitted to flex the overlap bar a minimum distance to allow the tool to be fitted to this location. The overlap bar should be rebent in a single, smooth, continuous motion until the bar is in the correct position. The tool should be removed and the overlap bar should be checked for alignment with connecting reinforcement and cover requirements.

Startabox bars should only be rebent with a temperature above 5 degrees Celsius. Below this bars may be indirectly heated to bring the bars above this temperature. Warming using any direct heat source such as flame guns etc is not permitted and can have a detrimental effect on the performance of the bars.

Rebending overlap bars using scaffold tubes, rebending manually by hand or hammering bars in position should not be carried out and will adversely affect the strength and future performance of the bar.

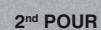
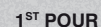
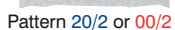
3



4







Customer Name \_\_\_\_\_ Project \_\_\_\_\_  
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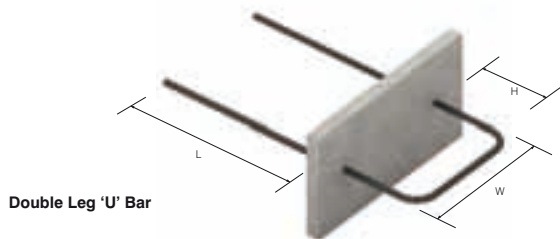
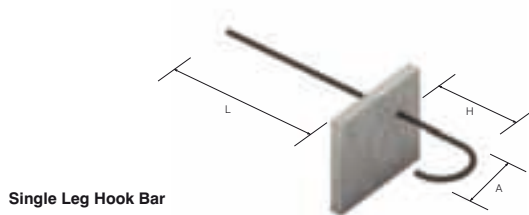
## Standard Units

Although most Startabox units are made to order using the engineers original rebar details, there are occasions when time pressures do not allow this and a quicker supply is required. Last minute drawing changes or rescheduling of pour sequences can require another solution.

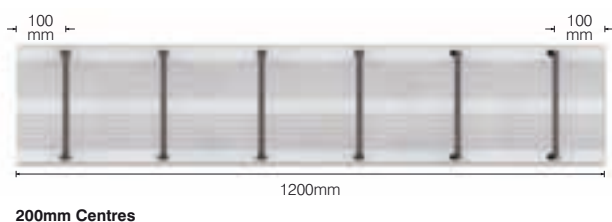
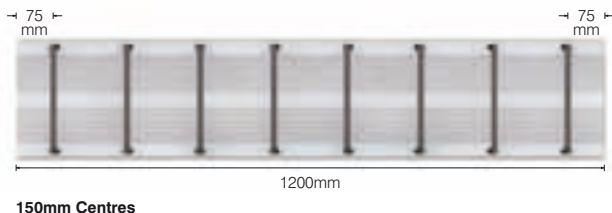
For this reason, a full range of Startabox standard units are kept in stock for rapid dispatch. The range covers a wide variety of wall and slab thicknesses and caters for the most popular bar diameters and bar centres. Standard units can be easily ordered using the relevant stock code.

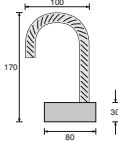
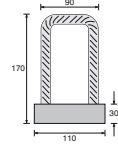
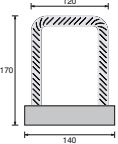
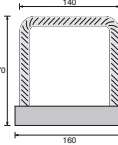
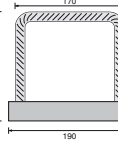
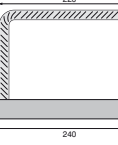
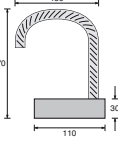
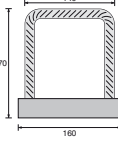
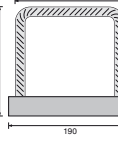
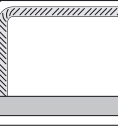
Standard units containing 12mm rebar are supplied with 500mm lap bars.

Standard units containing 16mm rebar are supplied with 650mm lap bars.



### Bar Spacings



Dimensions	Bar Type	Bar Spacing mm	Lap 'L' mm	Stock Code
	C12	150	500	S801215
	C12	200	500	S801220
	C12	150	500	S111215
	C12	200	500	S111220
	C12	150	500	S141215
	C12	200	500	S141220
	C12	150	500	S161215
	C12	200	500	S161220
	C12	150	500	S191215
	C12	200	500	S191220
	C12	150	500	S241215
	C12	200	500	S241220
	C16	150	650	S111615
	C16	200	650	S111620
	C16	200	650	S161620
	C16	150	650	S191615
	C16	200	650	S191620
	C16	150	650	S241615
	C16	200	650	S241620

## Frequently Asked Questions

### *How does a joint containing Startabox structurally perform compared to a traditionally formed joint?*

Full scale structural tests on Startabox units were carried out at Imperial College, London supervised by CARES. Testing showed that the flexural and shear strengths of construction joints formed with Startabox units are no less than traditionally formed construction joints. For further information please consult the Startabox CARES Technical Approval document and Imperial College study.

### *What is the lead time?*

Startabox units are generally supplied in 3-4 days from date of order. Standard units from stock can be supplied on a next day service.

### *Can you provide drawing take offs and scheduling?*

The RFA-TECH technical team carry out scheduling of Startabox material from supplied general arrangement, rebar drawings and schedules. Layout drawings are supplied to contractors to enable efficient location and fixing of Startabox units.

### *Can radiused units be manufactured and specified?*

Startabox units can be formed to a radius to suit structures such as round tanks and curved stairwells. Units for both internal and external radii can be produced. Please consult our technical team for further information.

### *What lap lengths can be provided considering BS8110 & EC2?*

Startabox units are generally supplied with 41 times bar diameter lap lengths although as units are detailed and made to order this can be varied as required by the engineer. Startabox units have been produced with 55 times bar diameter lap lengths in certain instances to meet the relevant design codes.

### *Can staggered lap lengths be provided?*

Differing lap lengths for top and bottom bars can be provided.

### *Is Startabox 'waterproof' and can waterstops be fitted?*

As the perforated Startabox case becomes fully embedded within the concrete, and as such becomes a composite material, the risk of any water ingress or transfer across the casing is remote. As site conditions cannot always be controlled and for reassurance, hydrophilic strips can be factory fitted to the Startabox cases where water ingress is of particular concern. Standard and WRAS Approved hydrophilic strips are used depending on the engineering and any potable water considerations.

### *What is the minimum and maximum length of unit?*

Generally the calculation of two times the required lap length will give the minimum unit length achievable. For a 500mm lap length on 12mm rebar this would give a minimum unit length of 1.0m.

The maximum length is limited by practicality. Startabox is supplied in up to 4m lengths if required. The weight and handling of units generally restricts units to 2.5m units as a practical maximum.

### *What is the thickness of the Startabox cases?*

In all applications the Startabox case is 30mm deep. In most applications a plastic lid can be fitted given a finished unit of 30mm. However, in some applications where a large volume of steel is being accommodated, an alternative lid needs to be fitted meaning the complete unit could be up to 50mm deep. Alternative lids can be manufactured to ensure specific cover requirements are met.

### *Can Startabox units be cut on site?*

We do not recommend units are cut on site. Cutting units on site costs time and produces sharp cutting edges and frequently results in the lap bars contained in the case being cut or damaged in error. Errors are usually only discovered when a unit is embedded in a concrete pour, requiring further work to rectify.

### *What bar diameters are supplied?*

Startabox units can be supplied with bar diameters of 8mm to 20mm and this full range of diameters is covered for use by the CARES Technical Approval. Where 20mm rebar is required we recommend the use of couplers in the first instance as only certain shape codes can be provided with limited dimensions. Although we are able to manufacture items in 20mm in our factory it is frequently difficult to install these heavy units on site.

### *Which shape codes can be used with the Startabox system?*

A large range of many differing shape codes are suitable for use with Startabox. Please consult the Pattern References on page 10 for details.

### *How are units identified and labelled?*

Units are delivered to site with adhesive labels fitted to each unit to identify the required location on site. The printed details can be as required or specified and generally refer to the wall, slab, level, core or other defining reference.

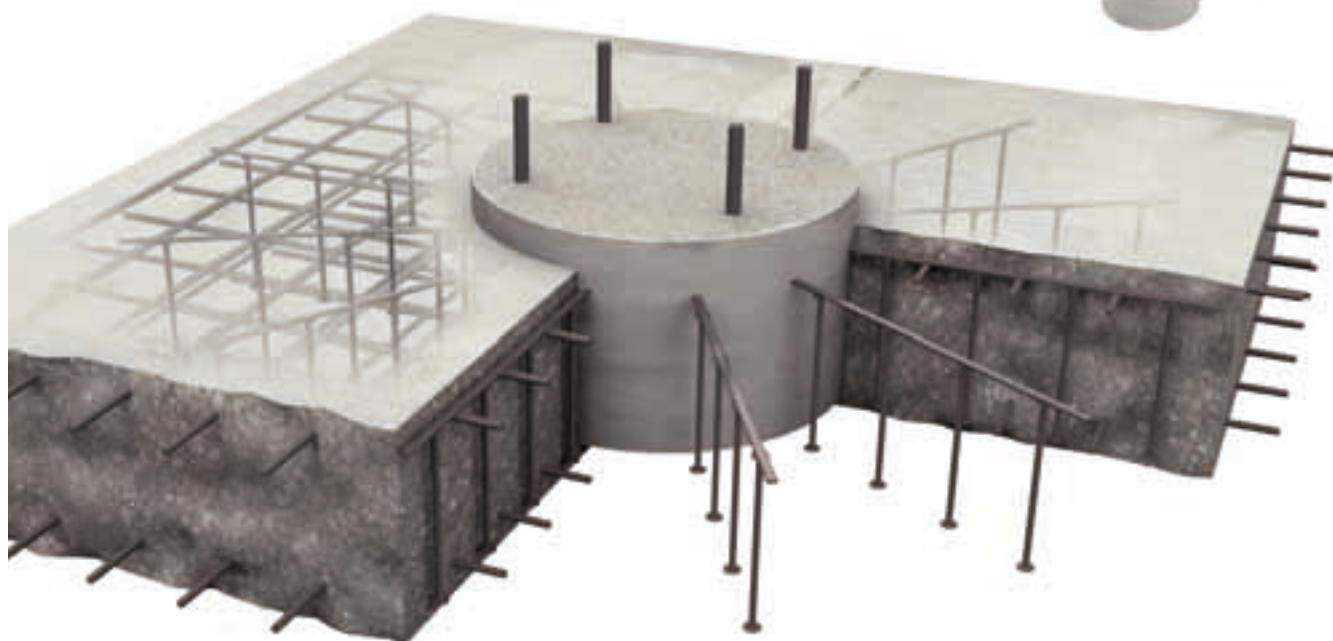
#### **SPECIFICATION CLAUSE**

Reinforcement connections using a rebend continuity system shall be Startabox Continuity System manufactured by RFA-TECH, UK, holding full CARES Technical Approval.

The system shall consist of a fully perforated galvanised steel case and contain reinforcement steel of grade B500C, cut and bent as required by the latest amendment of BS8666 and the specific requirement of CARES Technical Approval 5007.

# SHEARTECH®

The use of flat slab construction has become increasingly popular in the construction of concrete frame buildings. A flat slab design increases the speed of the construction process by simplifying the formwork system used. Floor heights can also be reduced offering greater space within the building and leading to more floors for a given building height. Material savings are also seen, as less concrete and associated materials are used.



Flat slab design brings many benefits, however, localised high shear stresses around column heads can be seen in these designs, and if additional measures are not taken, the weight of the slab can result in the column punching through the slab. In the past punching shear has been relieved by adding further concrete to the building, such as the use of downstand beams or localised thickening around column heads; however these measures require complex formwork and significantly reduce the benefits of the flat slab.

Adding further reinforcement in the form of loose shear links around column heads has been used as a measure to resist punching shear, but these links are time consuming and labour-intensive to install and design.

The Sheartech system offers a CARES Approved method of providing punching shear reinforcement. The system is fast to install with all component parts prefabricated to allow simple and accurate placement.

The Sheartech system has been independently tested, approved and certified by CARES to be fully compliant with the EC2 design code whilst being fully compatible with the outgoing BS8110 design code.

## Applications

- Columns
- Piles
- Diaphragm Walls
- Post-Tensioned Slabs
- Footing and Foundation Slabs
- Slab to Shearwall Junctions
- Beam and Column Junctions
- Raft Slabs

## Benefits & Advantages



The Sheartech system comprises of double-headed studs formed from ribbed reinforcing bar; grade B500C to BS4449, with a characteristic yield strength of 500 N/mm<sup>2</sup>.

The ends are enlarged by a hot forging process to three times the diameter of the shaft, giving a cross-sectional area ratio of 9:1 between head and shaft, to securely anchor the stud in the slab. Due to the hot forging process the studs retain the inherent strength of the reinforcing steel.

RFA-TECH manufacture the double-headed studs in diameters from 10mm to 25mm. A full range of shear stud lengths are available, in 5mm increments to ensure the correct placement of studs and cover in the slab is respected.

The Sheartech double-headed studs are supplied to site factory welded to carrier rails at predetermined spacings, in accordance with the relevant EC2 or BS8110 design standard under a BS EN ISO 9001:2008 Quality Management System. The carrier rails do not carry out any structural function but are used to ensure the correct and accurate placement of the studs.

The Sheartech rails are arranged around the column in a calculated and predetermined radial pattern to meet the particular design code specification; the number of studs and rails used being determined by calculations based on the effective depth of the slab.



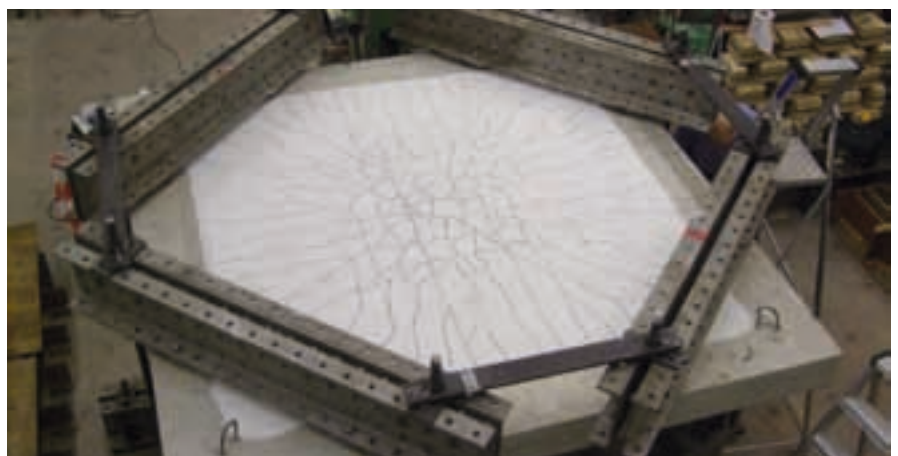
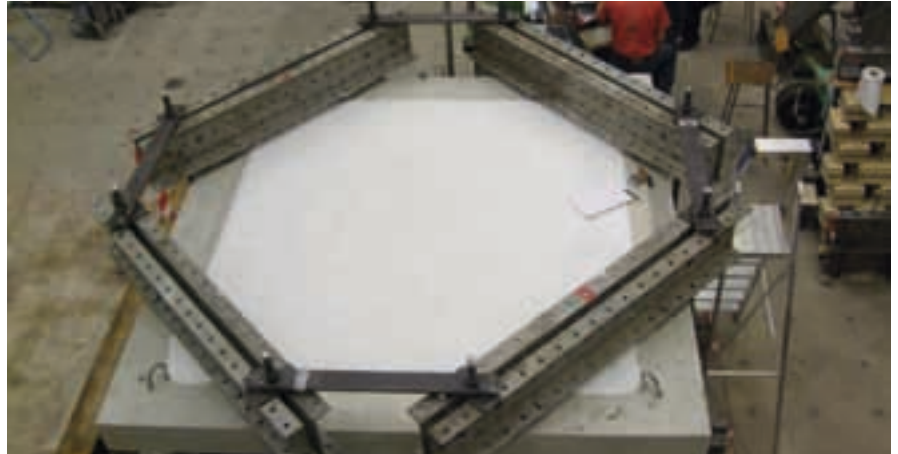


## Technical Approval & Product Testing

Independent testing of the Sheartech system was undertaken under the supervision and guidance of CARES at Cambridge University. Several test slabs were produced with Sheartech rails cast into the slab, the studs were arranged as in designs to EC2 with all studs at a perimeter being equidistant from the columns.

A series of structural tests were completed to evaluate the shear performance to EC2 design standards in addition to the requirements of CARES Appendix TA7 'Quality and Operations Schedule for the Technical Approval of Stud Shear Reinforcing Systems for Flat Slabs'.

In accordance with the Sheartech ISO 9001:2008 Quality Management System, a sample from each batch of Sheartech studs is tested to destruction in an in house laboratory, to ensure the continuity of the tensile strength of the reinforcement steel and to provide additional confirmation of the compliance and suitability of the system to meet the design standards.



## Design

The Sheartech system follows the design methodology of the EC2 design standard and has been fully tested and approved by CARES. A summary and key detailing requirements are shown below. For full details please refer to the EC2 design standard.

1

### Punching shear at the loaded area face

The first step is to check if ( $V_{Ed,0}$ ) – the design value of the shear stress at the loaded area face (column or pile) – can be resisted by ( $V_{Rd,max}$ ) – the concrete punching shear resistance.

Calculation of the design value of the shear stress must take account of the loaded area shape, the distance to the nearest edge, the value of direct shear force, any bending moments (if present) and the effective depth of the slab.

The concrete punching shear resistance at the loaded area face depends on compressive concrete strength and other factors. In case of failure at the loaded area face the input data must be changed.

2

### Punching shear at the basic control perimeter without reinforcement

This step is to determine if punching shear reinforcement is required.

According to EC2, if ( $V_{Ed,1}$ ) – the design value punching shear stress at the basic control perimeter (2d from the loaded area face) – is greater than ( $V_{Rd,c}$ ) – the concrete punching shear resistance – punching shear reinforcement is required.

If it is not, no further action is required.

3

### Punching shear at the basic control perimeter with reinforcement

If punching shear reinforcement is required, the  $u_{out}$  perimeter must be located, beyond which the concrete can resist shear stress itself.

The area inside the  $u_{out}$  perimeter must be in-filled with punching shear reinforcement calculated as per the basic control perimeter taking into account the detailing rules described in Step 4.

4

### Shear reinforcement detailing rules

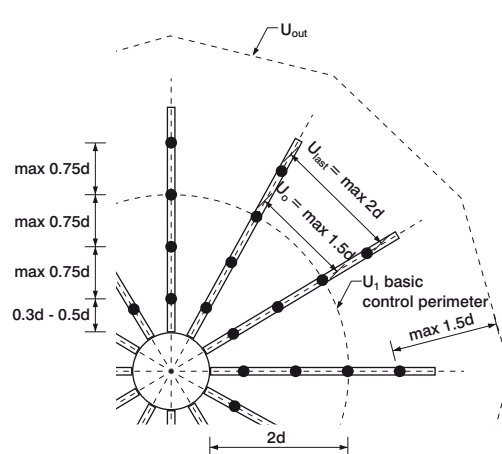
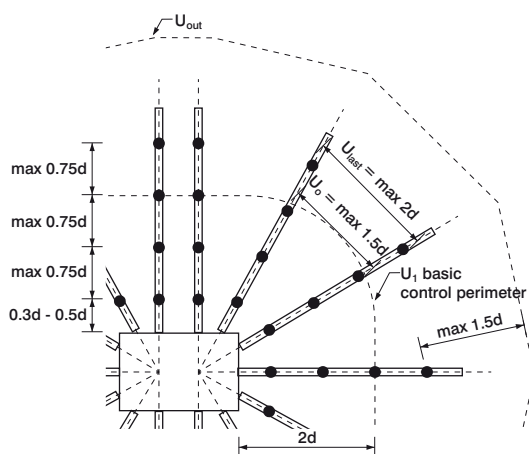
The first stud should be placed within 0.35d to 0.5d from the loaded area face.

The last stud should be placed at a distance not greater than 1.5d within the  $u_{out}$  perimeter.

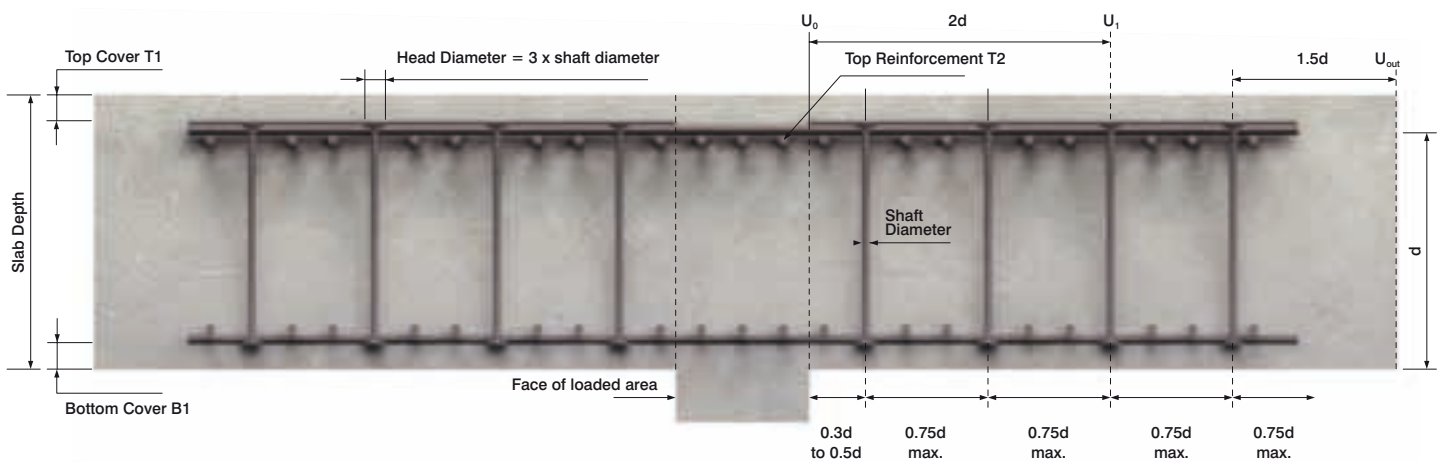
There should be a minimum of two perimeters of reinforcement.

The radial spacing of the shear reinforcement should not exceed 0.75d.

The tangential spacing of the shear reinforcement should not exceed 1.5d within the basic control perimeter and 2d outside the basic control perimeter.

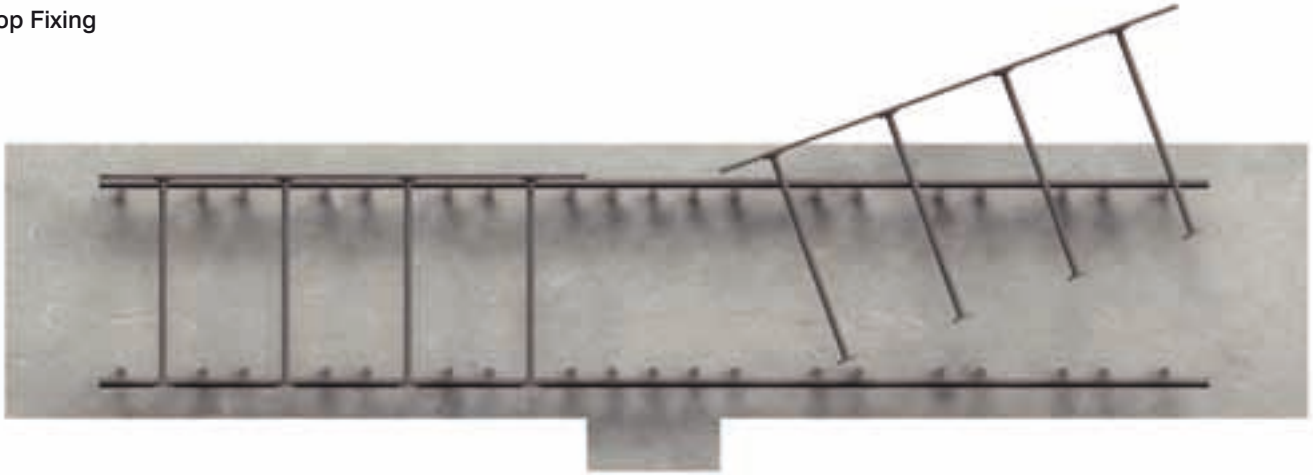


1. The distance from the face of the loaded area should be  $0.3d$  to  $0.5d$  when using a radial pattern layout.
2. The spacing of subsequent studs along the rail should be no more than  $0.75d$ .
3. When using a radial pattern layout, the tangential spacing of studs within the basic control perimeter at  $2d$  should be no more than  $1.5d$  and the tangential spacing outside of the basic control perimeter should be no more than  $2d$ , where that part of the perimeter is assumed to contribute to the shear capacity.
4. When using a cruciform pattern the spacing of studs within the basic control perimeter should be no more than  $1.5d$ . Please refer to Eurocode 2 for further detailed information.
5. The outermost perimeter of shear reinforcement should be placed at a distance not greater than  $1.5d$  within the outer perimeter beyond which shear reinforcement is no longer required.
6. The carrier rails are non-structural and can be placed on the top reinforcement layer (T1) or under the bottom reinforcement layer (B1).



## Installation

### Top Fixing



Fixing of Sheartech rails is carried out once all slab reinforcement and accessories have been placed with installation of Sheartech rails usually carried out from above. The rails are positioned on the top layer reinforcement bars (T1) so that the tops of the upper heads are at the level of the top surfaces of the T1 bars. The stud lengths are such that the bottoms of their lower heads are at the level of the undersides of the B1 bars. Where rails run parallel to the T1 bars an additional spacing device is available where required to ensure rails sit on this top reinforcement layer.

### Bottom Fixing



Alternatively the stud rails may be 'bottom fixed' and placed before the main reinforcement, with the upper faces of the rails at the level of the undersides of the B1 bars and the studs projecting upwards. When placed in this manner the rails should be supported by a proprietary spacing device to ensure respect of cover to the underside of slab. Where units are fixed in this manner care should be taken to ensure the stability of the Sheartech rails when placing the upper reinforcement.

#### SPECIFICATION CLAUSE

Punching shear reinforcement shall be Sheartech Punching Shear System, manufactured by RFA-TECH, UK, holding full CARES Technical Approval. The punching shear system shall consist only of shear studs formed from CARES Approved ribbed reinforcing steel, grade B500C. Shear stud ends to be formed by hot forging and otherwise to the specific requirements of CARES Technical Approval 5028.

# REBAR COUPLER SYSTEMS

The RFA Demu rebar coupler system is a full strength, parallel threaded system designed to produce high accuracy, compact, fast and cost effective connections in reinforcing steel.



The system features an enlarged joint area to provide a bar-break connection where 100% of the load can be transferred from the reinforcing steel through the coupled area, providing male threaded bars are tightened to the prescribed torque setting. All joints may be used in tensile, compression and shear applications.

The system consists of female threaded socket bars and male threaded connector bars. Positional coupling devices, fixing systems and thread protectors are also available to suit the specific application requirement.

The system is available in rebar sizes from 12mm to 40mm. Standard stock length bars are available along with bars produced to specific dimensions.

Due to the manufacturing processes, the system is very flexible in the type of connections, shapes of rebar and dimensions that can be achieved. The system uses parallel metric threads to easily utilise standard bolts, connectors and fixings.

## Applications

- Pour Breaks / Construction Joints
- Slab Penetrations
- Stairwells
- Tower Crane / Placing Boom Openings
- Future Extensions
- Dangerous Starter Bars
- Pile Extensions
- Beam to Columns
- Floor Slabs to Core Walls



## Specification

Reinforcement: BS 4449 Grade 500 B/C, nominal yield stress of 500 N/mm<sup>2</sup>.

Cropping and Bending: To BS 8666

Threaded Socket: Selected zinc plated tube with yield strength of 470 N/mm<sup>2</sup>. Minimum elongation 15%. Factory swaged onto reinforcement bars.

### Product Application

Static tension applications in reinforced concrete structures designed to BS8110: Part 1: 1997, Structural use of concrete, Code of Practice for design and construction.

### Design

BS8110 Clause 3.12.8.9, Laps and joints, states "Connections transferring stress may be lapped, welded or joined with mechanical devices. They should be placed, if possible, away from points of high stress and should be staggered."

However, BS8110, Clause 3.12.8.16.2, Bars in tension states:

"The only acceptable form of full strength butt joint for a bar in tension comprises a mechanical coupler," satisfying permanent elongation and tensile strength criteria.

The specified cover for resistance and durability should be provided to the coupler sleeve.

### Quality

All processes are carried out in a quality controlled environment to BS EN ISO 9001: 2000

The RFA Demu rebar coupler system is produced under a manufacturing procedure which includes regular batch testing of produced bars, internally and externally, to ensure continuing conformity with the requirement of BS 8110.

## Applications & Installation

### Female Socket Bars and Male Connector Bars (bar diameters 12, 16, 20, 25 and 32mm)

Female socket bars are formed by factory swaging high strength internally threaded collars on to reinforcement bars and are available in any length up to 6m. They are fixed in position by tying to the main reinforcement or fixed to formwork systems using nailing plates or standard metric thread bolts. If tied to main reinforcement the internal threads of the sockets should be protected by the use of sealing caps.

Male threaded connector bars are available in a range of sizes for screwing into the female socket bar. The bar end is enlarged by hot forging before roll threading to retain the full cross sectional area and strength of the bar. Thread dimensions comply with BS 3643-2-1981, tolerance class 8g.

### Female Socket Bars and Male Connector Bars (bar diameter 40mm)

Female socket bars are formed by factory swaging high strength internally threaded collars on to reinforcement bars and are available in any length up to 6m. They are fixed in position by tying to the main reinforcement or fixed to formwork systems using standard metric thread bolts

40mm male threaded connector bars consist of a 40mm female sockets bars with an M48 hot rolled threaded stud screwed and locked into the socket part to form a male connector bar.

A hot forged and roll threaded 40mm male connector bar is also available; please consult RFA-TECH for further details.

### Positional Coupler

Where male bars are bent it is often difficult to connect these bars due to the requirement for turning. For these applications a positional coupler is available to avoid turning the male bar.

### Female Studs / Threaded Rod

Standard metric threaded rod in grade 8.8 is available in full lengths or short studs. These items are especially useful to create fixings, linking female bars or creating bespoke long length male threaded bars from a female socket bar. Please consult RFA-TECH for further details.

Normal Detail



Nailing Plate Detail



## Scheduling & Ordering

Standard stock bar lengths for both female and male bars are shown in the following tables. The standard lengths are generally 40 to 50 x bar diameter to offer a solution for most lap length requirements. Other bar lengths and bar end combinations can be scheduled and ordered by using coding system below. Bent bars can be scheduled by adding the bending dimensions following the notation shown in the product tables and diagrams.

Single end female socket bars are coded CF

Double ended female socket bars are coded CFF

Double ended female socket bar U shapes are coded CFFU

Female socket / male connector bars are coded CFM

Single end male connector bars are coded CM

Double ended male connector bars are coded CMM

e.g.

Range	End Type	Bar Diameter	Length (mm) / Bending Dimensions
RFA	CF	20	1000
RFA	CFFU	20	H300, W250



## Linking Bars



## Fixing Detail



## Female

EL Elastic limit

Ab The nominal stress diameter of the reinforcing steel in mm<sup>2</sup>

a Thread depth

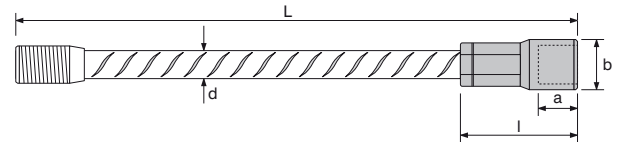
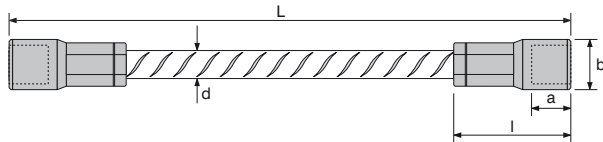
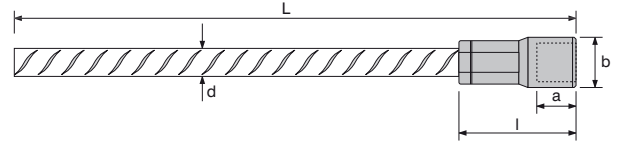
b Socket diameter

l Socket length

\* Standard stock size

# Specify length required (mm)

Rebar Diameter (mm) d	Thread	L (mm)	EL (kN)	Ab	a (mm)	b (mm)	l (mm)	Order Code
12	M16	615*	56	113	25	21	57	CF120615
		1040						CF121040
		≤6000						CF12#
16	M20	810*	100	201	33	26	71	CF160810
		1060						CF161060
		≤6000						CF16#
20	M24	1005*	157	314	38	32	87	CF201005
		1320						CF201320
		≤6000						CF20#
25	M30	1055*	245	491	48	40	113	CF251055
		1555						CF251555
		≤6000						CF25#
32	M42	1490*	401	804	65	54	139	CF321490
		≤2400						CF32#
40	M48	1600*	628	1256	48	67	179	CF401600
		≤2400						CF40#



### Female / Female

Rebar Diameter (mm) d	Thread	L (mm)	Order Code
12	M16	≤6000	CFF12#
16	M20	≤6000	CFF16#
20	M24	≤6000	CFF20#
25	M30	≤6000	CFF25#
32	M42	≤2400	CFF32#
40	M48	≤2400	CFF40#

# Specify length required (mm)

### Female / Male

Rebar Diameter (mm) d	Thread	L (mm)	Order Code
12	M16	≤2400	CFM12#
16	M20	≤2400	CFM16#
20	M24	≤2400	CFM20#
25	M30	≤2400	CFM25#
32	M42	≤2400	CFM32#
40	M48	≤2400	CFM40#

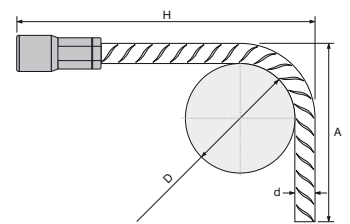
# Specify length required (mm)

### Female Single Bar Bent

Rebar Diameter (mm) d	Thread	Min Bend H (mm)	Min Bend A (mm)*	Order Code#
12	M16	130	130	CF12/H/A
16	M20	150	150	CF16/H/A
20	M24	190	190	CF20/H/A
25	M30	230	230	CF25/H/A
32	M42	325	325	CF32/H/A
40	M48	450	450	CF40/H/A

\* Bars can be cropped to a shorter length after bending

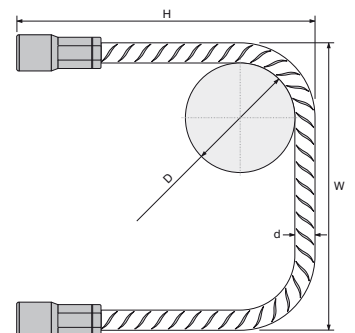
# Specify H/A dimension (mm)



### Female U Bar Bent

Rebar Diameter (mm) d	Thread	Min Bend H (mm)	Min Bend W (mm)	Order Code#
12	M16	130	Please consult RFA-TECH	CFFU12/H/W
16	M20	150	Please consult RFA-TECH	CFFU16/H/W
20	M24	190	Please consult RFA-TECH	CFFU20/H/W
25	M30	230	Please consult RFA-TECH	CFFU25/H/W
32	M42	325	Please consult RFA-TECH	CFFU32/H/W
40	M48	450	Please consult RFA-TECH	CFFU40/H/W

# Specify H/W dimension (mm)



## Male

EL Elastic limit

Aa Stress diameter of tube in mm<sup>2</sup>

Ab The nominal stress diameter of the reinforcing steel in mm<sup>2</sup>

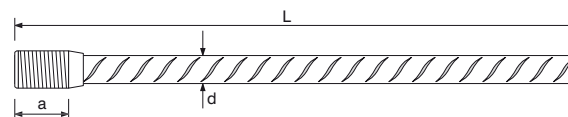
a Thread length

a1 Minimum screw in length

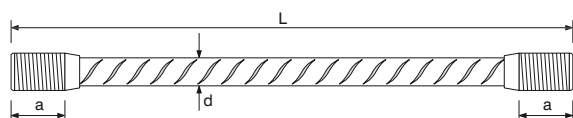
b Socket diameter

\* Standard stock size

# - Specify length required



Rebar Diameter (mm) d	Thread	L (mm)	EL (kN)	Ab	a	Order Code
12	M16	575* 1000 ≤2400	56	113	≥25	CM120575 CM121000 CM12#
16	M20	770* 1020 ≤2400	100	201	≥33	CM160770 CM161020 CM16#
20	M24	965* 1280 ≤2400	157	314	≥38	CM200965 CM201280 CM20#
25	M30	1000* 1500* ≤2400	245	491	≥48	CM251000 CM251500 CM25#
32	M42	1400* ≤2400	401	804	≥44	CM321400 CM32#
40	M48	1655* ≤2400	628	1256	≥54	CM401655 CM40#



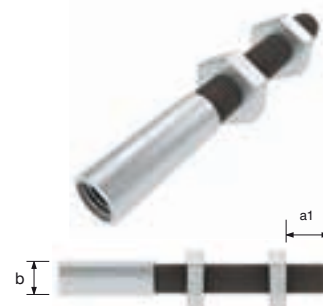
### Male / Male

Rebar Diameter (mm) d	Thread	L (mm)	a	Order Code
12	M16	≤2400	≥25	CMM12#
16	M20	≤2400	≥33	CMM16#
20	M24	≤2400	≥38	CMM20#
25	M30	≤2400	≥48	CMM25#
32	M42	≤2400	≥44	CMM32#
40	M48	≤2400	≥54	CMM40#

# Specify length required (mm)

### Male Postional Coupler

Rebar Diameter (mm)	Thread	L (mm)	EL (kN)	Aa	Ab	a1	b
12	M16	90	75	161	157	25	21
16	M20	110	115	245	245	33	26
20	M24	135	180	385	355	38	32
25	M30	170	284	605	560	48	40
32	M42	220	470	1002	1122	65	54



### Torque Required

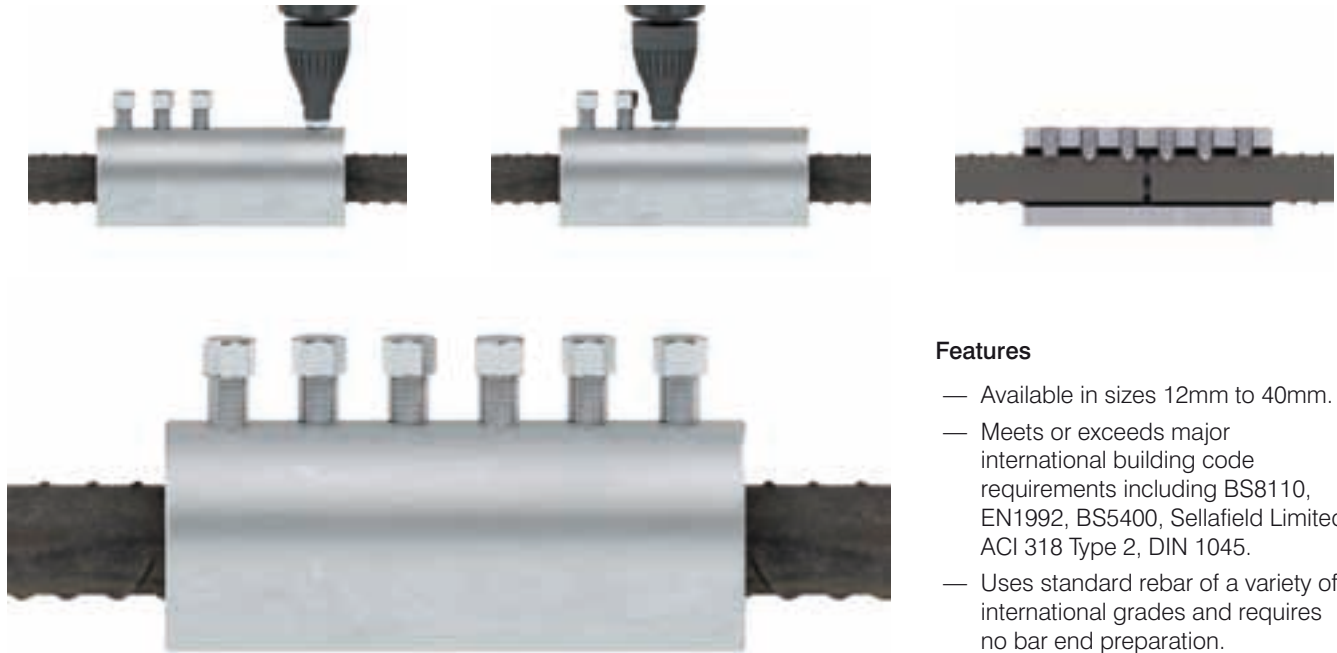
Rebar Diameter (mm)	Thread	Required Torque (Nm)
12	M16	75
16	M20	100
20	M24	160
25	M30	250
32	M42	400
40	M48	400

#### SPECIFICATION CLAUSE

Mechanical reinforcing bar connections shall be RFA Demu parallel, metric threaded couplers manufactured by RFA-TECH, UK.

Female couplers shall be affixed to reinforcing bar using hydraulic press, in line with manufacturers guidelines. Male threaded ends shall be upset hot forged then roll threaded in line with manufacturers guidelines.

## Lenton® Lock Mechanical Rebar Splicing System



The Lenton Lock coupler is an in-situ rebar splice which requires no bar end preparation and carries a full CARES Technical Approval\*. It is ideal for new construction, repair or retrofit applications. The coupler body features patented gripping technology that provides for the development of full rebar strength and improved overall structural integrity in tension, compression, stress-reversal and dynamic applications. The Lenton Lock connection performs similar to a continuous piece of rebar and meets or exceeds major international building codes.

Typical applications include use in column splicing, bridge applications, pile cages and pile heads, splicing to protruding dowels cast in concrete, closure pours, beams and chimney construction. The Lenton Lock coupler can work as a reducer, offering a one-step transition depending on rebar diameter, please see details below.

Lenton Lock couplers allow for fast and easy site installation since no bar end preparation, sawing or swaging is necessary. The couplers can be installed with a standard wrench, nut runner or an impact wrench, depending on the coupler size.

The bolt heads will shear off when proper installation tightness has been reached, which allows visual verification of correct application.

### Features

- Available in sizes 12mm to 40mm.
- Meets or exceeds major international building code requirements including BS8110, EN1992, BS5400, Sellafield Limited, ACI 318 Type 2, DIN 1045.
- Uses standard rebar of a variety of international grades and requires no bar end preparation. Ideal for in situ splices.
- Performs like a piece of continuous rebar.
- Installs quickly using hand operated tools, does not require skilled labour.
- Allows for simple visual inspection.
- Works for repair, bent rebar, retrofit, precast and new construction applications.
- Works as a one-step transition in certain rebar sizes.

40mm to 32mm rebar using LL40

32mm to 25mm rebar using LL32

25mm to 20mm rebar using LL25

20mm to 16mm rebar using LL20

16mm to 12mm rebar using LL16

12mm to 10mm rebar using LL12

\*Lenton® Lock couplers have been tested to satisfy the requirements of CARES Appendix TA1-A, TA1-B and TA1-C for couplers with reinforcing bars to BS4449 grade B500B and B500C in sizes 12mm to 32mm.

Rebar Size (mm)	Order Code	Length (mm)	Outside Diameter (mm)	Inside Diameter (mm)	Weight (kg)	Socket Size (mm)	Bolt Torque Nm	Number of Bolts
12	LL12	127	29	15	0.6	13	205	6
16	LL16	159	35	19	0.9	13	205	6
20	LL20	191	41	24	1.4	13	205	8
25	LL25	254	54	30	3.4	16	475	8
32	LL32	323	65	38	5.9	21	680	8
40	LL40	400	80	47	10.9	21	790	12



# SHEARTECH GRID®

The Sheartech Grid system has been developed to overcome the problem of fitting many traditional shear links in deep slabs, where the angles, distances and number of layers of rebar can make fitment of these links very difficult. The main application of this system is deep slabs of around 800mm or greater, generally in basements of high rise buildings or airport apron slabs.



Traditionally all slab reinforcement, including all layers of reinforcing steel and wire chairs, are placed before the required shear links are fixed, spanning the distance between top and bottom layers of steel. In thinner floor slabs this operation does not present a problem, as the reinforcing steel being small to medium diameter and the smaller element thicknesses allow some adjustment if required to enable shear links or a punching shear stud system such as Sheartech to be fitted.

In deeper concrete slabs the distances between top and bottom layers of reinforcement can make the placement of shear reinforcement particularly difficult, requiring steel fixers to try and place awkward shaped shear links over one metre spans and greater. The weight of the heavier reinforcing bar used in these applications may mean that any adjustment required is not possible. Any small misalignments of the many layers of reinforcement can also prohibit the use of regular shear stud systems, as the path between all layers to place the stud is effectively blocked. The use of carpet type reinforcement systems, with heavy mats of reinforcement can also present difficulties if subject to any misalignment between top and bottom mat layers.

Sheartech Grid allows shear reinforcement in deeper slabs to be fixed in separate stages to allow easier and faster deep slab construction. Sheartech Grid also provides an alignment system for all layers of reinforcing steel to be placed against. The system features forged shear studs manufactured from grade B500C ribbed reinforcing bar, produced under the requirements of CARES Technical Approval 5028, combined with a full strength, parallel thread coupling system.

## Sheartech Grid

### Installation

The grid consists of multiple female studs fitted to a grid system of flat steel to maintain the position of the originally designed shear links. The grids are supplied in large sections to minimise fixing operations and can be supplied in up to 2m x 2m sections.

The female grids are laid onto the ground onto proprietary concrete spacers to suit the cover required. All bottom layers of rebar are then arranged around the grid formation offering a template for the steel fixer to work to. The height of the female studs is manufactured specifically to the slab detail and reinforcing bar arrangement and is such that all bottom layers of rebar can be aligned to the studs.

Male threaded bars are then fitted by screwing into the female studs and then chair spacers can be placed. The male bars are produced to a tolerance of 5mm to ensure that the top cover of the slab is respected. All top layers of reinforcing steel can then be fitted and the up stood male bars offer an easy reference for alignment.

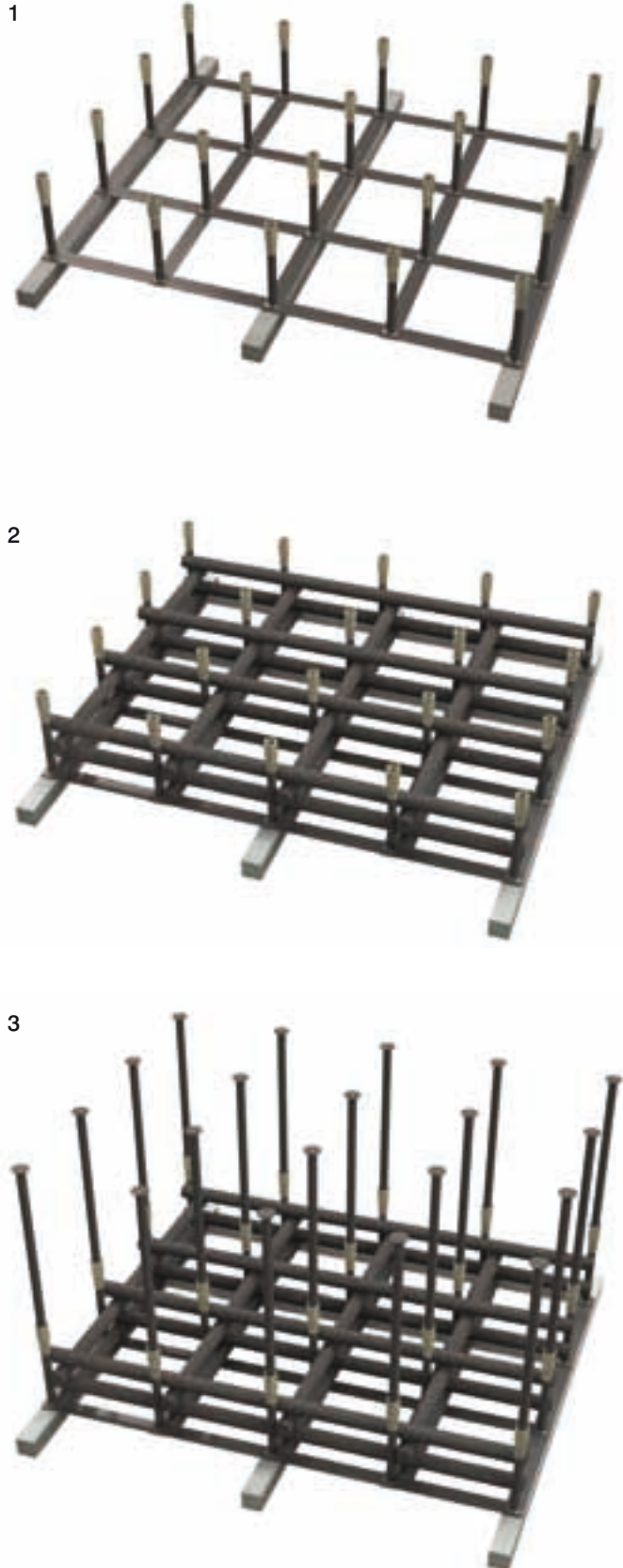
### Design

Sheartech Grid is produced for individual applications and is designed in conjunction with the concrete element thicknesses, cover requirements, rebar design and other requirements of the consulting engineer and contractor.

Sheartech Grid can be supplied with coupled shear studs to suit 12mm to 25mm reinforcing bar.

Full schematic drawings showing Sheartech Grid placement and laying sequence drawings are produced for each Sheartech Grid project.

The flexibility of the system and range of rebar diameters that can be produced ensure a solution is possible for most applications. Please consult us at the earliest opportunity to discuss the possibilities of Sheartech Grid.



4

**SPECIFICATION CLAUSE**

Shear reinforcement shall be provided by Sheartech Grid, manufactured by RFA-TECH, UK and consisting of two component shear studs formed from grade B500C reinforcing steel material. Head and foot anchorages of the shear studs are to be formed by hot forging in line with the requirements of CARES Technical Approval 5028. Connections of the two components to be provided by RFA Demu enlarged, parallel, metric thread coupled connections offering a full strength connection. Grid formation, welding and production to be in line with the manufacturers guidelines.

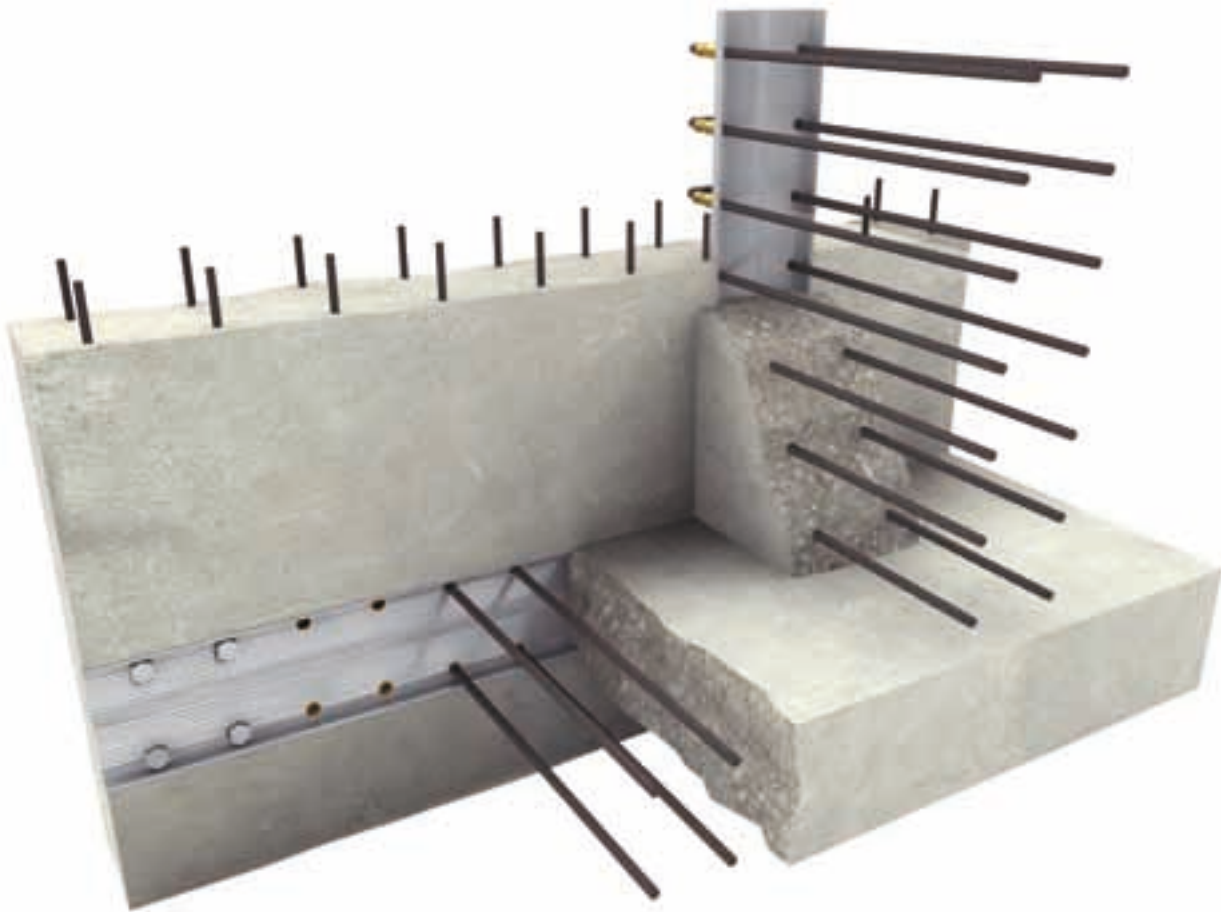
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# COUPLERBOX®

The Couplerbox is a combination of the Startabox perforated case assembly and RFA Demu rebar coupler system, in a single unit. Couplerbox has been developed to offer a rebar continuity system for larger bar diameters and where a high concentration of reinforcement or other factors prohibit the use of a rebend system, such as Startabox.



The unit is cast in to a first concrete pour to provide threaded connections to the subsequent, adjoining concrete pour. When in use and once the lid is removed, a very neat and keyed joint is produced, requiring no need for scabbling, retarders or jetwashing of the joint. As the Couplerbox is produced in a factory environment, the coupled bars are at the correct bar centres specified and not subject to errors on site.

The system was initially developed to offer a reinforcement continuity product for the areas where a rebend system was being specified, but in a larger bar diameter than possible to produce. Without the requirement to rebend reinforcing bar, diameters of up to 32mm rebar can be produced in the Couplerbox system.

The Couplerbox has been further introduced to solve the problem of locating rows of individual coupled bars especially with the use of some types of moving formwork systems such as slipform rigs. Coupled bars can become easily displaced and slip back from the concrete surface making location and preparation for future use a time consuming and costly process requiring the use of mechanical equipment in a difficult environment. If coupled bars cannot be located, rectification works can be required.

The recent introduction of the Eurocode 2 building regulations has now seen a requirement for much longer lap lengths, making the use of couplers more economical and restricting the manufacturing possibilities of rebend continuity systems.

## Applications

Couplerbox has the potential to be used in many concrete joints requiring a connection for reinforcement. It is especially suited and useful in applications where there is a requirement to fix many coupled bars and where climbing formwork systems are being used.

- Energy from Waste Facilities
- Slipform Systems
- Water Treatment Works
- Diaphragm Walls
- High Rise Construction
- Composite Floors

## Benefits & Advantages



### Safety

Couplerbox can offer a lower weight unit when compared to the equivalent unit of a rebend system as the threaded extension / splice bars are fitted separately and not contained within the casing system.

The perforated casing negates the need for any further joint preparation with mechanical tools, such as scabbling, or chemical preparation, such as retarders and jetwashing of the joint.

Couplerbox ensures there are no protruding bars until immediately required for use reducing any injury risk and providing an enhanced working area.

### Quality

Units are assembled in a factory environment ensuring the correct number of coupled bars are fitted at the correct bar centres, reducing the number of setting out operations and the risk of any possible errors from fixing on site.

The threads of the female couplers are fully protected until required for use. The featured set screw and washer arrangement ensures no concrete ingress into the thread area.

The perforated casing offers improved shear connection and provides an additional joint rebate when compared to pouring a traditional wall and slab detail.

Couplerbox can be easily seen on the concrete face and easily stripped ready for use. The resulting clean and neat joint with no concrete ingress ensures that no jackhammering of the concrete surface is required to reveal couplers, which has the potential for serious damage to the coupler and threads.

### Application

Couplerbox allows for the production of shorter units than would be possible in a rebend system. As the minimum length of unit is not constrained by the lap bars inside the box, much shorter units can be produced.

Couplerbox provides a solution where larger bar diameters, including 25mm and 32mm, are required to provide continuity between two concrete elements. Bars of differing diameters can be contained in the same unit.

Couplerbox offers a solution for construction joints requiring a high cross sectional area of steel where alternative continuity system are not suitable for use. The combination of small bar centres, longer lap lengths and a larger rebar size can present such a problem, however this can be easily produced in a Couplerbox unit.

Units for circular or radiused structures can be produced in a Couplerbox unit. The flexibility of the Startabox case ensures that solutions are available for small diameter structures with heavy reinforcement.

### Cost

No 'lost' couplers, due to movement in concrete pours, ensures that costly remedial works such as drilling, jackhammering and use of resin anchor systems are not required.

The Couplerbox unit features many couplers fitted in a single box requiring less fixing time when compared to the fitting of individual coupled bars.

### Design

Couplerbox units are produced for individual applications and are designed in conjunction with the concrete element thicknesses, cover requirements, rebar design and other requirements of the consulting engineer and contractor. Units can be supplied to suit 12mm to 32mm rebar couplers.

The flexibility of the system and range of rebar diameters that can be produced ensure a solution is possible for most applications.

Please consult us at the earliest opportunity to discuss the possibilities of the Couplerbox system. Further specific details of the components used can be found in the Startabox and Rebar Coupler sections of this brochure.

### SPECIFICATION CLAUSE

Connections shall be formed using Couplerbox manufactured by RFA-TECH, UK. Connections will be RFA Demu parallel, metric threaded coupler system. Case material shall be fully perforated galvanised steel in line with CARES Technical Approval 5007. Specification and manufacture to be in line with manufacturers guidelines.



## TERMS AND CONDITIONS



### Terms and Conditions of sale of RFA-TECH Limited ("the company")

#### 1. General

Except to the extent that such provisions of the Sale of Goods Act 1979 are non-excludable these conditions together with such provisions of the said Act are not inconsistent herewith shall apply to all sales by RFA-TECH (the company) and shall form the basis of a contract between the company and the customer. No variation of these conditions shall be effective unless made in writing and signed by a director of the company. Unless otherwise agreed in writing these conditions shall prevail over any other terms and conditions whether in writing or implied by Law or by trade, custom, practice or previous course of dealing and any such inconsistent terms and hereby expressly excluded. This agreement will be governed and construed in accordance with the laws of England and Wales. The parties' hereto submit to the exclusive jurisdiction of the courts of England and Wales.

#### 2. Price

All prices quoted are based on costs ruling at the date of quotation, (excluding VAT). If there are any alterations to these costs the Company reserves the right to alter the prices and will notify the customer in writing thereof, the issuing of a new price list is by the Company shall be deemed to be such notice. Thereafter the customer shall have the right to cancel the order on written notice to that effect being given to the company within seven days of the written notice giving the alteration in price.

#### 3. Payment

(a) In the absence of any concession to the contrary by the Company from time to time accounts are due and payable in full within 30 days of the end of the month in which the invoice was dated (due date) of the respective invoice.

(b) If the customer fails to pay any amount due on the due date:-

(i) The company has the right to cancel any contract made with the customer and/or suspend or continue delivery of goods and materials at the company's option without prejudice to the company's right to recover damages for any loss sustained by it.

(ii) The outstanding sum shall carry interest from the due date at a rate of 4% above Barclays Bank plc base rate from time to time and for the time being in force per month until settlement. A part of a month being treated as a whole month for the purposes of calculating interest.

(iii) The whole balance of the price of this contract and all other contracts invoiced shall immediately become due and payable together with interest.

#### 4. Suitability of Goods

The customer is responsible for the suitability of the goods and materials bought. No warranty is given nor shall any warranty condition be implied that the goods are reasonable fit and suitable in size shape capacity quality or otherwise for the purpose for which they are bought and the Company shall not be under any liability whatsoever due to any goods being unfit or unsuitable.

#### 5. Notification of Loss, Shortages, Damage in Transit

(a) Any damage shortage or pilferage in transit to goods must be notified in writing to the Company within seven days of delivery all damage, shortage or pilferage to goods apparent at the time of delivery must be noted on the carriers delivery note at the time of delivery otherwise the Company cannot consider accepting liability.

(b) Non-delivery of goods must be notified in writing to the Company within seven days of our invoice relating thereto otherwise liability by the Company cannot be considered.

#### 6. Defects

If any goods show defects arising solely from faulty materials and/or workmanship, the Company's liability shall be limited to replacing such goods, but no such liability shall arise unless notification of such defects is received WITHIN SEVEN DAYS from receipt of the goods and the alleged defective goods are returned to the Company. In no circumstances shall the Company be liable for any consequential loss howsoever caused.

#### 7. Sale by Sample and/or Description

Unless the contract specifically provides for a sale by sample and/or description, the submission of a sample and/or the giving of a description shall not be held to indicate the sale is a sale by sample and/or description and any warranty expressed or implied by law to the contrary effect is hereby excluded. Where the contract specifically provides for a sale by sample and/or description regard will be given to normal variations arising from the nature of the materials from which the goods are manufactured. Any variation required at a future date must be subject to further negotiations.

#### 8. Cancellation

Contracts and orders may be cancelled by customers with the sanction of a Director of the Company, which sanction is in the Company's sole discretion and can only be given upon payment of such sum by way of compensation as specified by the Company, and such sum by way of compensation would include payment in respect of loss of profits.

#### 9. Retention of Title

(a) The title to the property in the goods comprised in an order shall not pass to the customer until amounts for all goods comprised in that order and all other outstanding amounts due to us in respect of any other transactions between the parties then outstanding has been paid in full not withstanding that the goods may have been delivered to the customer.

(b) Notwithstanding the above paragraph the goods shall be at risk of the customer from the time of delivery to or collection by the customer and the customer shall take all necessary steps to insure the goods for their full invoice value.

(c) The customer shall separately store the goods and identify the goods as belonging to the Company until the relevant invoice has been settled in full. The customer is prohibited from incorporating the goods or using the same until such settlement.

(d) The customer may sell the goods to a third party in the ordinary course of the customer's business but only under the following conditions:-

(i) Only at such a price that would enable the customer to repay the amount due to the Company under (a) above.

(ii) The customer shall in every case make it a condition that the title in the goods shall not pass to the third party until the third party has paid to the customer the amount in paragraph (d)(i) above.

(iii) Immediately upon such sub-sale the customer shall notify the Company of the name and address of the third party and the Company shall be entitled to inform the third party of our interest in the goods.

(iv) The proceeds of any sub-sale shall be held by the customer on trust for the Company and shall be paid into a separate Bank Account specifically designed as being a trust account for the Company and such time as payment for the goods is made in full to the Company.

(e) Save as above, the customer shall not dispose of the goods in any way or create or allow to be created any rights in the goods in favour of the third party.

(f) Should the customer be in arrears with any payment to the Company, the Company is hereby granted an implied license to enter the customer's premises where the goods are then being kept or stored in order to re-possess the goods and the cost of any such re-possession shall be borne by the customer. The Company shall not be responsible for any damage howsoever caused arising out of the re-possession of the goods under this clause.

#### 10. Limitation of Liability

In all cases the Company's liability in any claim is limited to the amount covered by the Company's insurance. The Company cannot accept liability for any loss or damage caused to the customer by reason of the Company's products being found to involve the infringement of any third party's patent or patents.

#### 11. Termination

The Company reserves the right to terminate the order upon giving reason able written notice to the customer. The Company further reserves the right to terminate this order if sums due and payable by the customer under previous orders remains outstanding.

#### 12. Insolvency

This clause applied if :-

12.1.1 The customer makes any voluntary arrangement with the creditors or becomes subject to an administration order (being an individual or firm) becomes bankrupt or (being a Company) goes into liquidation otherwise than for the purposes of amalgamation or reconstruction or

12.1.2 An encumbrancer takes possession or a receiver is appointed of any of the property or assets of the Customer or

12.1.3 The customer ceases or threatens to cease to carry on business or

12.1.4 The Company reasonably apprehends that any of the events mentioned above is about to occur in relation to the customer

12.2 If 12.1 above applies then without prejudice to any other rights of the Company.

12.2.1 The Company shall be entitled to cancel the contract and

12.2.2 Any payment due but not paid (not withstanding that the due date may not have arisen) shall become immediately due and payable not withstanding any previous agreement or arrangement to the contrary together with interest at the rate specified in 3(b) above

#### 13. Delivery

13.1 The Company shall make all reasonable efforts to meet quoted delivery dates, although such dates and times are not guaranteed.

13.2 The Company shall not be liable for any delay in delivery due to factors beyond the Company's control, which shall include without prejudice to generality of the foregoing. Acts of God, explosion, flood, tempest, fire, accident, war or threat of war, sabotage insurrection civil disturbance or measures of any kind on the part of any Government or Parliamentary Authority. Strikes lock out or any other industrial actions or trade disputes (whether involving the Company's employees or third parties) power failure, shortage of fuels or materials or breakdown in machinery. The Company shall endeavour to fulfil its obligations as soon as is reasonably practicable taking into account the relevant aforementioned event.

#### 14. Returned Goods

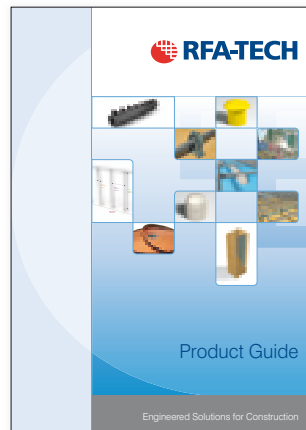
Goods may be returned by the customer with the prior agreement of the Company, but will be subject to a 25% rehandling charge, or a minimum charge of 20.00(GBP), whichever is the greater.

## Further Information

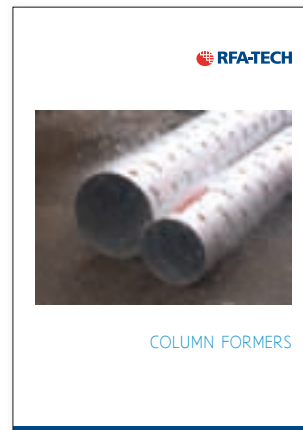
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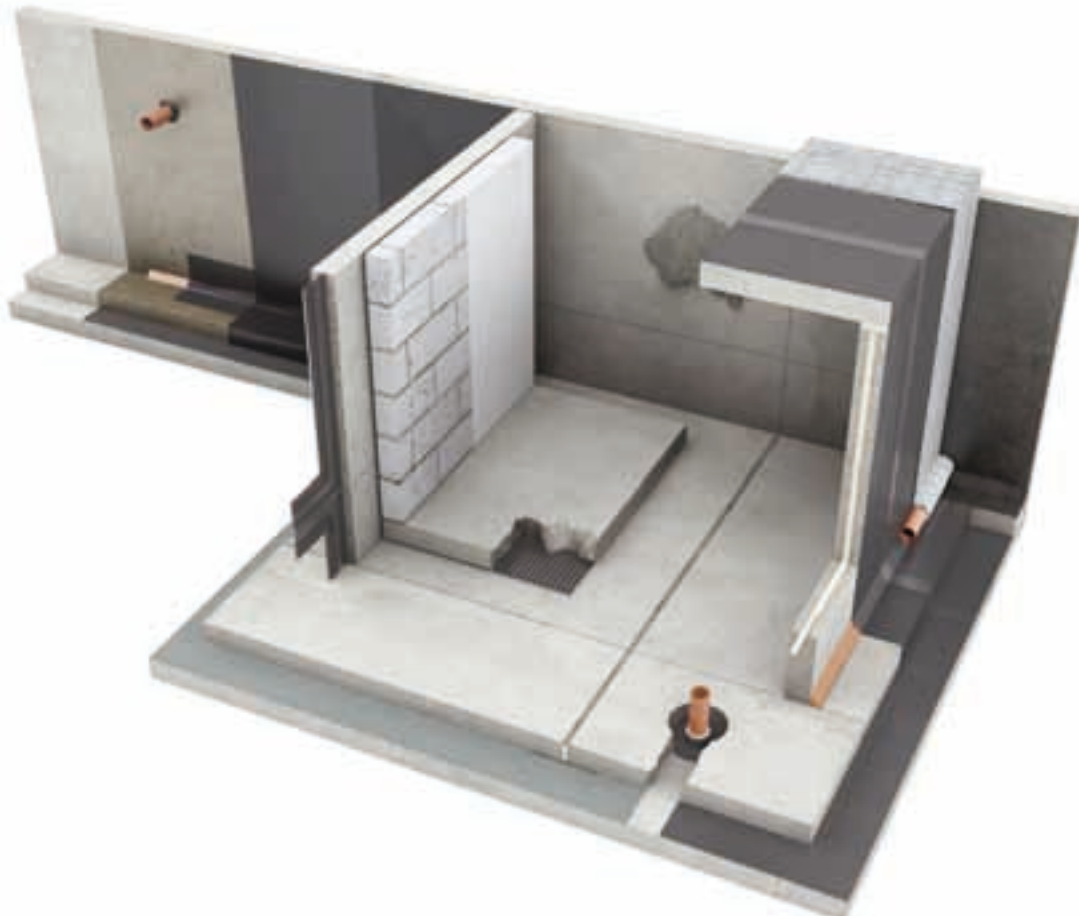
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