INCON

Mechanical Splices (Couplers and Bar Terminators)

Contents

INCON

BRINGS YOU THE COMPLETE SOLUTION

ABOUT INCON

INCON is a Canadian company specialized in designing and manufacturing high-quality steel products and accessories for the construction industry throughout North America and the international market. Our innovative designs not only accelerate the construction workflow but also enhance the overall integrity of the structural system. Our outstanding products, modern machines and enormous production put us in a global front line to supply our valued clients with the complete solution according to their needs. INCON prides itself on having successfully delivered all of its projects on time. Our good results have allowed us to create partnerships with our clients and have them procure our services. We possess the required knowledge, experience and know-how to manufacture superior quality products for your desired use. We have an increasingly global outreach due to our excellent reputation that we acquired over years of providing our clients with extraordinary solutions to their concerns. Close cooperation between our technical support and top management ensures that we incorporate all feedback from our clients and consider them to continuously develop our products and services.

INCON FACILITIES

INCON's headquarter is located in Canada, where engineering; development; research and technical support departments work together to come up with solutions for the construction industry. Our facilities are managed and operated under the strictest Canadian quality control criteria and international standards. In our factories and labs, we use state-of-the-art equipment to perform all tests in order to ensure the accuracy and reliability of our results. Our expert engineering team and highly skilled specialists are dedicated to achieve the optimum performance of our products and services. Proactivity of our quality control inspectors ensures early detection of any potential quality concern before it becomes an issue. In order to maintain a leading position in the engineering market, INCON allocates part of its budget toward Research and Development through working in collaboration with top Canadian educational institutions.

INCON RESEARCH AND DEVELOPMENT

Research and development projects support the development of innovative manufacturing processes and products to supply the construction market with the most efficient solutions. Modern technologies provide high production capacity with superior quality products. At INCON, we believe in cooperation between industry and academia. This is why part of the budget is allocated towards research in collaboration with top Canadian Educational Institutes like Western University. We keep aiming at creating the products of tomorrow by performing comprehensive researches in our facilities that focus on innovation, introduction and enhancement of our products and services. INCON products are suitable for use in buildings, stadiums, bridges, dams and power plants under both static and dynamic loads such as wind, seismic and blast loads. Despite the competitive business environment, our innovative superior quality products and excellent experience we posses in this field, put us in a leading position in the global market. We possess the required knowledge, experience and know-how to manufacture superior quality products for your desired use.

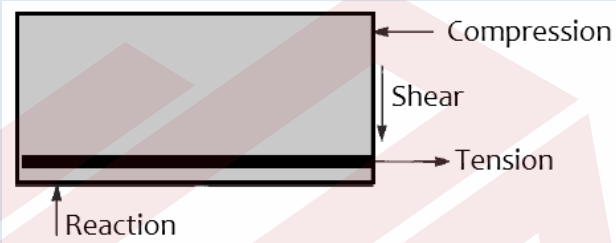
INCON GLOBAL PRESENCE

Our consistent and continuous development of superior quality construction products have put us in a global leading position that we will never abandon. We have accumulated the best practices throughout years of ongoing research to put them in our clients' hands. Our innovative products, modern machines and enormous production put us in a global front line to supply our valued clients with the complete solution to their needs. Our facilities produce and sell more than **10 millions** mechanical splicing devices to cover the market demands in North America, Europe and Asia. INCON's global success is achieved by earning our client's trust through providing them with innovative products especially designed to meet their needs. INCON prides itself on having successfully delivered all of its projects on time. Our good results have allowed us to create partnerships with our clients and have them procure our services.

SPLICING AND ANCHORAGE OF STEEL BARS

BOND STRESSES IN STEEL BARS

In reinforced concrete flexural members, the applied bending moment induces compressive stresses in concrete and tensile stresses in the main steel bars. In order for the composite action to be activated, there must be a force transfer (bond) between the two materials. The equilibrium between the tensile force acting on the steel bar and the bonding force with concrete ensures that this mechanism is achieved. However, if the length of the bar is not sufficient to develop the required bond, then it will pull out of the concrete and the tensile force will drop to zero causing the flexural member to fail.

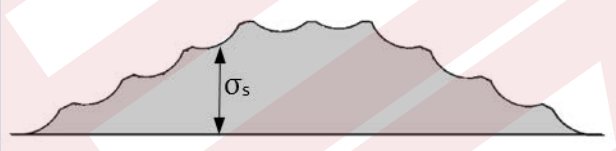


Internal forces in typical flexural member at an arbitrary section.

Stresses acting on main steel bars in flexural members.

TRUE BOND STRESS

In a cracked reinforced concrete beam, steel reinforcement resist all tensile stresses at the crack locations. However, between the cracks, part of the load is transferred to the concrete by bonding stresses. Hence, the resulting stress distribution along the beam is not constant and fluctuates between each two successive cracks. The true bond stress at any section is proportional to the slope of the corresponding steel tensile stress diagram. The true bond stress is also called "in-and-out bond stress" to indicate that stresses are transferred into the embedded bar and back out again.



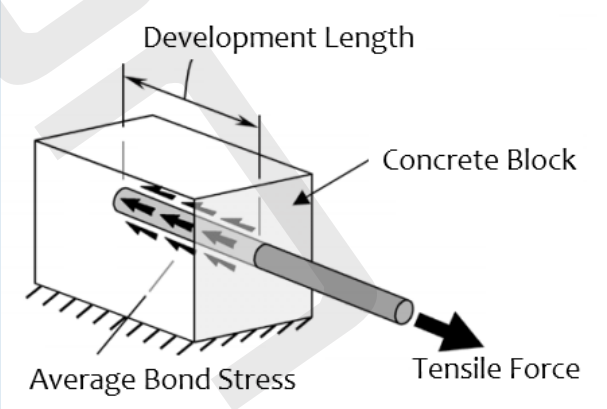
Typical tensile stress (σ_s) variation in the main steel bars along a two-point loaded flexural member.

Typical tensile stress distribution in a uniformly cracked flexural member.

Variation of true bond stress between concrete and the embedded steel bars along the span.

DEVELOPMENT LENGTH

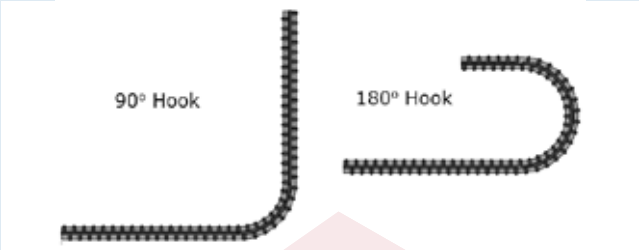
Development length in reinforcing steel bars is the minimum distance required for the stresses to increase from zero to the bar yield strength. If the bar length is smaller than the calculated development length, then it will pull out of concrete at the onset of yielding. Due to the fluctuation in the actual bond stresses along the main bar length, building codes adopt the concept of development length instead of the true bond stresses. Development length is calculated in terms of bar diameter, steel grade, concrete tensile strength, concrete cover, transverse steel ratio and bar surface condition.



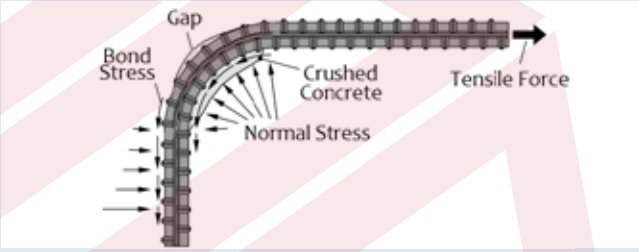
Concept of development length. Note that if the embedded bar length is less than the required development length, then the bar will eventually pull out of the concrete block.

HOOKED ANCHORAGE

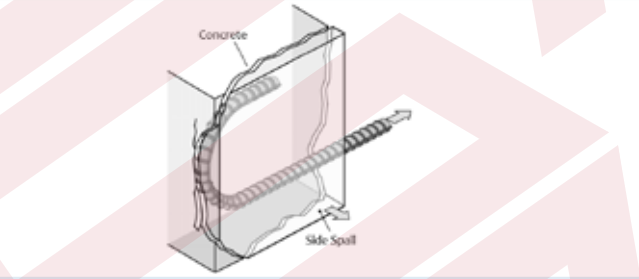
Hooks are considered to provide additional anchorage for the bar when there is insufficient straight length available to satisfy the required development length. Building codes usually specify standard hooks to be used in such situations. For bars with large diameters, standard hooks are not recommended by engineers and contractors due to construction difficulties. In a typical hook anchorage, tensile stress in the bar is resisted by bond of the straight portion of the bar and by the bearing on the concrete inside the hook. As the load increases, the hook slightly moves inward, leaving a gap between it and the concrete. Because the compressive force inside the bend is not collinear with the applied tensile force, the bar tends to straighten out, producing compressive stresses on the outside of the tail. Failure of a hook almost always involves crushing of the concrete inside the hook. However, if the hook is close to a side face, the crushing will extend to the surface of the concrete, removing the side cover. Occasionally, the concrete outside the tail will crack, allowing the tail to straighten.



Common standard hook types specified in building codes.



Stress distribution in a typical hooked bar.

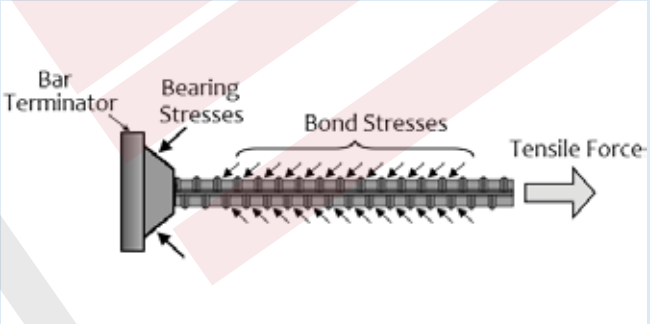


Side spalling failure associated with hooked bars.

HEADED ANCHORAGE

Force transfer mechanism between concrete and the headed bars are achieved by a combination of bond along the straight portion of the bar and bearing against the head. Building codes specify shorter development length for headed bars than that for hooked bars. This results in a great advantage in terms of saving materials, reducing congestion, decreasing construction time, lowering labor cost and simplifying concrete work.

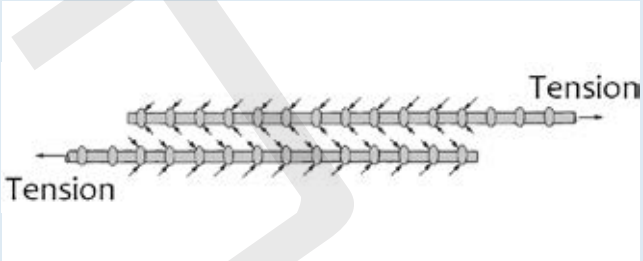
INCON innovative ICT Bar Terminators (End Anchors) are designed considering the aforementioned force transfer mechanism to achieve outstanding structural integrity.



Load transfer mechanism in headed bars.

REINFORCEMENT SPLICES

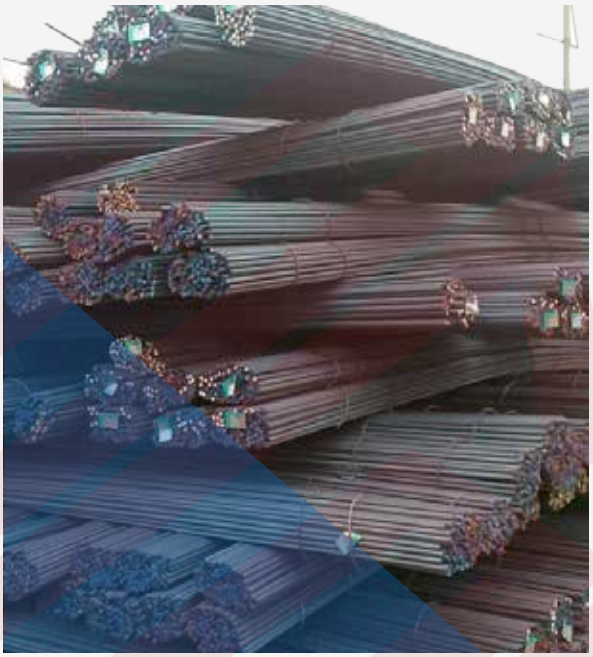
In a lapped splice, the tensile force is transferred between the adjacent bars through the surrounding concrete matrix. The force transfer mechanism induces radial outward pressure acting on the concrete that may cause splitting cracks along the bar. Once these cracks are formed, the structural member fails at the splice location. Usually, the initiation of cracks commences at the ends of each bar where the splitting pressure is large. To avoid premature failure of the structural member, building codes usually put several limitations on using lap splices.



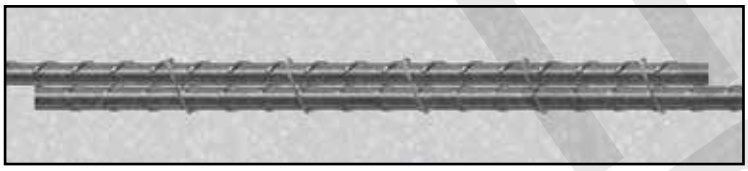
Stress transfer mechanism in conventional lap splices.

SPLICING OF REINFORCEMENT

In the modern construction, reinforced concrete is widely used as a building material. In most applications, both carbon steel and stainless steel bars are widely used as reinforcement. These bars are manufactured with specific lengths due to shipping and handling constraints. This creates another dimension for engineers to consider when designing the connection between the bars in order to form one structural entity. Among the various splicing methods, swaged mechanical couplers are found to provide the optimum solution for all applications. This is why at INCON, we are devoted to bring the highest quality of swaged mechanical splicing devices for our clients worldwide in lieu of the existing less efficient techniques such as lap splices, welded splices and threaded mechanical splices.

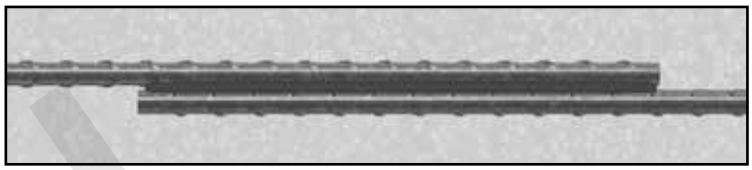


CONVENTIONAL LAP SPLICES



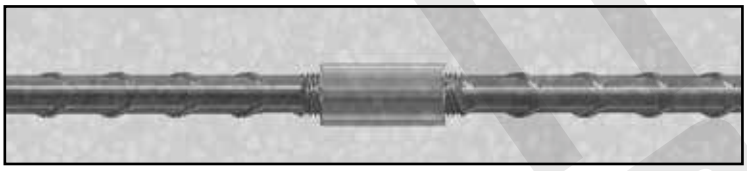
A lap is formed when two steel bars are overlapped to create a continuous profile. The length of the lap is dependent on concrete strength, bar grade, size, and spacing. Assembling lap splices on site is tedious and consumes a considerable amount of time. Special precautions should be made during both the design and construction phases to ensure that the lap length is sufficient to transfer the forces between the bars. For bars with large diameters, lap splices are not allowed to be used by most building codes. In many situations, the required lap length could exceed the available space within the structural components. In addition, splicing the bars results in undesirable reinforcement congestion at critical locations such as connections.

WELDED SPLICES



Field-welded splices are accomplished by electric arc welding the reinforcing bars together. For projects of all sizes, manual arc welding will usually be the most costly method, due to direct and indirect costs of proper inspection. In general, most organizations including the Concrete Reinforcing Steel Institute (CRSI) are against manual arc welding in the field. If performed at site, all welded splices shall confirm to the relevant structural welding code for reinforcing steel bars. This process adds unnecessary design and construction costs that can be simply avoided using swaged mechanical splices.

THREADED MECHANICAL SPLICES



The use of threaded mechanical splicing devices to join steel bars is accompanied by many disadvantages that can add an avoidable extra cost to the project. Threading the steel bars on site is a time consuming process and may result in considerable alterations in cross-sectional dimensions and may cause unintended hair cracks in the steel bars due to the threading process. In addition, the quality control of the threading process is not strict as that performed in factories. This may cause significant problems at the threaded part due to stress concentration there.

To overcome all the problems associated with the aforementioned splicing techniques, INCON has developed state-of-the-art swaged mechanical splicing devices that are convenient for all construction needs.

INCON PRODUCTS

INCON ICS - STANDARD COUPLER

INCON standard couplers are used when at least one of the bars to be connected possesses both axial and rotational degrees of freedom along its profile. This feature allows the mechanical connections to be assembled in normal situations that do not involve significant construction constraints.

INCON ICP - POSITION COUPLER

INCON positions couplers are used when the bars to be connected are restrained against rotational movement and at least one of them possesses an axial degree of freedom along its longitudinal axis. This feature allows the mechanical connections to be assembled in situations where two steel cages are to be connected simultaneously or at least one of the bars is non-uniform along its profile (i.e. bent or curved bars).

INCON ICST - TRANSITION COUPLER

INCON transition couplers function in a similar manner to the ICS - Standard and ICP - Position couplers but are used when the bars to be connected have different diameters. This feature allows the mechanical connections to be assembled in locations that experience abrupt variation in bars' sizes especially at beam-column connections, column-column connections and joints.

INCON ICT - BAR TERMINATOR

INCON bar terminators (end anchors) are used in lieu of bent bars to achieve the required bond between concrete and the embedded reinforcement in all structural members.

SWAGING TECHNOLOGY

INCON 3RD GENERATION SWAGING MACHINE

At INCON, we developed our high-tech third generation swaging machine which accelerates the workflow while enhancing the quality of the product. Simplicity and outstanding performance are key features of our swaging machines. They provide an immense 1000 T pressing force that reduces the swaging time of a 40 mm bar coupler to less than 15 seconds. The fully digital controlled system, touch screen, flexible die changing and laser metering technique make the construction process fast and accurate. It can operate efficiently under all weather conditions either on site or in workshops. The swaging mechanism does not require special preparation of the steel bars and does not alter their original mechanical properties. Using INCON swaging machine at site is the optimum way for our clients to overcome construction obstacles effectively, eliminate undesired labor and material costs, and enhance the integrity and performance of the structural system.

EFFICIENT INSTALLATION PROCESS

Swaging is a cold working manufacturing process that involves exerting a considerably large compressive force around the object's circumference to alter its geometry. The process is performed by compressing the coupler around the profile of the steel bar to create a secured and strong mechanical interlock.

Half section view of a typical swaged coupler showing the embedded steel bar. The marks left by the deformed steel bar are clearly visible on the internal surface of the vacant side.

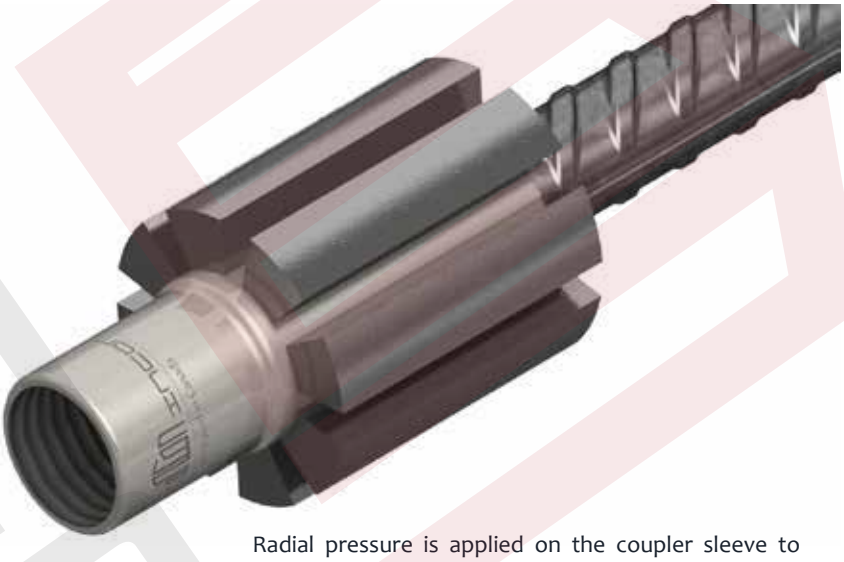
BEFORE COUPLER SWAGING

INCON couplers are engineered and manufactured to exceed the requirements of the strictest standards worldwide. The chemical composition and physical properties of our couplers are carefully examined to ensure that they maintain their strength, durability and high performance during and after the swaging process.

Steel bar inserted in a typical female sleeve before the swaging process.

DURING COUPLER SWAGING

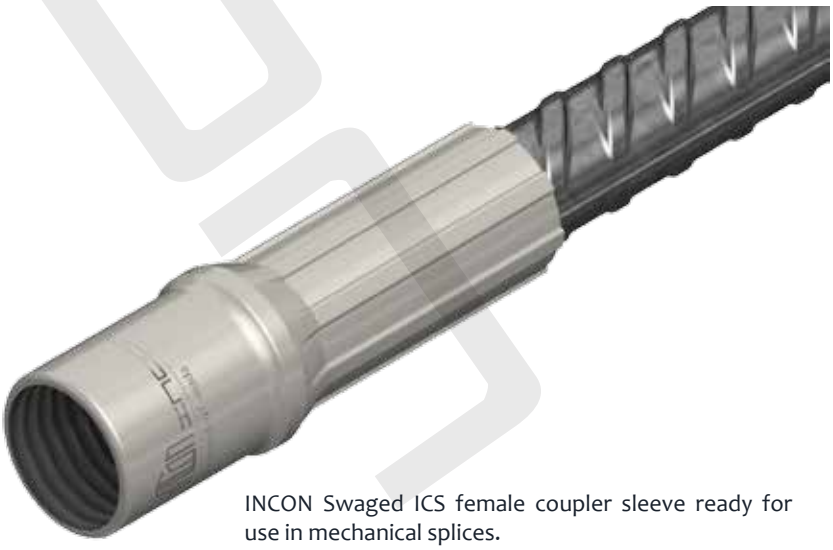
The coupler sleeve is swaged against the embedded steel bar by applying a radial compressive force on the outer surface. The external surface of the coupler takes the shape of the confining dies; whereas the internal surface becomes in full contact with the steel bar regardless of its grade or deformation pattern.



Radial pressure is applied on the coupler sleeve to form a perfect bond with the embedded steel bar.

AFTER COUPLER SWAGING

The external surface of the coupler takes the shape of the confining dies; whereas the internal surface becomes in full contact with the steel bar regardless of its grade or deformation pattern. The load transfer mechanism between the steel bar and the coupler sleeve ensures that they act as one entity.



INCON Swaged ICS female coupler sleeve ready for use in mechanical splices.

WHY INCON SWAGED MECHANICAL SPLICES?

Our clients asked, and we listened! Announcing the arrival of the innovative swaged mechanical splicing system that integrates durability, structural performance and cost effectiveness. Conventional lap splices have been replaced by different types of mechanical joints not only to save the bar material, but also to accelerate the speed of construction, increase productivity and simplify the design.

STRUCTURAL PERFORMANCE

- Ductile behavior is maintained in the structural members.
- Structural performance is independent of concrete type and strength.
- Slip is completely eliminated between couplers and the embedded steel bars.
- Bars are concentrically aligned resulting in direct force transfer between the two bars.
- Eliminates potential cracks that exist in conventional lap splices.
- Enhances the overall integrity of the structural members due to continuity in steel reinforcement.
- Eliminate potential slip, hook straightening or side spalling that may occur in conventional hooked or bent bars.

CONSTRUCTION SIMPLICITY

- Fast construction process is achieved due to the availability of on-site INCON innovative swaging services.
- Significant reduction in reinforcement congestion at splicing and connection locations.
- Formation of construction joints is greatly simplified.
- Swaging process does not require special preparation of the bars as in threaded splices.
- Problems associated with inappropriate concrete casting due to reinforcement congestion are eliminated.
- Formwork damaging is avoided during construction of core-slab connections.
- Substantial reduction in labors needed to construct lap splices, form bent bars and dispose steel waste.

COST EFFECTIVENESS

- Remarkable save in labor cost that accompanies other splicing methods such as lap splices, welded splices and threaded mechanical splices.
- Save in steel cost and welding material, especially for long splices.
- Eliminating formwork cutting and drilling makes it possible to reuse it multiple times in construction.
- Reduce the time required for preparing detailed drawings and detailed calculation sheets for lap splices and bent bars during the design phase.
- Reduce the inspection time for lap splices and bent bars during the construction phase.

QUALITY CONTROL

- INCON couplers and bar terminators are manufactured in accordance with the strictest Canadian standards in ISO certified and UKAS accredited facilities.
- Both experimental and analytical investigations are performed on our products to ensure outstanding structural performance that exceeds the requirements provided in building codes and standards.
- In addition to our research and development program, INCON has been working in collaboration with **Western University in Canada** to continuously develop the quality of our mechanical splicing devices.

ENVIRONMENT

- INCON mechanical splicing devices are recyclable and may be manufactured of recycled materials.
- Reinforcement waste associated with lap splices and bent bars is significantly reduced.
- Noise pollution associated with threading of steel bars on site is significantly reduced.
- No welding; or heating required neither in production process nor in site applications.

INCON products are key for achieving construction efficiency and structural integrity in any reinforced concrete structure.

APPLICATIONS OF INCON MECHANICAL SPLICING DEVICES

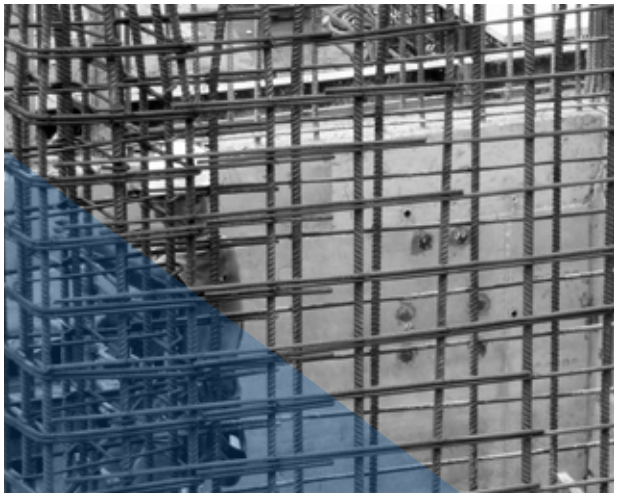
The use of INCON mechanical couplers not only simplifies construction, but also enhances the structural performance of the structural system. Other than their use in normal construction to connect bars and steel cages, mechanical couplers are recommended by many North American and European standards in the following situations:

1. LARGE SIZE BARS ARE USED IN CONSTRUCTION.

Typical applications include raft foundations, columns, deep beams, transfer slabs and other heavily reinforced concrete members. Different standards recommend using bar couplers for sizes 20M (US #6, EU 20 mm) and above. For bars larger than 45M (US #14, EU 40 mm), codes do not permit the use of conventional lap splices.

2. SPACING OF THE BARS IS INSUFFICIENT TO ALLOW LAP SPLICING.

This usually occurs in cases that require large quantities of steel reinforcement and the larger size bars as in heavily loaded structural members.



3. THE REQUIREMENTS OF THE CODES RESULT IN LONG LAP SPLICES.

Provisions of different building codes usually result in long lap splices especially for bar size 30M (US #9, EU 28 mm) and above. In such situations, building codes usually specify using mechanical splices to avoid changing the behavior of the structural members from ductile to the undesired brittle as a result of being over-reinforced.

4. REINFORCED CONCRETE STRUCTURAL MEMBER IS SUBJECTED TO TENSION.

Building codes do not allow tension lap splices of reinforcing bars in tension tie members. For similar construction applications, swaged mechanical splices should be used in lieu of conventional splicing techniques.

5. TENSILE CONTINUITY AT SOME CONSTRUCTION JOINT LOCATIONS IS TO BE MAINTAINED.

Mechanical splices are often preferable to having long bar lengths projecting from existing concrete construction. This ensures perfect reinforcement continuity and saves the cutting and drilling in the formwork required in case lap splices are used.

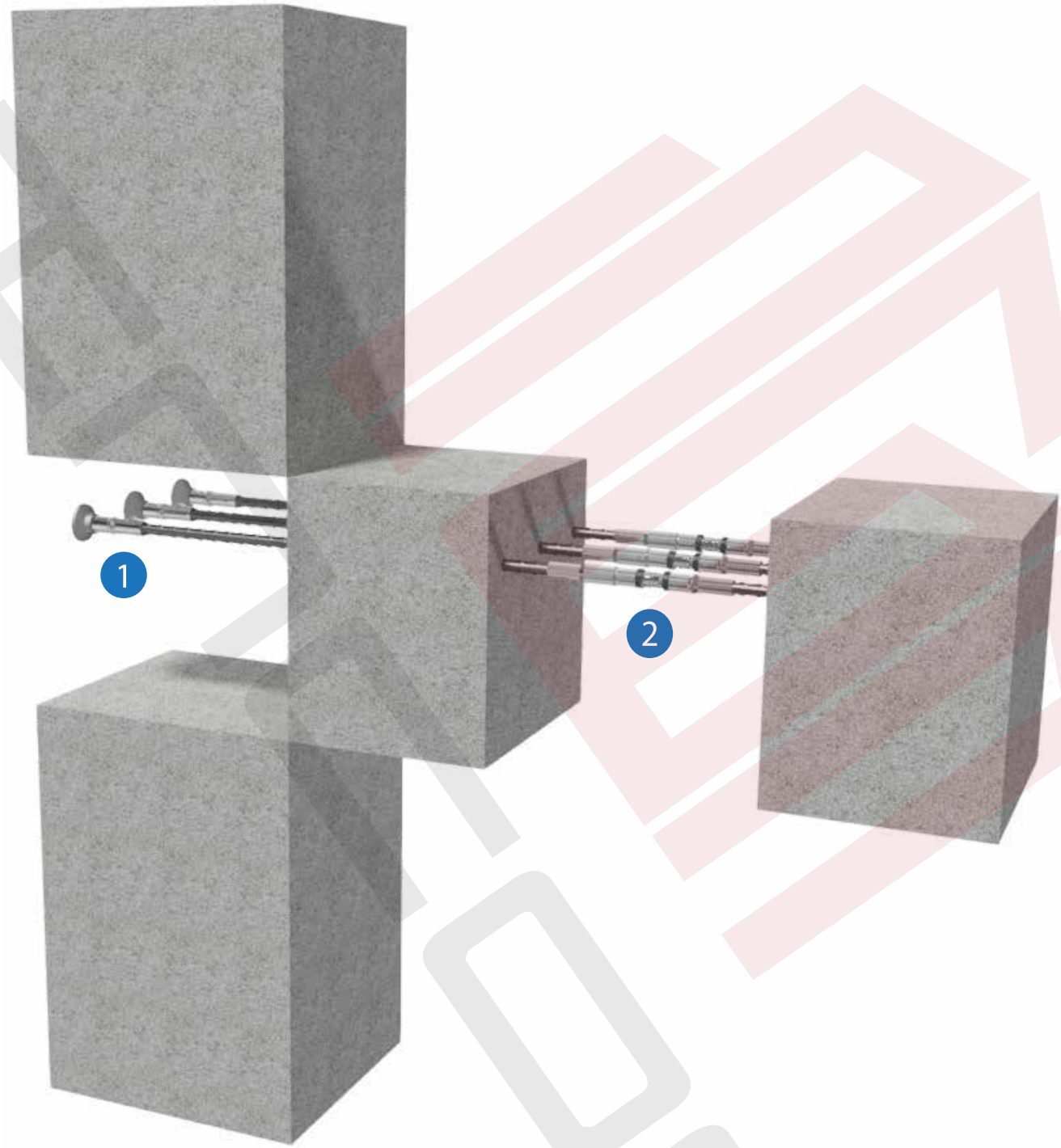
6. STEEL REINFORCEMENT RATIO IN THE SPLICE REGION IS HIGHER THAN THE MAXIMUM LIMIT SPECIFIED IN THE CODE.

Codes usually specify maximum limits for steel reinforcement ratio in structural members. Thus, checks should be made not only along the member length, but also at the regions where splices are anticipated. Using traditional lap splices can result in undesirable increase in cross-sectional dimensions or decrease in the amount of bars to satisfy the code.

7. BARS OF EXISTING STRUCTURAL MEMBERS ARE TO BE CONNECTED WITH ADDITIONAL REINFORCEMENT FOR STRENGTHENING AND REPAIR APPLICATIONS.

Using conventional lap splices for repairing structural members require large amount of concrete removal to expose not only the damaged portion of the bar, but also a sufficient distance from both sides to account for the development length. However, when mechanical splices are used, then only the damaged part of the bar needs to be exposed.

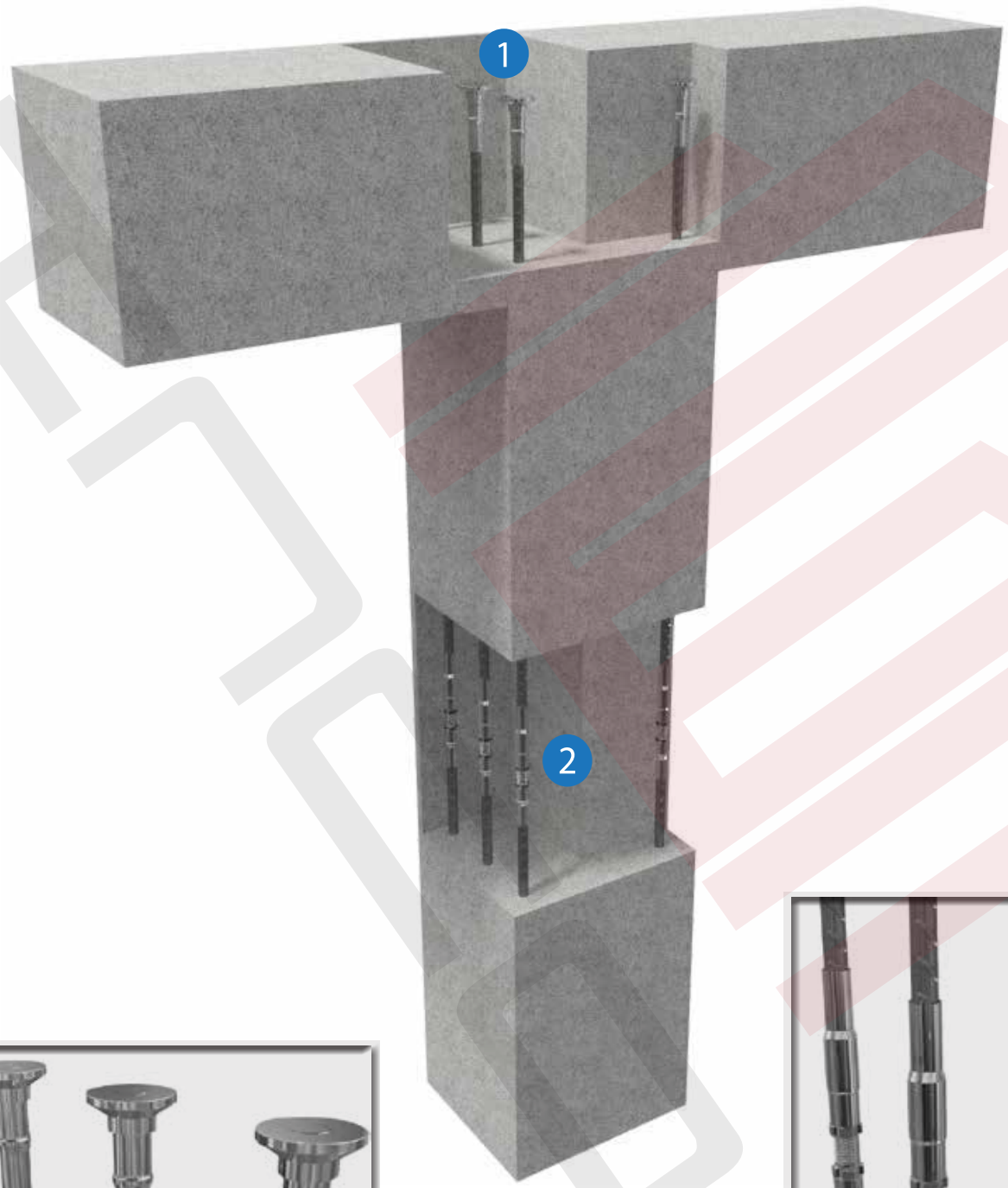
FLOOR COLUMN TO BEAM CONNECTIONS



INCON ICT Bar Terminators provide the required anchorage strength for the reinforcement in typical beam to column connections.

INCON ICP Position Couplers are the optimum solution for maintaining reinforcement continuity when all bars are restrained against rotational movement.

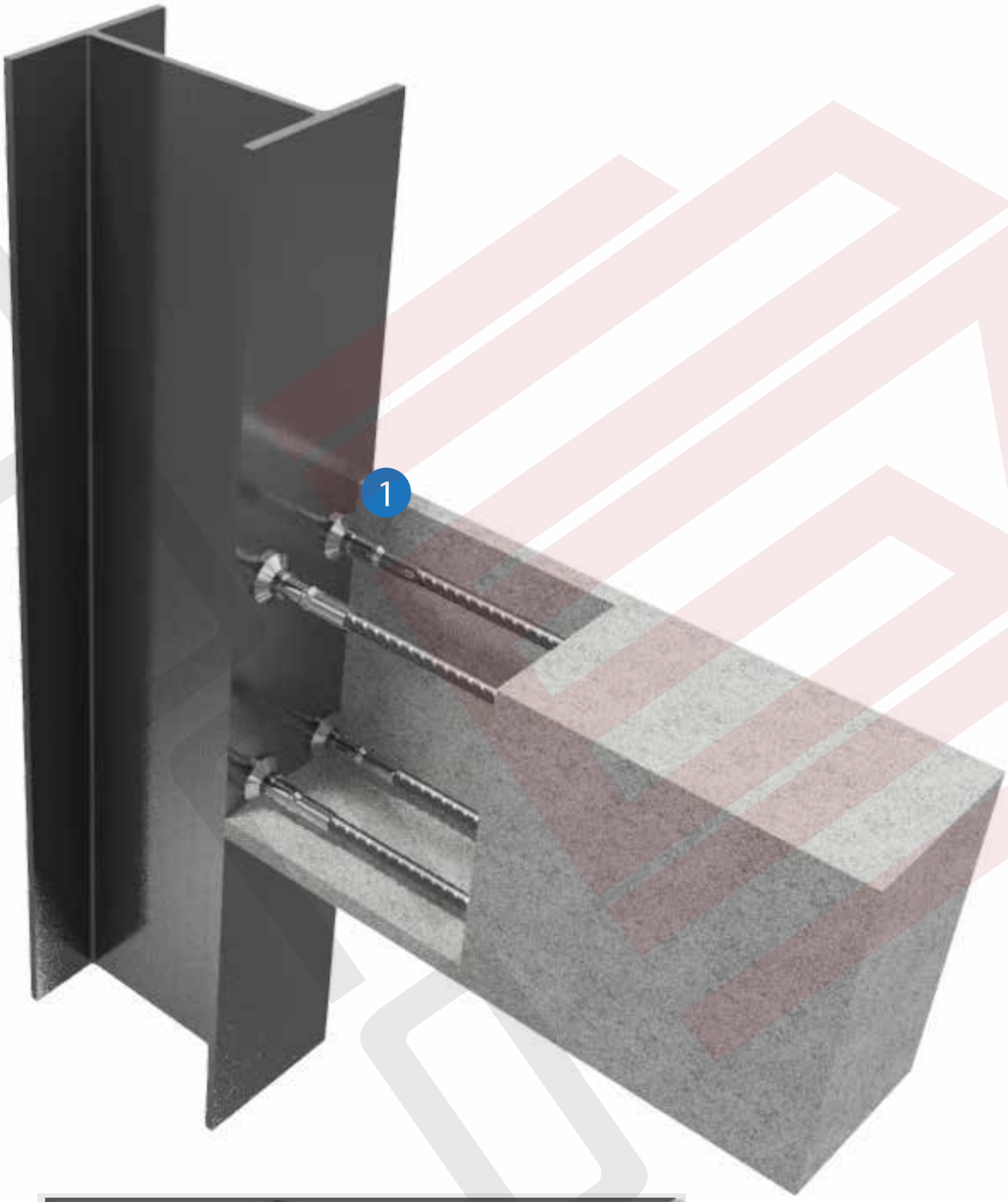
ROOF COLUMN TO BEAM CONNECTIONS

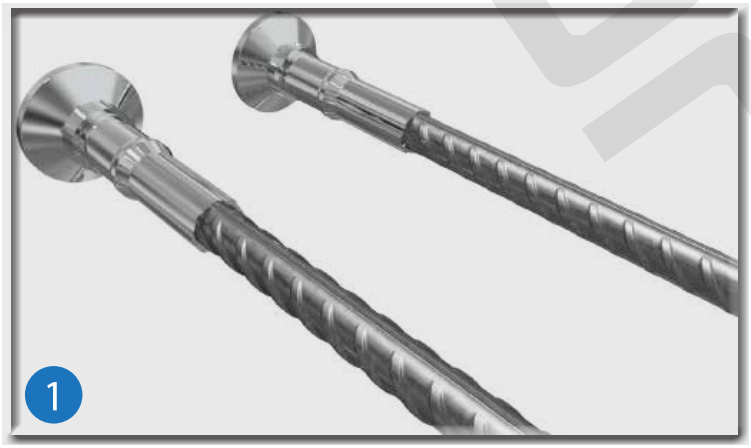


INCON ICT Bar Terminators can be used in lieu of bent bars in beam-column connections to provide the required anchorage with concrete.

INCON ICP Position Couplers are widely used to connect two steel cages in columns simultaneously.

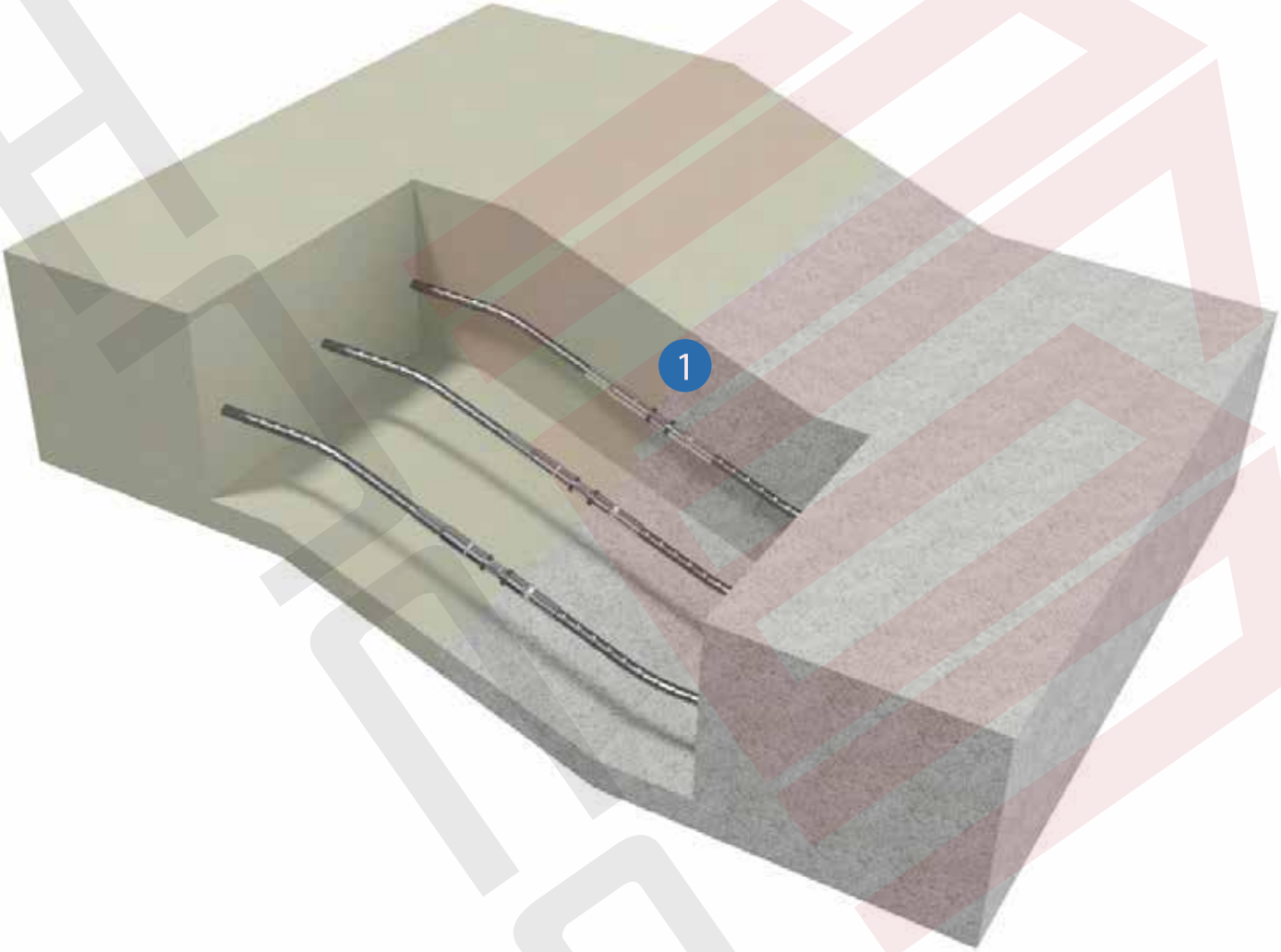
STEEL COLUMNS TO RC BEAMS





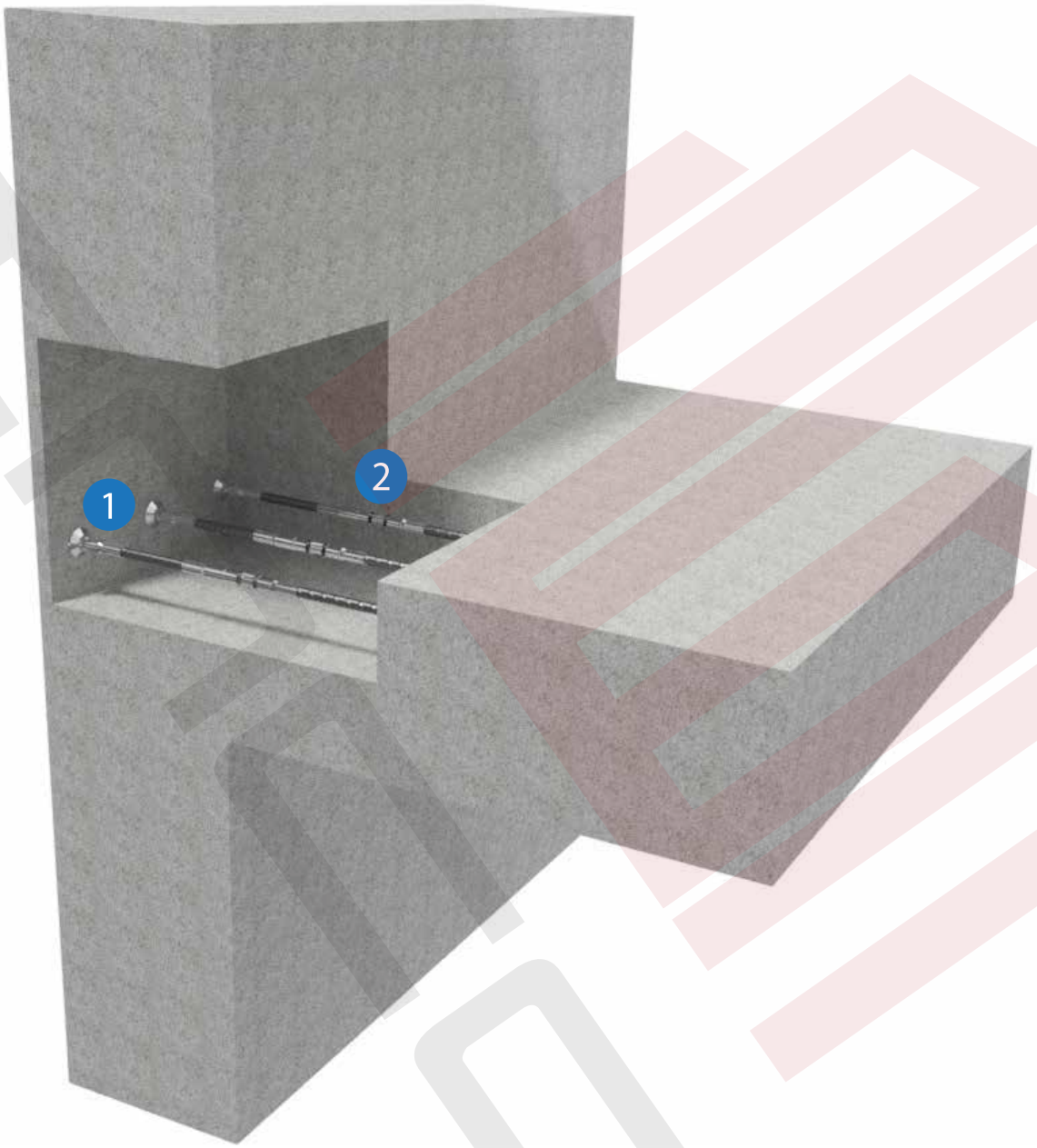
INCON ICT Bar Terminators are especially designed to connect steel bars to structural steel sections using arc weld.

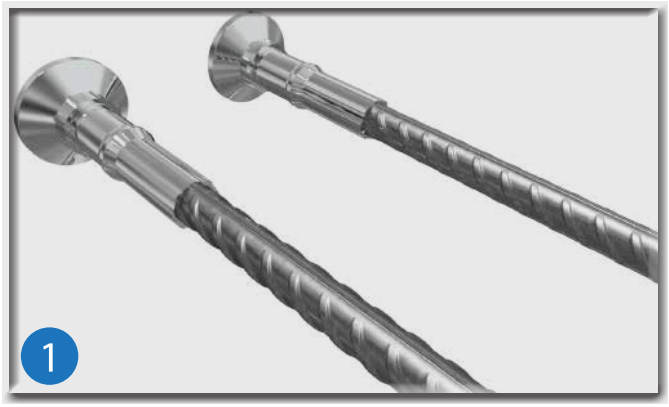
CURVED BARS IN CONSTRUCTION



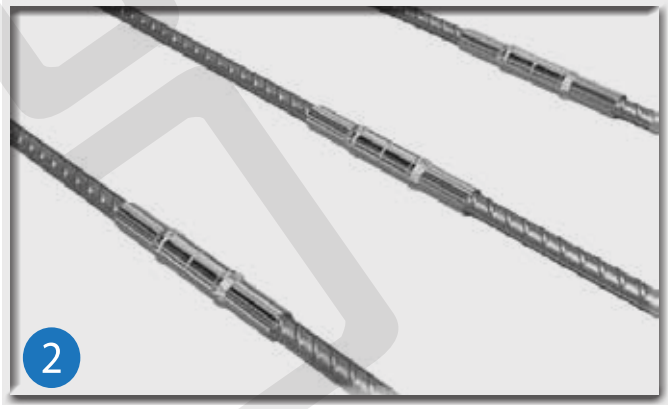
INCON ICP Position Couplers are the optimum solution for connecting two curved steel bars together.

SLAB TO WALL CONNECTION



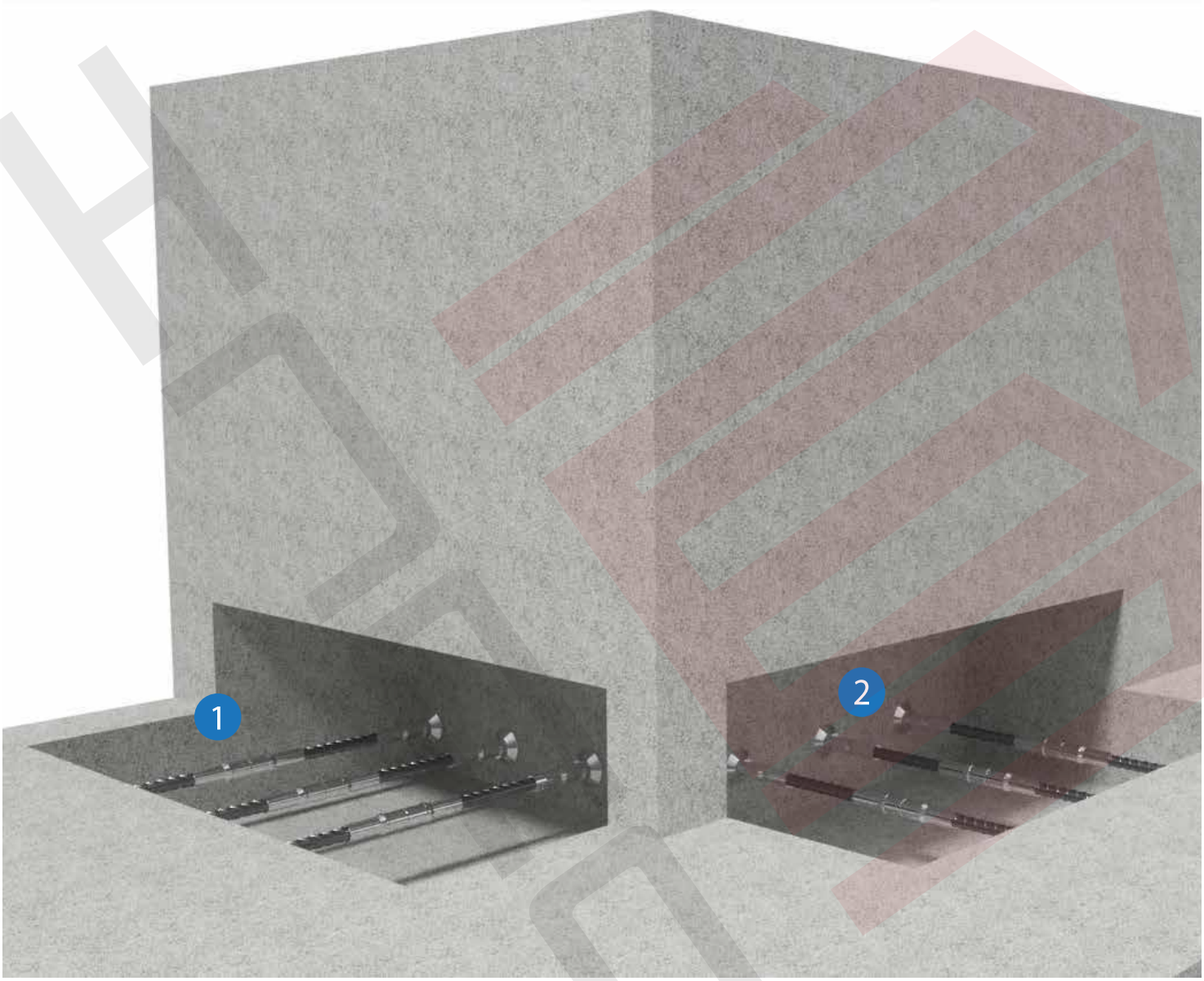


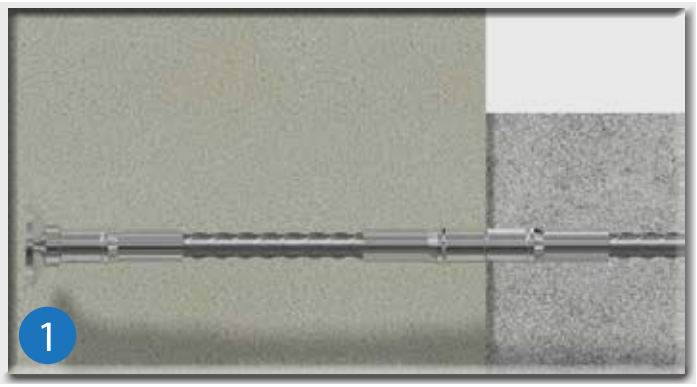
INCON ICT Bar Terminators are commonly used in slab to wall connections to provide the required anchorage of the steel reinforcement instead of bent bars or hooked bars.



INCON ICS Standard Couplers are considered as the first alternative to connect the reinforcement of shear wall with that of the slab. In case steel bars are restrained against rotational movement, then INCON ICP Position Couplers are the best choice.

SLAB TO CORE CONNECTION

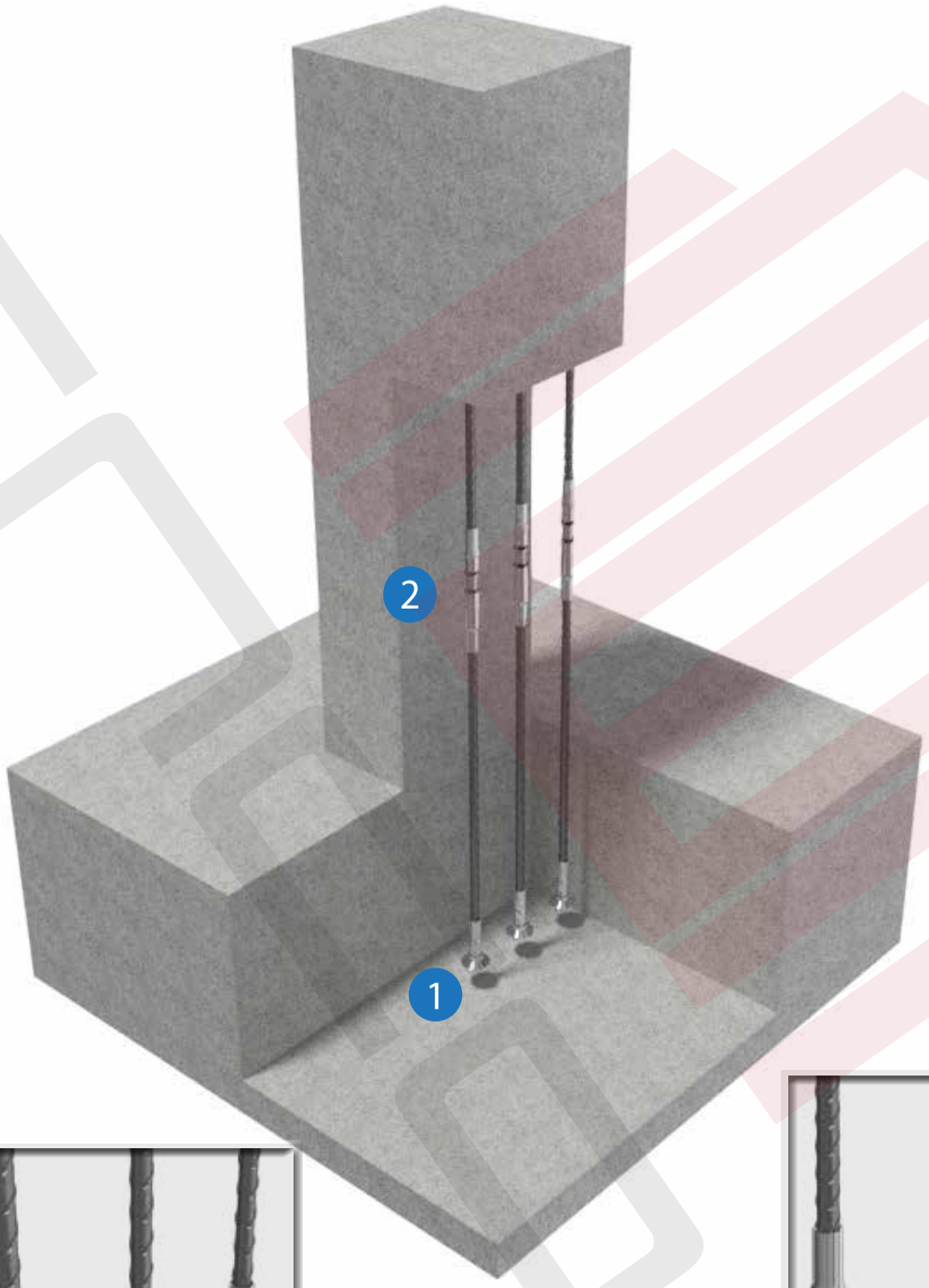


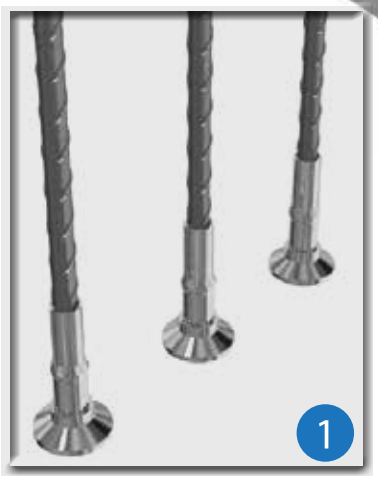


Notice that the connection between the old concrete and the new concrete is achieved using INCON ICS Standard Couplers and INCON ICT Bar Terminators. In case steel bars are restrained against rotational movement, then INCON ICP Position Couplers become handy.

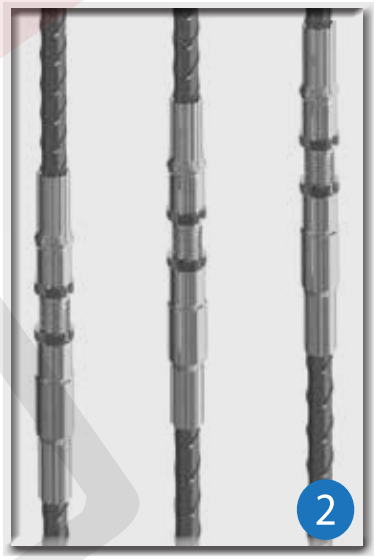
INCON ICS Standard Couplers and INCON ICT Bar Terminators are the optimum solution to create reinforcement continuity between the existing steel reinforcement in the wall and the added bars in the slab.

COLUMN TO FOOTING CONNECTION



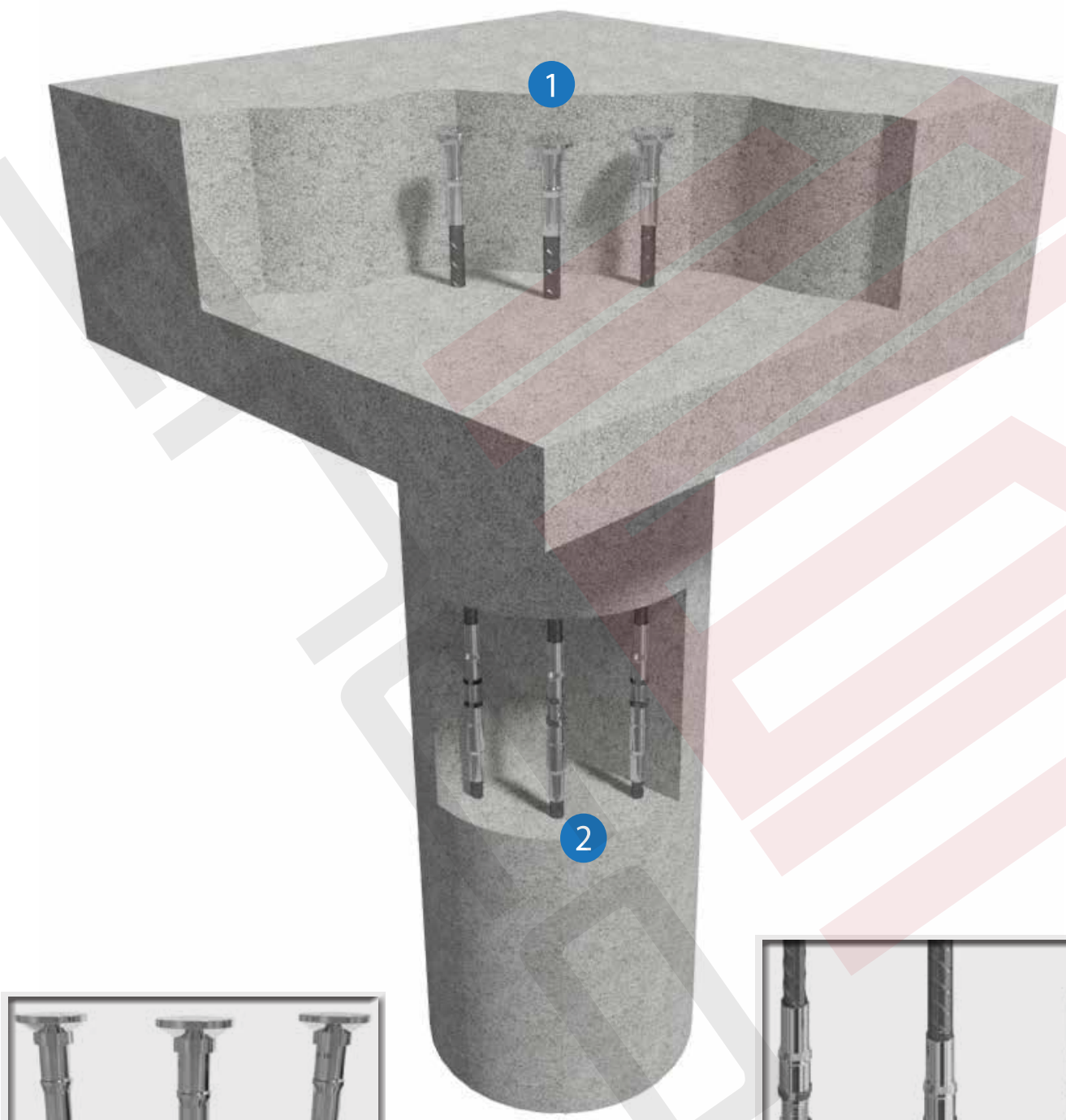


INCON ICT Bar Terminators are ideal in footings and pile caps to eliminate the undesirable reinforcement congestion and to facilitate concrete casting in such critical areas.



INCON ICP Position Couplers are very common in columns to footing and columns to pile cap connections. They facilitate the process of connecting two steel cages simultaneously.

PILE LONGITUDINAL REINFORCEMENT



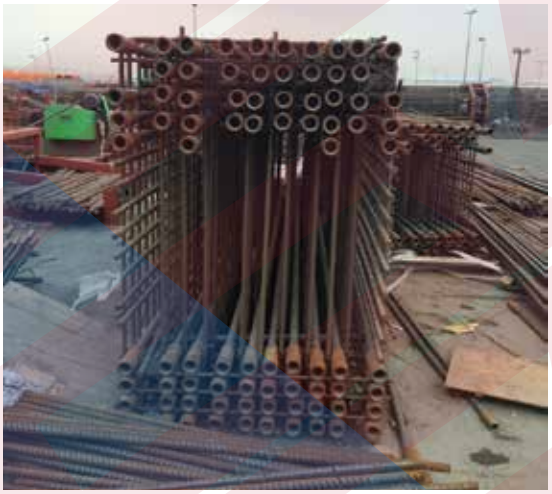
INCON ICT Bar Terminators are used as a replacement of bent or hooked bars in pile to pile cap connections to reduce reinforcement congestion and accelerate construction flow.

INCON ICP Position Couplers are used extensively in construction of piles where two steel cages can be first assembled on site and then erected simultaneously at the intended location.

SAMPLE CONSTRUCTION PROJECTS

INCON couplers and bar terminators enhance the structural performance of every structural members they are used in. With many years of continuous research and design, we acquired the experience and know-how technology to accelerate construction and to overcome construction difficulties. Our mechanical splicing devices are well known to significantly reduce labor cost, construction time and reinforcement congestion. In many applications, INCON couplers and bar terminators are recommended by engineers to overcome structural problems associated with conventional splicing and anchoring techniques. At INCON, we are proud of being always successful in delivering all of our projects on time. Our good results have allowed us to create partnerships with our clients and have them procure our services. Close cooperation between our technical support and top management ensures that we incorporate all feedback from our clients and consider them to continuously develop our products and services. We are dedicated to providing optimum engineering solutions to our clients without sacrificing quality, reliability or performance.

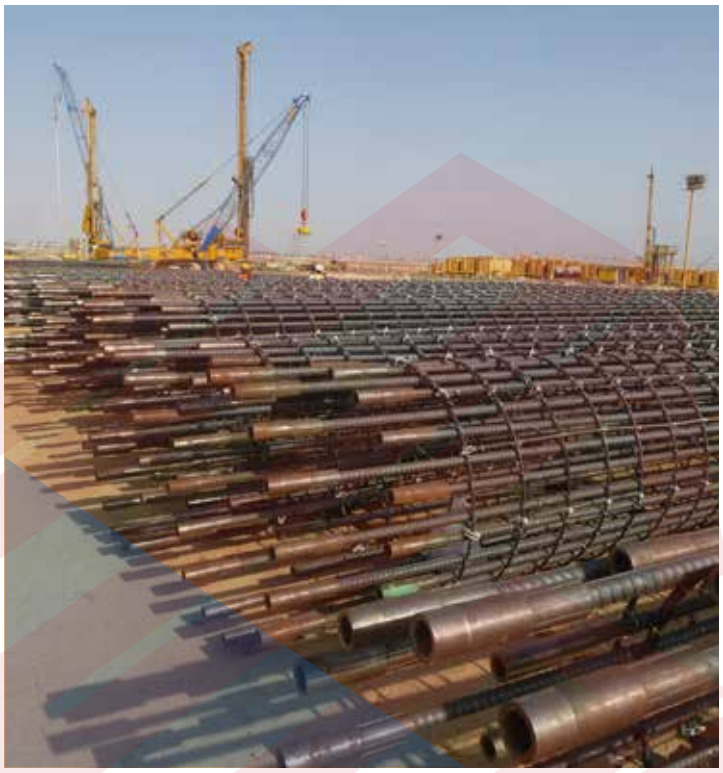
A typical pile erected on site showing INCON ICP Position coupler sleeves.



INCON couplers are installed on steel cages.

Templates are used to erect each reinforcement cage to ensure alignment is maintained during erection.

Construction process using INCON couplers is carried out in three main phases. Firstly, the coupler sleeves are installed on the steel bars using our innovative third generation swaging machine. In many applications, INCON ICP Position Couplers are used when complete cages are erected and stored on site according to the construction timeline. The second construction stage encompasses handling and erecting part of the reinforcement at their location in the structural members. The reinforcement is secured and the coupler sleeves are oriented in the correct location to receive the corresponding couplers from the other part. Finally, the remaining steel bars or cages are lifted to the intended location and aligned with the existing reinforcement. The couplers are then secured according to the installation procedure and specifications of each coupler type.

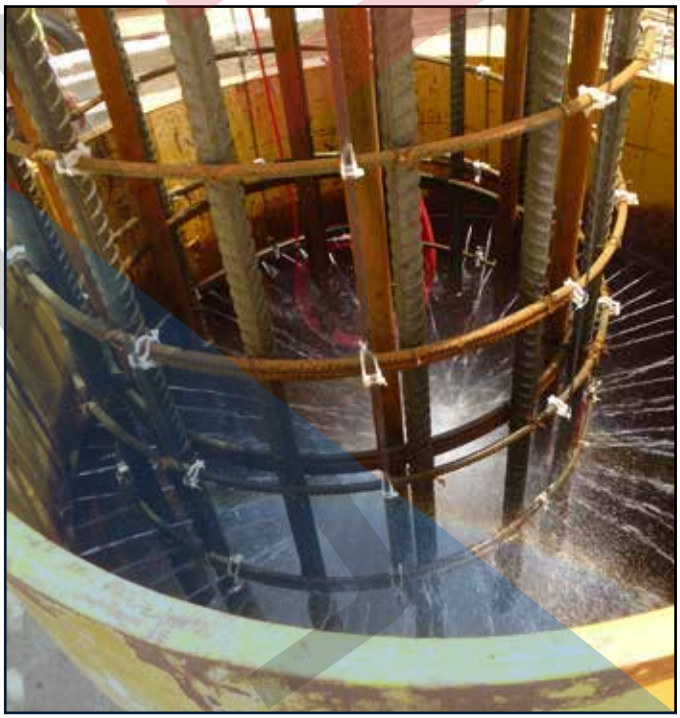


Close up view showing the stored pile reinforcement where INCON ICP Position Coupler is installed and ready for use.

Storage of pile cages on site before being lifted and erected at their intended location.

Lifting of a pile cage with INCON ICP Position couplers installed and ready for use.

Close up view of INCON ICP Position coupler sleeves in a typical pile reinforcement cage during handling.



Placement of a pile reinforcement cage at its desired location.

Process of erecting two piles simultaneously using INCON ICP Position Couplers.

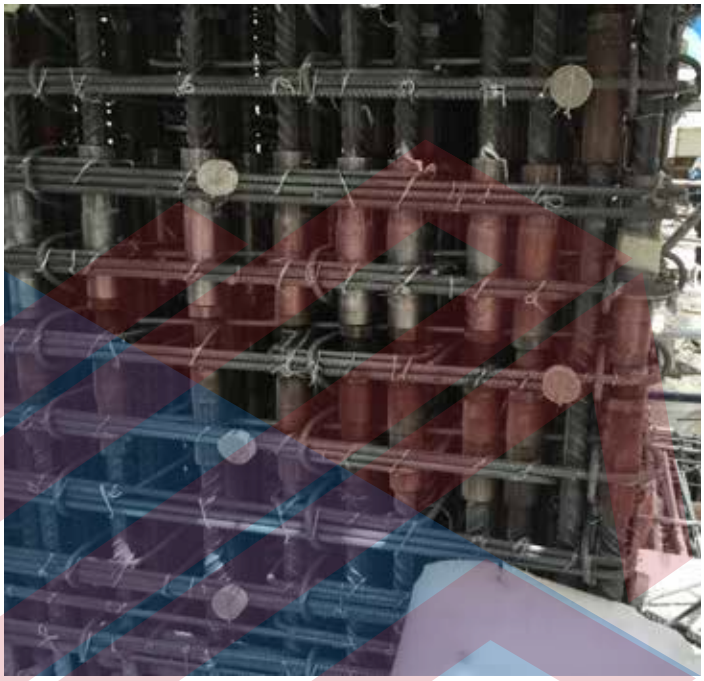
INCON ICP Position Couplers significantly simplify both the design and construction processes of splices. The process of preparing detailed drawings and calculation sheets for each lap splices, welded splices and hooked bars during the design phase is time consuming. Also, the fabrication of such splices and anchorages on site require more labor effort and time. Many engineering and contracting companies are continuously shifting toward using INCON mechanical splicing devices for the fabrication of reinforced concrete members due to the better structural performance and lower cost associated with them.

The extended sleeves in INCON ICP Position Couplers are aligned with the female sleeve.

The second pile cage is lifted to its intended location using a crane.

Erection of two pile cages simultaneously using INCON ICP Position Couplers.

INCON ICP Position Couplers are easily secured after being aligned.

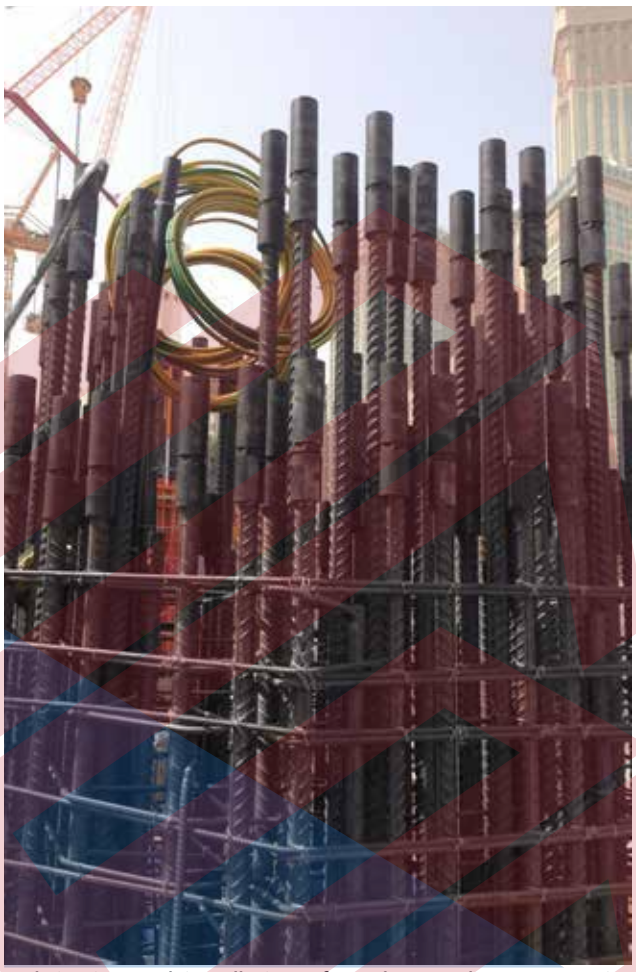


Swaged mechanical splice is formed in a typical column using INCON ICP Position Couplers.

The use of INCON mechanical splicing devices in construction has a major advantage of solving the problem of reinforcement congestion associated with conventional lap splices and anchorage techniques. Congestion reduction not only improves the load transfer mechanism in reinforcement, but also enhances the durability and structural integrity of reinforced concrete members. When the reinforcement is congested, it would be difficult to ensure that concrete fills all the gap inside the formwork. This may cause premature cracks, strength reduction, durability problems, honeycombing among other common problems. This is why codes and standards specify minimum spacing between the steel bars in typical construction applications.

INCON ICP Position Couplers are ideal for reducing reinforcement congestion and accelerating construction flow.

INCON ICP Position Couplers provide a great advantage of reducing reinforcement congestion in heavily reinforced members.

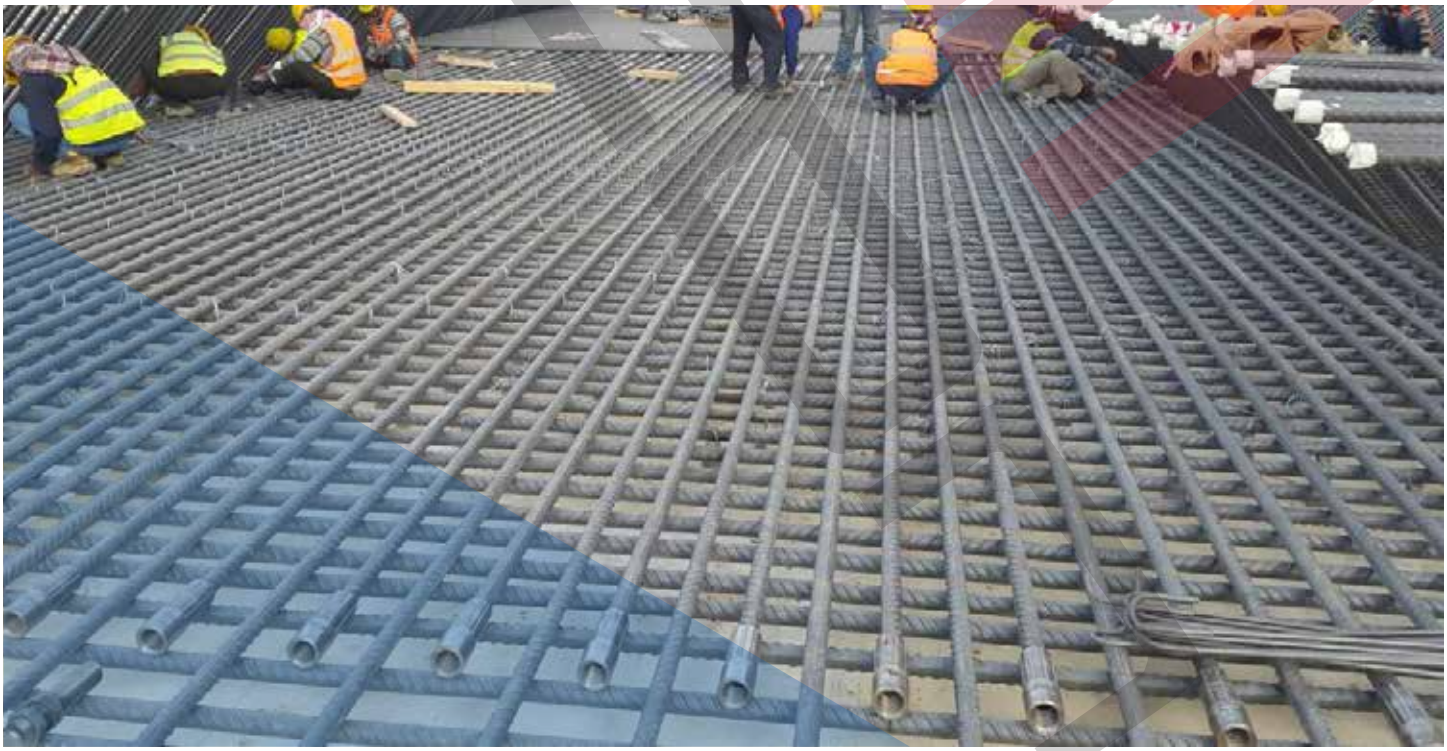


Fabrication and installation of steel cages becomes easier when INCON ICP Position Couplers are considered.

With INCON ICP Position Couplers, reinforcement continuity is achieved without the need to rotate any bar.

INCON ICP Position Couplers installed on horizontal reinforcement in reinforced concrete walls.

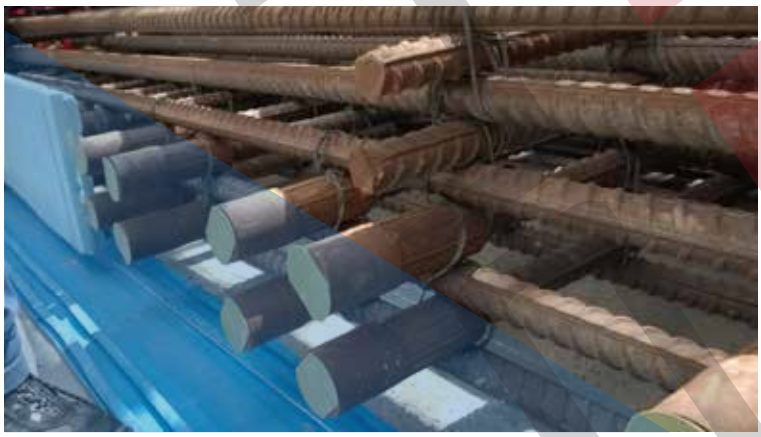
INCON ICP Position Couplers installed on the vertical reinforcement in reinforced concrete walls.



INCON ICP Position Couplers are widely used in slabs and raft foundations to connect steel bars and maintain reinforcement continuity.

INCON couplers are recommended by engineers and contractors for enhancing the splice performance while reducing congestion.

Close up view of INCON ICP Position Couplers after being assembled.



INCON female couplers are used extensively in construction joints to save formworks and to facilitate work.

INCON couplers and bar terminators are used together to create the optimum reinforcement configuration.

INCON ICP Position Couplers greatly reduces construction time and labor cost associated with pile cage erection.

INCON bar terminators are considered as an ideal solution for reducing the required development length while enhancing the anchorage between concrete and the embedded steel bars. The innovative design of our bar terminators allow labors to quickly and accurately install them without the need of special tools. The load transfer mechanism between the steel bars and the surrounding concrete matrix ensures that cracks due to bar straightening and side spalling phenomena encountered in conventional hooked bars are eliminated. In addition, INCON splicing devices can be utilized to create shear links that consist of two bar terminators connected by a steel bar with specified length. These links are extensively used in construction to prevent punching shear in slabs and raft foundations without the need to increase the section depth.

INCON ICT Bar Terminators are easily assembled on site.

Shear links are easily assembled on site using INCON ICT Bar Terminators.

INCON ICT Bar Terminators are used to create shear links for resisting punching shear in slabs and raft foundations.

Close up view of INCON ICT Bar Terminators.

INCON ICT Bar Terminators provide excellent anchorage strength.

INSTALLATION OF FULL STEEL CAGE USING INCON ICP POSITION COUPLERS

(1) Connect the long coupler sleeve at one side of the steel bars using swaging process and erect the first steel cage.

(2) Completely insert the threaded rod in the long coupler sleeve.

(3) Connect the short coupler sleeve at one side of the steel bars of the other steel cage. Then, using a crane, align the second steel cage with the first one.

(4) Connect the two steel cages by rotating the threaded rod in the opposite direction until the connection is fully secured.

SPECIAL CONSIDERATIONS FOR MECHANICAL SPLICES

- Couplers can be either aligned or staggered when placed in adjacent reinforcing bars. The selection criteria rely chiefly on the bar size, clearance required and construction applicability.

- Engineers and contractors should always refer to the technical data provided for each coupler and bar terminator in order to ensure the optimum performance of the mechanical splice.

- When installing certain types of mechanical splicing devices on coated bars, precautions should be taken to ensure that the steel surfaces in contact with the coupler sleeve are exposed. This can be performed during the coating process by shielding the bar's ends. However, if the bars are already coated, then the coating must be fully removed over the entire length of the coupler sleeve.

- When the mechanical splice involves stainless steel bars, precautions should be made to use stainless steel couplers possessing similar physical and chemical properties to avoid the potential development of galvanic corrosion.

- Minimum concrete cover to the stirrups, ties or spirals at coupler locations should be checked. In many situations, the patterns of the confinement reinforcement can be adjusted to avoid decreasing the concrete cover.

- In a flexural member, the mechanical splice should not result in a low effective longitudinal stiffness of the reinforcement that violates the strain conditions assumed in the member design.

- For strengthening and repair of structural members, the condition of the existing reinforcement should be taken into consideration when evaluating the strength of the mechanical splice.

- At the locations of potential plastic hinges or excessive inelastic strains, the mechanical connection should have sufficient ductility to avoid premature failure.

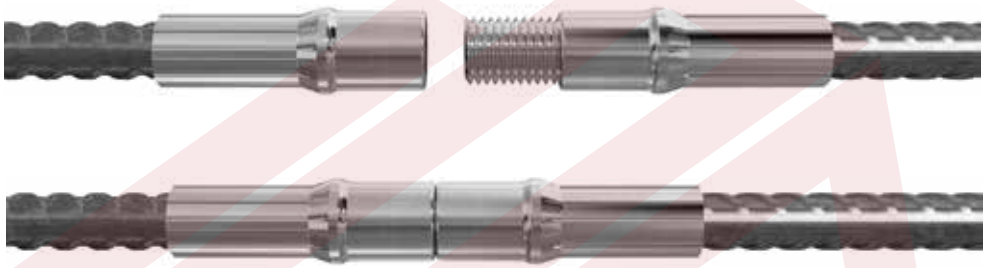
- Types, locations and installation requirements for the used mechanical splicing devices should be clearly defined in the design drawings and specifications.

INCON ICS - STANDARD COUPLERS

INSTALLATION

1- Press the couplers on the steel bars using INCON swaging machine.

2- Align the two bars and rotate one bar to completely secure the connection.



CONFIGURATION

INCON ICS - Standard Coupler is composed of a female and a male sleeves swaged on two bars to be connected.

MAIN APPLICATION

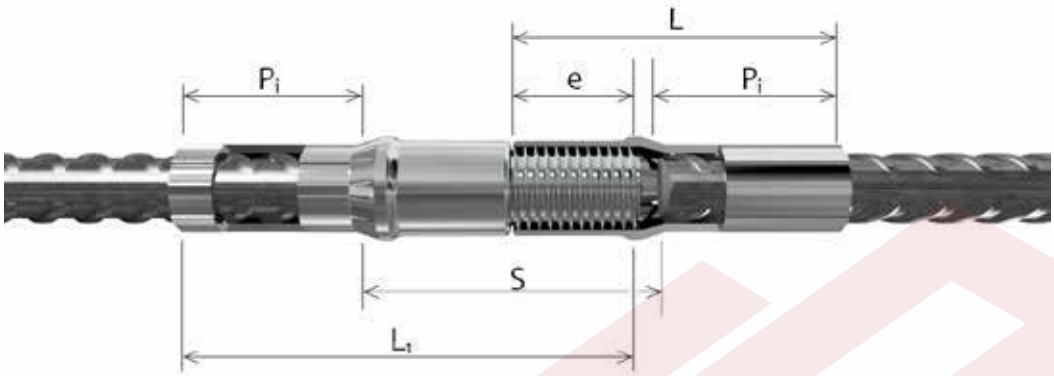
INCON ICS - Standard Coupler is widely used for general applications to connect to bars of the same diameter where the rotation and axial movement of at least one bar is allowed.

FEATURES

- Applicable for high strength reinforcing bars up to ASTM Grade 75.
- Satisfies the requirements of ACI 318, BS 8110, UBC 1997, NF 35-20-1 and DIN 1045.
- Easily installed and highly efficient for preparing the splice and assembly on site.
- Accurate splice length control due to the precise coupler joint.
- Highly reliable and consistent performance due to our swaging technology and enhanced coupler design.
- Compact design of the coupler to reduce reinforcement congestion.

AVAILABLE MATERIALS AND COATINGS

- **Uncoated steel** couplers for splicing steel bars in typical construction applications.
- **Zinc coated steel** couplers for splicing steel bars in corrosive environments and for other special applications.
- **Stainless steel** couplers for splicing stainless steel bars and for other special applications.
- **Galvanized steel** couplers for splicing galvanized steel bars and for other special applications.



CANADA

Coupler Code	Bar Size	Bar Nominal Diameter (Db)	Thread Size	Tube Outer Diameter (ØD)	Tube Inner Diameter (Ød)	Female Coupler Length (L)	Male Coupler Length (L1)	Thread Length (e)	Bar Insertion Length (Pi)	Splice Space (S)
ICS10M	10M	11.3	M14	22.0	14.5	56.5	73.5	17.0	37.0	39.0
ICS15M	15M	16.0	M20	28.0	19.0	71.5	94.0	22.5	46.0	51.0
ICS20M	20M	19.5	M24	34.0	23.5	89.0	116.0	27.0	59.0	60.0
ICS25M	25M	25.2	M30	42.0	29.0	112.0	146.5	34.5	74.0	76.0
ICS30M	30M	29.9	M36	50.0	34.0	128.0	166.5	38.5	86.0	84.0
ICS35M	35M	35.7	M42	59.0	39.0	152.5	198.0	45.5	103.0	99.0

Note: All units are in (millimeters).

USA

Coupler Code	Bar Size	Bar Nominal Diameter (Db)	Thread Size	Tube Outer Diameter (ØD)	Tube Inner Diameter (Ød)	Female Coupler Length (L)	Male Coupler Length (L1)	Thread Length (e)	Bar Insertion Length (Pi)	Splice Space (S)
ICS#3	#3	0.375	9/16-12 NC	0.73	0.49	2.01	2.64	0.63	1.30	1.42
ICS#4	#4	0.500	5/8-11 NC	0.87	0.57	2.42	3.17	0.75	1.57	1.69
ICS#5	#5	0.625	3/4-10 NC	1.10	0.75	2.81	3.70	0.89	1.81	2.01
ICS#6	#6	0.750	1-8 NC	1.34	0.93	3.43	4.49	1.06	2.24	2.36
ICS#7	#7	0.875	1-1/8-7 NC	1.50	0.98	3.96	5.18	1.22	2.60	2.72
ICS#8	#8	1.000	1-1/4-7 NC	1.65	1.14	4.49	5.89	1.40	2.95	3.07
ICS#9	#9	1.128	1-3/8-6 NC	1.81	1.22	4.88	6.36	1.48	3.27	3.23
ICS#10	#10	1.270	1-1/2-6 NC	2.13	1.42	5.49	7.09	1.59	3.74	3.50
ICS#11	#11	1.410	1-5/8-6 NC	2.32	1.54	6.08	7.91	1.83	4.09	3.98

Note: All units are in (inches).

EUROPE & MIDDLE EAST

Coupler Code	Bar Size	Bar Nominal Diameter (Db)	Thread Size	Tube Outer Diameter (ØD)	Tube Inner Diameter (Ød)	Female Coupler Length (L)	Male Coupler Length (L1)	Thread Length (e)	Bar Insertion Length (Pi)	Splice Space (S)
ICS10	10,0	10.0	M14	18.5	12.5	51.0	67.0	16.0	33.0	36.0
ICS12	12,0	12.0	M16	22.0	14.5	58.5	76.5	18.0	38.0	41.0
ICS16	16,0	16.0	M20	28.0	19.0	71.5	94.0	22.5	46.0	51.0
ICS20	20,0	20.0	M24	34.0	23.5	90.0	117.0	27.0	60.0	60.0
ICS25	25,0	25.0	M30	42.0	29.0	110.0	143.5	33.5	73.0	74.0
ICS32	32,0	32.0	M39	54.0	36.0	137.5	177.0	39.5	94.0	87.0
ICS40	40,0	40.0	M48	67.5	45.0	169.0	218.0	49.0	115.0	108.0

Note: All units are in (millimeters).

INCON ICP - POSITION COUPLERS

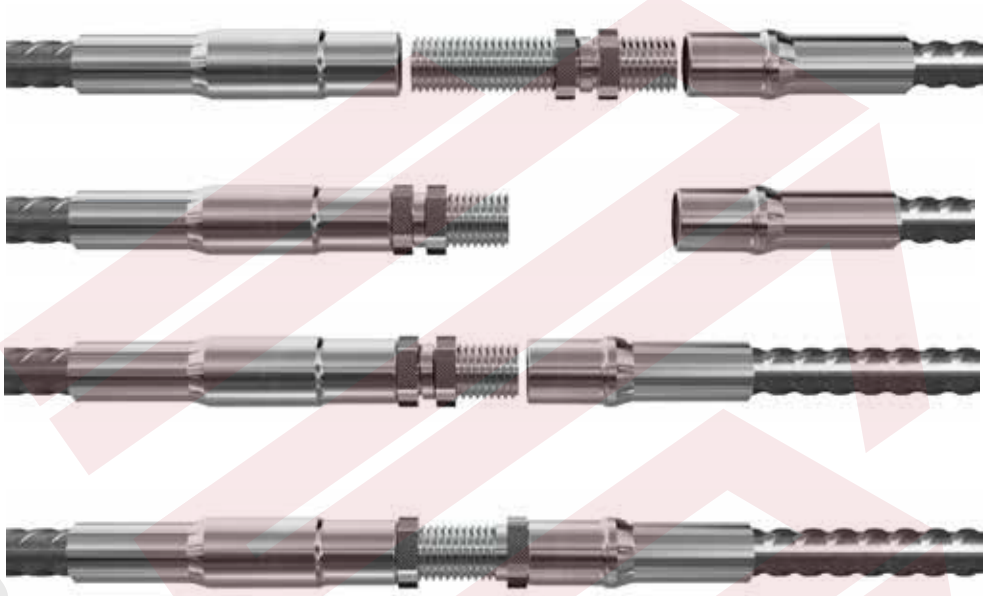
INSTALLATION

1- Press the long and short coupler sleeves at the end of each bar and align them with each other.

2- Insert the threaded rod completely into the extended coupler sleeve.

3- Bring the second steel bar closer to the first one, then rotate the threaded rod in the opposite direction.

4- Tighten the nuts to ensure strong attachment between the two bars.



CONFIGURATION

INCON ICP - Position Coupler is composed of a female coupler sleeve, an extended coupler sleeve assembly, a central bolt and two nuts.

MAIN APPLICATION

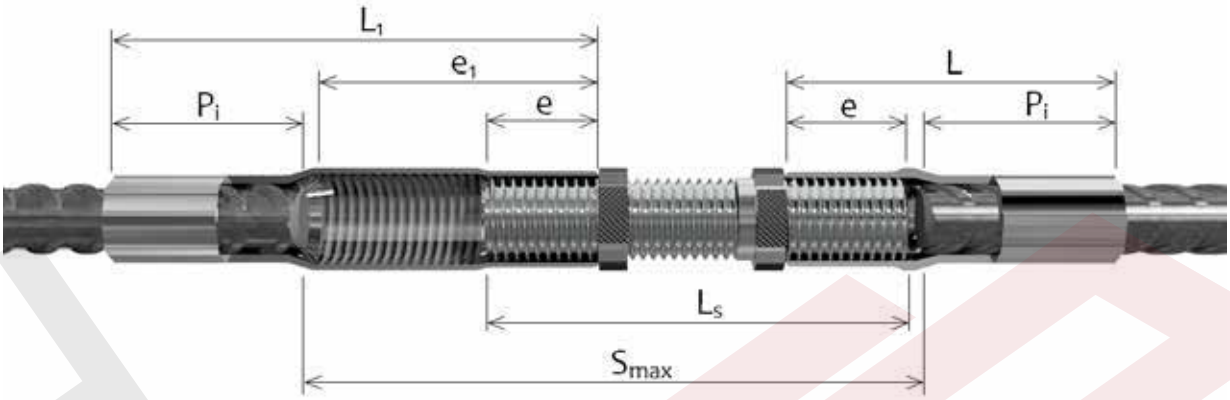
INCON ICP - Position Coupler is suitable for the most challenging connections when rotation in both bars is restricted while the translational movement of only one bar is allowed.

FEATURES

- Applicable for high strength reinforcing bars up to ASTM Grade 75.
- Satisfies the requirements of ACI 318, BS 8110, UBC 1997, NF 35-20-1 and DIN 1045.
- Significantly reduces construction time.
- Accurate and fast connection of steel bars that are restricted against rotational movement.
- Easily installed and highly efficient for preparing the splice and assembly on site.
- Accurate splice length control due to the precise coupler joint.
- Highly reliable and consistent performance due to our swaging technology and enhanced coupler design.
- Compact design of the coupler to reduce reinforcement congestion.

AVAILABLE MATERIALS AND COATINGS

- **Uncoated steel** couplers for splicing steel bars in typical construction applications.
- **Zinc coated steel** couplers for splicing steel bars in corrosive environments and for other special applications.
- **Stainless steel** couplers for splicing stainless steel bars and for other special applications.
- **Galvanized steel** couplers for splicing galvanized steel bars and for other special applications.



CANADA

Coupler Code	Bar Size	Thread Size	Tube Outer Diameter (ØD)	Tube Inner Diameter (Ød)	Female Coupler Length (L)	Female Thread Length (e)	Bar Insertion Length (Pi)	Central Bolt Length (Ls)	Extended Coupler Length (L1)	Extend Coupler Thread Length (e1)	Max Gap	Max Splice Space
ICP10M	10M	M14	22.0	14.5	56.5	17.0	37.0	82.0	84.8	45.3	11.0	114.6
ICP15M	15M	M20	28.0	19.0	71.5	22.5	46.0	107.0	110.0	61.0	16.0	151.0
ICP20M	20M	M24	34.0	23.5	89.0	27.0	59.0	128.0	135.5	73.5	19.0	180.5
ICP25M	25M	M30	42.0	29.0	112.0	34.5	74.0	163.0	171.7	94.2	25.0	228.9
ICP30M	30M	M36	50.0	34.0	128.0	38.5	86.0	185.0	196.4	106.9	29.0	260.3
ICP35M	35M	M42	59.0	39.0	152.5	45.5	103.0	213.0	233.7	126.7	35.0	301.4

Note: All units are in (millimeters).

USA

Coupler Code	Bar Size	Thread Size	Tube Outer Diameter (ØD)	Tube Inner Diameter (Ød)	Female Coupler Length (L)	Female Thread Length (e)	Bar Insertion Length (Pi)	Central Bolt Length (Ls)	Extended Coupler Length (L1)	Extend Coupler Thread Length (e1)	Max Gap	Max Splice Space
ICP#3	#3	9/16-12 NC	0.73	0.49	2.01	0.63	1.30	2.93	3.01	1.63	0.38	4.10
ICP#4	#4	5/8-11 NC	0.87	0.57	2.42	0.75	1.57	3.49	3.67	2.00	0.50	4.94
ICP#5	#5	3/4-10 NC	1.10	0.75	2.81	0.89	1.81	4.19	4.33	2.40	0.63	5.94
ICP#6	#6	1-8 NC	1.34	0.93	3.43	1.06	2.24	5.02	5.24	2.88	0.75	7.07
ICP#7	#7	1-1/8-7 NC	1.50	0.98	3.96	1.22	2.60	5.74	6.05	3.32	0.88	8.11
ICP#8	#8	1-1/4-7 NC	1.65	1.14	4.49	1.40	2.95	6.51	6.89	3.80	1.00	9.19
ICP#9	#9	1-3/8-6 NC	1.81	1.22	4.88	1.48	3.27	6.99	7.49	4.08	1.13	9.87
ICP#10	#10	1-1/2-6 NC	2.13	1.42	5.49	1.59	3.74	7.63	8.36	4.46	1.27	10.81
ICP#11	#11	1-5/8-6 NC	2.32	1.54	6.08	1.83	4.09	8.48	9.32	5.07	1.41	12.03

Note: All units are in (inches).

EUROPE & MIDDLE EAST

Coupler Code	Bar Size	Thread Size	Tube Outer Diameter (ØD)	Tube Inner Diameter (Ød)	Female Coupler Length (L)	Female Thread Length (e)	Bar Insertion Length (Pi)	Central Bolt Length (Ls)	Extended Coupler Length (L1)	Extend Coupler Thread Length (e1)	Max Gap	Max Splice Space
ICP10	10	M14	18.5	12.5	51.0	16.0	33.0	75.0	77.0	42.0	10.0	105.0
ICP12	12	M16	22.0	14.5	58.5	18.0	38.0	85.0	88.5	48.0	12.0	120.0
ICP16	16	M20	28.0	19.0	71.5	22.5	46.0	107.0	110.0	61.0	16.0	151.0
ICP20	20	M24	34.0	23.5	90.0	27.0	60.0	129.0	137.0	74.0	20.0	181.5
ICP25	25	M30	42.0	29.0	110.0	33.5	73.0	159.0	168.5	92.0	25.0	224.5
ICP32	32	M39	54.0	36.0	137.5	39.5	94.0	191.0	209.0	111.0	32.0	270.0
ICP40	40	M48	67.5	45.0	169.0	49.0	115.0	231.0	258.0	138.0	40.0	330.0

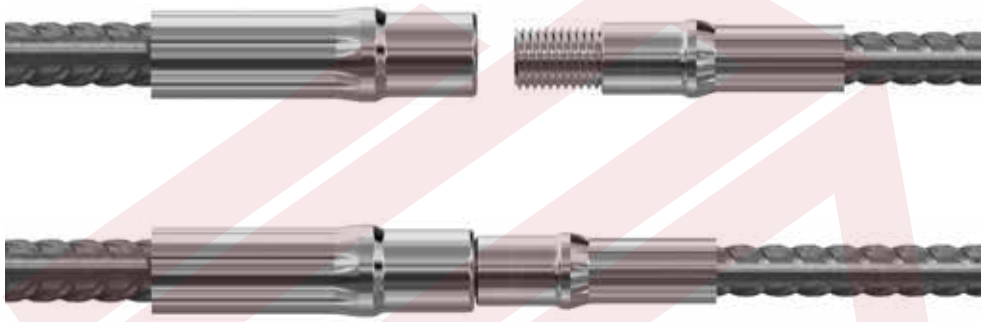
Note: All units are in (millimeters).

INCON ICST - TRANSITION COUPLERS

INSTALLATION

1- Press the female coupler sleeve on the bar with larger diameter and press the male coupler sleeve on the bar with smaller diameter.

2- Align the two bars and rotate one bar to completely secure the connection.



CONFIGURATION

INCON ICST - Transition Coupler is composed of a female and male coupler sleeves swaged on two bars of different diameters to be connected. The female coupler sleeve is swaged on the bar with the larger diameter.

MAIN APPLICATION

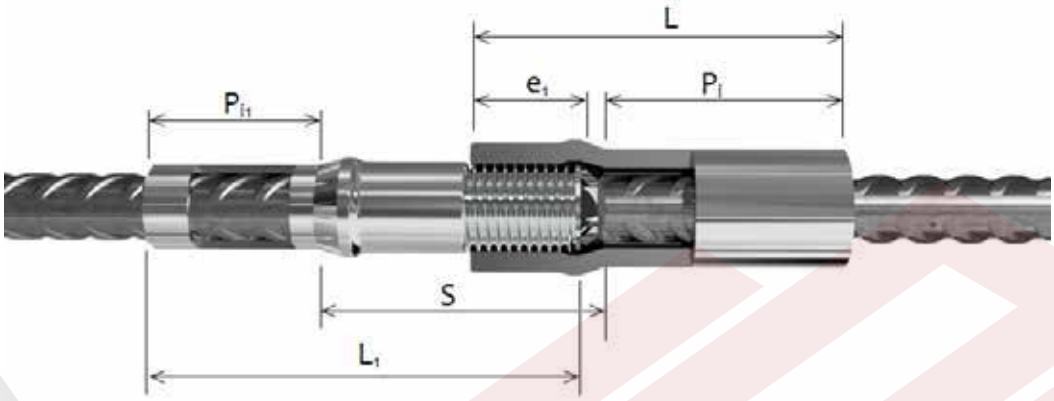
INCON ICST - Transition Coupler is widely used for connecting two bars of different diameters where the rotation and axial movement of at least one bar is allowed.

FEATURES

- Applicable for high strength reinforcing bars up to ASTM Grade 75.
- Satisfies the requirements of ACI 318, BS 8110, UBC 1997, NF 35-20-1 and DIN 1045.
- Accurate and fast connection of steel bars of different diameters.
- Easily installed and highly efficient for preparing the splice and assembly on site.
- Accurate splice length control due to the precise coupler joint.
- Highly reliable and consistent performance due to our swaging technology and enhanced coupler design.
- Compact design of the coupler to reduce reinforcement congestion.

AVAILABLE MATERIALS AND COATINGS

- **Uncoated steel** couplers for splicing steel bars in typical construction applications.
- **Zinc coated steel** couplers for splicing steel bars in corrosive environments and for other special applications.
- **Stainless steel** couplers for splicing stainless steel bars and for other special applications.
- **Galvanized steel** couplers for splicing galvanized steel bars and for other special applications.



CANADA

Coupler Code	Bar Size	Thread Size	Female Coupler Outer Diameter (ØD)	Female Coupler Inner Diameter (Ød)	Female Coupler Length (L)	Bar Insertion Length (Pi)	Male Coupler Outer Diameter (ØD1)	Male Coupler Inner Diameter (Ød1)	Male Coupler Length (L1)	Thread Length (e1)	Bar Insertion Length (Pi1)	Splice Space (S)
ICST15M-10M	15M-10M	M14	28.0	19.0	65.5	46.0	22.0	14.5	56.5	17.0	37.0	22.0
ICST20M-15M	20M-15M	M20	34.0	23.5	84.5	59.0	28.0	19.0	71.5	22.5	46.0	28.5
ICST25M-20M	25M-20M	M24	42.0	29.0	104.5	74.0	34.0	23.5	89.0	27.0	59.0	33.5
ICST30M-25M	30M-25M	M30	50.0	34.0	124.0	86.0	42.0	29.0	112.0	34.5	74.0	41.5
ICST35M-30M	35M-30M	M36	59.0	39.0	145.5	103.0	50.0	34.0	128.0	38.5	86.0	46.0

Note: All units are in (millimeters).

USA

Coupler Code	Bar Size	Thread Size	Female Coupler Outer Diameter (ØD)	Female Coupler Inner Diameter (Ød)	Female Coupler Length (L)	Bar Insertion Length (Pi)	Male Coupler Outer Diameter (ØD1)	Male Coupler Inner Diameter (Ød1)	Male Coupler Length (L1)	Thread Length (e1)	Bar Insertion Length (Pi1)	Splice Space (S)
ICST#5 - #4	#5 - #4	5/8-11 NC	1.10	0.75	2.68	1.81	0.87	0.57	3.17	0.75	1.57	1.71
ICST#6 - #5	#6 - #5	3/4-10 NC	1.34	0.93	3.25	2.24	1.10	0.75	3.70	0.89	1.81	2.01
ICST#7 - #6	#7 - #6	1-8 NC	1.50	0.98	3.80	2.60	1.34	0.93	4.49	1.06	2.24	2.38
ICST#8 - #7	#8 - #7	1-1/8-7 NC	1.65	1.14	4.31	2.95	1.50	0.98	5.18	1.22	2.60	2.72
ICST#9 - #8	#9 - #8	1-1/4-7 NC	1.81	1.22	4.80	3.27	1.65	1.14	5.89	1.40	2.95	3.07
ICST#10 - #9	#10 - #9	1-3/8-6 NC	2.13	1.42	5.37	3.74	1.81	1.22	6.36	1.48	3.27	3.25
ICST#11 - #10	#11 - #10	1-1/2-6 NC	2.32	1.54	5.85	4.09	2.13	1.42	7.09	1.59	3.74	3.50

Note: All units are in (inches).

EUROPE & MIDDLE EAST

Coupler Code	Bar Size	Thread Size	Female Coupler Outer Diameter (ØD)	Female Coupler Inner Diameter (Ød)	Female Coupler Length (L)	Bar Insertion Length (Pi)	Male Coupler Outer Diameter (ØD1)	Male Coupler Inner Diameter (Ød1)	Male Coupler Length (L1)	Thread Length (e1)	Bar Insertion Length (Pi1)	Splice Space (S)
ICST16-12	16-12	M16	28.0	19.0	67.0	46.0	22.0	14.5	76.5	18.0	38.0	41.5
ICST20-16	20-16	M20	34.0	23.5	85.5	60.0	28.0	19.0	94.0	22.5	46.0	51.0
ICST25-20	25-20	M24	42.0	29.0	103.5	73.0	34.0	23.5	117.0	27.0	60.0	60.5
ICST32-25	32-25	M30	54.0	36.0	131.5	94.0	42.0	29.0	143.5	33.5	73.0	74.5
ICST40-32	40-32	M39	67.5	45.0	159.5	115.0	54.0	36.0	177.0	39.5	94.0	88.0

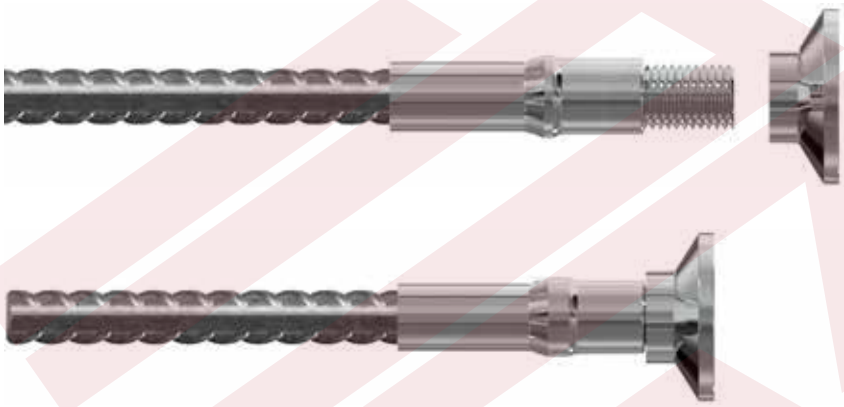
Note: All units are in (millimeters).

INCON ICTF - BAR TERMINATOR

INSTALLATION

1- Press INCON ICS Standard male coupler on the steel bar using INCON swaging machine.

2- Place the bar terminator on the threaded rod of the coupler and rotate it until it is completely secured.



CONFIGURATION

INCON ICTF - Bar Terminator is composed of a female end anchor compatible with a corresponding INCON ICS - Standard male coupler sleeve.

MAIN APPLICATION

INCON ICTF - Bar Terminator is used in lieu of hooked or bent bars to provide the required anchorage and development length of the embedded steel bars.

FEATURES

- Applicable for high strength reinforcing bars up to ASTM Grade 75.
- Satisfies the requirements of ACI 318, BS 8110, UBC 1997, NF 35-20-1 and DIN 1045.
- Easily installed and highly efficient for achieving the required anchorage strength of steel bars.
- Highly reliable and consistent performance due to our swaging technology and enhanced terminator design.
- Compact design of the bar terminator to reduce reinforcement congestion at the connections.
- Enhances anchorage performance compared to hooked or bent bars especially for large bar diameters.

AVAILABLE MATERIALS AND COATINGS

- **Uncoated steel** bar terminators for providing anchorage of bars in typical construction applications.
- **Zinc coated steel** bar terminators for providing anchorage of steel bars in corrosive environments and for other special applications.
- **Stainless steel** bar terminators for providing anchorage of stainless steel bars and for other special applications.
- **Galvanized steel** bar terminators for providing anchorage of galvanized steel bars and for other special applications.

CANADA

Bar Terminator Code	Bar Size	Thread Size	Tube Outer Diameter (Ød)	Head Diameter (ØD)	Terminator Length (h)	Relevant ICS Male Coupler
ICT-F-10M	10M	M16	22.0	40.0	17.5	ICS10M
ICT-F-15M	15M	M20	28.0	53.0	22.0	ICS15M
ICT-F-20M	20M	M24	34.0	66.0	26.0	ICS20M
ICT-F-25M	25M	M30	42.0	86.0	33.0	ICS25M
ICT-F-30M	30M	M37	51.0	94.0	18.0	ICS30M
ICT-F-35M	35M	M43	61.0	118.0	48.0	ICS35M

Note: All units are in (millimeters).

USA

Bar Terminator Code	Bar Size	Thread Size	Tube Outer Diameter (Ød)	Head Diameter (ØD)	Terminator Length (h)	Relevant ICS Male Coupler
ICT-F-#3	#3	9/16-12 NC	0.73	1.32	0.63	ICS#3
ICT-F-#4	#4	5/8-11 NC	0.87	1.57	0.75	ICS#4
ICT-F-#5	#5	3/4-10 NC	1.10	2.09	0.89	ICS#5
ICT-F-#6	#6	1-8 NC	1.34	2.60	1.06	ICS#6
ICT-F-#7	#7	1-1/8-7 NC	1.50	2.87	1.22	ICS#7
ICT-F-#8	#8	1-1/4-7 NC	1.65	3.39	1.40	ICS#8
ICT-F-#9	#9	1-3/8-6 NC	1.81	3.62	1.48	ICS#9
ICT-F-#10	#10	1-1/2-6 NC	2.13	4.13	1.59	ICS#10
ICT-F-#11	#11	1-5/8-6 NC	2.32	4.41	1.83	ICS#11

Note: All units are in (inches).

EUROPE & MIDDLE EAST

Bar Terminator Code	Bar Size	Thread Size	Tube Outer Diameter (Ød)	Head Diameter (ØD)	Terminator Length (h)	Relevant ICS Male Coupler
ICT-F-10	10	M14	18.5	34.0	16.0	ICS10
ICT-F-12	12	M16	22.0	40.0	18.0	ICS12
ICT-F-16	16	M20	28.0	53.0	23.0	ICS16
ICT-F-20	20	M24	34.0	66.0	27.0	ICS20
ICT-F-25	25	M30	42.0	86.0	35.0	ICS25
ICT-F-32	32	M39	54.0	105.0	40.0	ICS32
ICT-F-40	40	M48	67.5	132.0	50.0	ICS40

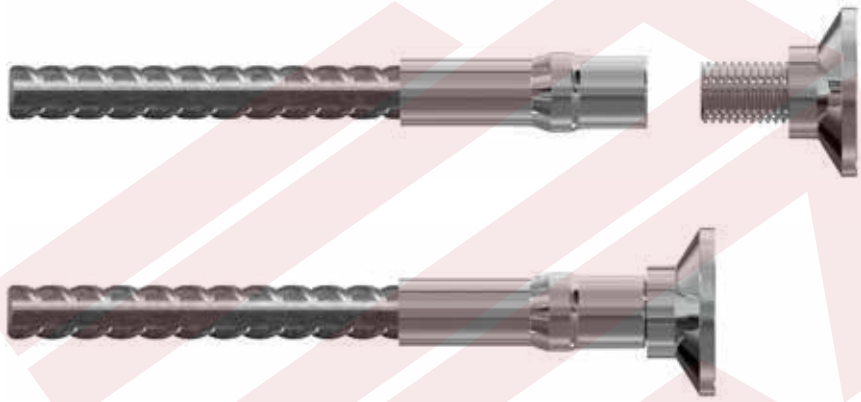
Note: All units are in (millimeters).

INCON ICTB - BAR TERMINATOR

INSTALLATION

1- Press INCON ICS Standard female coupler on the steel bar using INCON swaging machine.

2- Place the threaded rod of the bar terminator on the coupler's end and rotate it until it is completely secured.



CONFIGURATION

INCON ICTB - Bar Terminator is composed of a male end anchor compatible with a corresponding INCON ICS - Standard female coupler sleeve.

MAIN APPLICATION

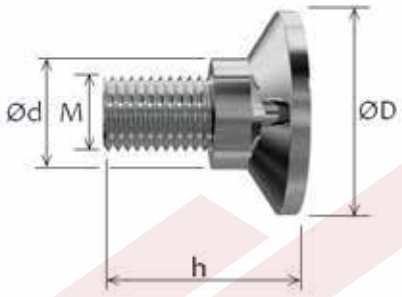
INCON ICTB - Bar Terminator is used in lieu of hooked or bent bars to provide the required anchorage and development length of the embedded steel bars.

FEATURES

- Applicable for high strength reinforcing bars up to ASTM Grade 75.
- Satisfies the requirements of ACI 318, BS 8110, UBC 1997, NF 35-20-1 and DIN 1045.
- Easily installed and highly efficient for achieving the required anchorage strength of steel bars.
- Highly reliable and consistent performance due to our swaging technology and enhanced terminator design.
- Compact design of the bar terminator to reduce reinforcement congestion at the connections.
- Enhances anchorage performance compared to hooked or bent bars especially for large bar diameters.

AVAILABLE MATERIALS AND COATINGS

- **Uncoated steel** bar terminators for providing anchorage of bars in typical construction applications.
- **Zinc coated steel** bar terminators for providing anchorage of steel bars in corrosive environments and for other special applications.
- **Stainless steel** bar terminators for providing anchorage of stainless steel bars and for other special applications.
- **Galvanized steel** bar terminators for providing anchorage of galvanized steel bars and for other special applications.



CANADA

Bar Terminator Code	Bar Size	Thread Size	Tube Outer Diameter (Ød)	Head Diameter (ØD)	Terminator Length (h)	Relevant ICS Female Coupler
ICT-B-10M	10M	M16	22.0	40.0	34.5	ICS10M
ICT-B-15M	15M	M20	28.0	53.0	44.5	ICS15M
ICT-B-20M	20M	M24	34.0	66.0	53.0	ICS20M
ICT-B-25M	25M	M30	42.0	86.0	67.5	ICS25M
ICT-B-30M	30M	M37	51.0	94.0	56.5	ICS30M
ICT-B-35M	35M	M43	61.0	118.0	93.5	ICS35M

Note: All units are in (millimeters).

USA

Bar Terminator Code	Bar Size	Thread Size	Tube Outer Diameter (Ød)	Head Diameter (ØD)	Terminator Length (h)	Relevant ICS Female Coupler
ICT-B-#3	#3	9/16-12 NC	0.73	1.32	1.26	ICS#3
ICT-B-#4	#4	5/8-11 NC	0.87	1.57	1.50	ICS#4
ICT-B-#5	#5	3/4-10 NC	1.10	2.09	1.77	ICS#5
ICT-B-#6	#6	1-8 NC	1.34	2.60	2.13	ICS#6
ICT-B-#7	#7	1-1/8-7 NC	1.50	2.87	2.44	ICS#7
ICT-B-#8	#8	1-1/4-7 NC	1.65	3.39	2.80	ICS#8
ICT-B-#9	#9	1-3/8-6 NC	1.81	3.62	2.95	ICS#9
ICT-B-#10	#10	1-1/2-6 NC	2.13	4.13	3.19	ICS#10
ICT-B-#11	#11	1-5/8-6 NC	2.32	4.41	3.66	ICS#11

Note: All units are in (inches).

EUROPE & MIDDLE EAST

Bar Terminator Code	Bar Size	Thread Size	Tube Outer Diameter (Ød)	Head Diameter (ØD)	Terminator Length (h)	Relevant ICS Female Coupler
ICT-B-10	10	M14	18.5	34.0	32.0	ICS10
ICT-B-12	12	M16	22.0	40.0	36.0	ICS12
ICT-B-16	16	M20	28.0	53.0	45.5	ICS16
ICT-B-20	20	M24	34.0	66.0	54.0	ICS20
ICT-B-25	25	M30	42.0	86.0	68.5	ICS25
ICT-B-32	32	M39	54.0	105.0	79.5	ICS32
ICT-B-40	40	M48	67.5	132.0	99.0	ICS40

Note: All units are in (millimeters).

INCON QUALITY ASSURANCE

INCON ensures consistent production and delivery of superior quality products based on a stringent quality management system in accordance with ISO 9001 certification. Our products are designed and manufactured to comply with the relevant codes and standards such as ACI 318, CSA A23.3, Eurocode 2, BS 8110, DIN 1045, IBC, AASHTO and ASME Sec 3 Div 2. INCON developed its quality assurance program by defining an ongoing iterative monitoring at each manufacturing stage to comprehensively assess the products until reaching their intended destination. The evaluation practices are fully traceable and encompass all production phases such as planning, designing, manufacturing, packaging, shipping and customer serving. To date, INCON has achieved a high level of customer satisfaction through providing them with zero-defect innovative products that efficiently fulfill their requirements and applications.

INCON MEMBERSHIPS

INCON is proudly an active member in the most prestigious organizations and committees in Canada and the United States.

ICC INTERNATIONAL CODE COUNCIL®

aci American Concrete Institute Always advancing

ASTM INTERNATIONAL Standards Worldwide

TCA Toronto Construction Association Since 1867

THE ROAD AUTHORITY®

ISO AND UKAS ACCREDITATION

As an ISO 9001:2008 and UKAS certified company, we have implemented Quality Management System (QMS) in all areas of our business including not only our facilities, but also our services.

SGS

Certificate CN04/0098

The management system of

Hangzhou Nekon Construction Hardware Co., Ltd.

No. 4 Guanshan Road, Fengdu Villiage, Pingyao Town, Hangzhou City, Zhejiang Province, P.R. China

Organization Code 74410379-0

has been assessed and certified as meeting the requirements of

ISO 9001:2008

For the following activities

Manufacture of rebar couplers, transport anchors, fixing anchors, anchor channel

Further clarifications regarding the scope of this certificate and the applicability of ISO 9001:2008 requirements may be obtained by consulting the organization

This certificate is valid from 17 January 2016 until 15 September 2018 and remains valid subject to satisfactory surveillance audits. Recertification audit due a minimum of 60 days before the expiration date Issue 5. Certified since 17 January 2004

Authorised by

SGS United Kingdom Ltd Systems & Services Certification
Rossmore Business Park Ellesmere Port Cheshire CH65 3EN UK
t +44 (0)151 350-6666 f +44 (0)151 350-6600 www.sgs.com
The certification information can be verified on the web site of Certification and Accreditation Administration of the People's Republic of China www.cnca.gov.cn

SGS 9001-8 01 0614

Page 1 of 1

SYSTEM CERTIFICATION ISO 9001 SGS

UKAS MANAGEMENT SYSTEMS 0005

RESEARCH AND EXPERIMENTAL STUDIES

An experimental study was performed at Western University in Canada aiming at investigating the behaviour of mechanical splices embedded in concrete, with emphasis on quantitatively characterizing the capacity and deformation behaviour of INCON mechanical couplers and bar terminators.

TEST CERTIFICATES

Material test certificate obtained from Western University in Canada stating that INCON mechanical couplers and bar terminators fulfill the performance requirements of American and European standards.

Western Engineering

Department of Civil & Environmental Engineering

Material Test Certificate 9-May-2016

To Whom it May Concern:

Samples of INCON swaged standard (ICS), position (ICP) and transition (ICST) mechanical couplers and ICT rebar terminators have been supplied to Western University to assess their compliance with the relevant provisions specified by ACI 318 and BS 8110 standards.

The geometry of the provided couplers have been determined through taking careful measurements of their internal and external dimensions. The process was performed on ten different specimens of each coupler type and the obtained readings were compared to the manufacturer's technical data. The precision and accuracy of the recorded measurements confirm the adherence of the examined INCON couplers to high levels of quality control during production.

Mechanical splices have been constructed in the structural lab at Western University in accordance with the procedure described by INCON installation manual. Grade 75 (BS500C) steel reinforcing bars of sizes compatible with the considered couplers have been used in the investigation. Static uniaxial tensile tests have been performed on two specimens of each coupler type to assess their structural performance in terms of strength and failure mode. The experimental results revealed that both strength and deformation criteria of the tested couplers comply with the regulatory and approval requirements specified by ACI 318 and BS 8110 standards. In addition, the tests have demonstrated that all specimens fulfill the performance requirements defined in CARES Appendix TA11.

Hereby, this material test certificate is issued to INCON company for the hereunder products if used in accordance with the manufacturer's instructions and recommendations.

Western University SEB, 3005, 1151 Richmond Street North, London, ON, CANADA N6A 5B9
t. 519.661.2111 f. 519-661-3779

Material test certificate showing the geometrical characteristics and mechanical properties of INCON ICS32 - Standard Coupler.

Western Engineering

Department of Civil & Environmental Engineering

Description: ICS32 Rebar Coupler Test Certificate

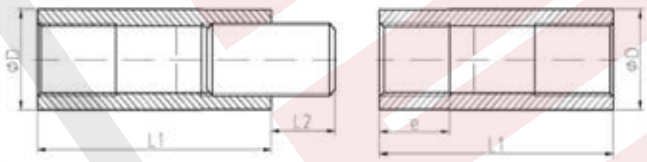


Table 7: Dimensions of the ICS32 Rebar Coupler in (mm).

Dimension	Required Range		Sample No.									
	Min.	Max.	1	2	3	4	5	6	7	8	9	10
L1	136.5	138.5	137.5	137.8	137.6	137.4	137.5	137.8	137.5	137.5	137.8	137.4
L2	38.5	39.5	39.1	38.9	39.1	38.7	38.9	39.1	38.7	39.2	39.1	39.1
e	43.5	46.5	45.5	45.5	45.5	45.5	45.5	45.5	45.5	46.0	46.0	46.0
D	53.8	54.2	53.9	54.0	54.0	53.9	54	53.9	54.0	53.9	53.9	54.0

Table 8: Tensile Test Results of the ICS32 Rebar Coupler.

	ACI 318 Min. Limit	BS 8110 Min. Limit	Test Results	
			Sample 1	Sample 2
Breaking Load (kN)	554.9 (Comply)	462.4 (Comply)	578.7	576.8
Breaking Stress (MPa)	690.0 (Comply)	575.0 (Comply)	719.6	717.2

- **Remarks:**
  1. Grade 75 (BS500C) Ø32 steel rebars are used in the tensile tests.
  2. Test results comply with the specifications of ACI 318 and BS 8110.
  3. Fracture in all tests occurred in the steel reinforcing bar.

Western University SEB, 3005, 1151 Richmond Street North, London, ON, CANADA N6A 5B9
t. 519.661.2111 f. 519-661-3779

Material test certificate showing the geometrical characteristics and mechanical properties of INCON ICP32 - Position Coupler.

Western Engineering

Department of Civil & Environmental Engineering

Description: ICP32 Rebar Coupler Test Certificate

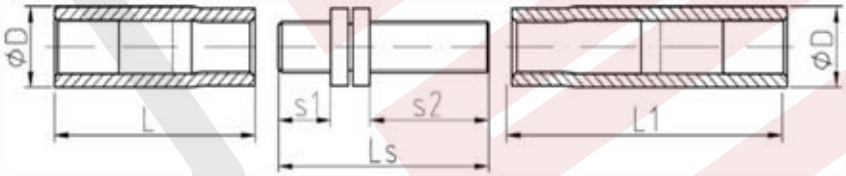


Table 17: Dimensions of the ICP32 Rebar Coupler in (mm).

Dimension	Required Range		Sample No.									
	Min.	Max.	1	2	3	4	5	6	7	8	9	10
L	137.5	137.8	137.6	137.4	137.5	137.8	137.5	137.5	137.8	137.4	137.5	137.8
L1	209.3	209.1	209.3	209.2	209.1	209.3	209.1	209.2	209.1	209.1	209.3	209.1
Ls	190.2	190.2	190.4	190.2	190.4	190.2	190.4	190.2	190.4	190.3	190.2	190.2
D	53.9	54.0	54.0	53.9	54.0	53.9	54.0	53.9	53.9	54.0	53.9	54.0
s1	40.1	40.2	39.9	39.8	40.2	39.9	39.8	39.8	40.2	40.1	40.1	40.2
s2	111.9	111.8	112.1	112	111.8	112.1	112	111.8	112.1	111.9	111.9	111.8

Table 18: Tensile Test Results of the ICP32 Rebar Coupler.

	ACI 318 Min. Limit	BS 8110 Min. Limit	Test Results	
			Sample 1	Sample 2
Breaking Load (kN)	554.9 (Comply)	462.4 (Comply)	579.3	573.7
Breaking Stress (MPa)	690.0 (Comply)	575.0 (Comply)	720.3	713.3

- **Remarks:**
  1. Grade 75 (BS500C) Ø32 steel rebars are used in the tensile tests.
  2. Test results comply with the specifications of ACI 318 and BS 8110.
  3. Fracture in all tests occurred in the steel reinforcing bar.

Western University SEB, 3005, 1151 Richmond Street North, London, ON, CANADA N6A 5B9
t. 519.661.2111 f. 519-661-3779

Material test certificate showing the geometrical characteristics and mechanical properties of INCON ICST32-25 - Transition Coupler.

Western Engineering

Department of Civil & Environmental Engineering

Description: ICST32-25(M30) Rebar Coupler Test Certificate

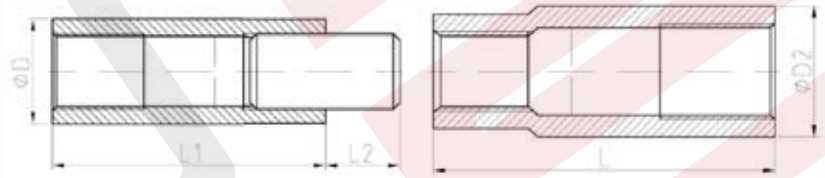


Table 30: Dimensions of the ICST32-25(M30) rebar coupler in (mm).

Dimension	Required Range		Sample No.									
	Min.	Max.	1	2	3	4	5	6	7	8	9	10
L1	109	111	110.2	110.1	110.2	110.3	110.2	110.2	110.1	110.2	110.2	110.2
L2	32.5	33.5	33.2	33.1	33.1	33	33.2	33.1	33.1	33	33.1	33
D	41.8	42.2	42	41.9	41.9	42	41.9	42	42	41.9	41.9	42
L	136.5	138.5	137.5	137.8	137.6	137.4	137.5	137.8	137.5	137.5	137.8	137.4
D2	53.8	54.2	53.9	54	54	53.9	54	53.9	54	53.9	53.9	54

Table 31: Mechanical properties of the ICST32-25(M30) components.

	Minimum Value	Test Results				Compliance
		Sample 1	Sample 2	Sample 3	Sample 4	
Yield Strength (MPa)	350	436.6	438.5	442.2	441.7	Comply
Tensile Strength (MPa)	550	635.3	631.9	647.3	638.8	Comply

Table 32: Tensile Test Results of the mechanical connection using ICST32-25(M30).

	ACI 318 Min. Limit	BS 8110 Min. Limit	Test Results		Compliance
			Sample 1	Sample 2	
Breaking Load (kN)	338.7	282.3	345.6	347.7	Comply
Breaking Stress (MPa)	690.0	575	704	708.3	Comply

- **Remarks:**
  1. Grade 75 (BS500C) Ø25 and Ø32 steel rebars are used in the tensile tests.
  2. Test results comply with the specifications of ACI 318 and BS 8110.
  3. Fracture in all tests occurred in the steel reinforcing bar.

Western University SEB, 3005, 1151 Richmond Street North, London, ON, CANADA N6A 5B9
t. 519.661.2111 f. 519-661-3779

Material test certificate showing the geometrical characteristics and mechanical properties of INCON ICT32-F - Bar Terminator.

Western Engineering

Department of Civil & Environmental Engineering

Description: ICT32-F Rebar terminator Test Certificate

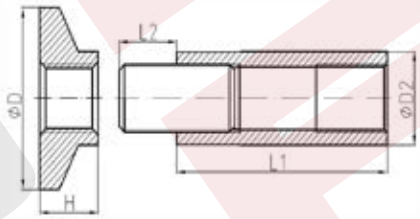


Table 45: Dimensions of the ICT32-F Rebar terminator in (mm).

Dimension	Required Range		Sample No.									
	Min.	Max.	1	2	3	4	5	6	7	8	9	10
L1	109	111	110.2	110.1	110.2	110.3	110.2	110.2	110.1	110.2	110.2	110.2
D2	167.5	169.5	168.3	168.2	168.1	168.5	168.2	168.1	168.5	168.2	168.1	168.4
L2	33.5	35	33.7	33.8	33.6	33.8	33.8	33.6	33.8	33.6	33.9	33.7
D	103	107	105.7	105.6	105.4	105.2	105.7	105.6	105.2	104.9	104.8	105.2
H	38.5	40.5	39.6	39.8	40.2	40.1	39.8	39.6	39.7	39.4	39.2	39.6

Table 46: Mechanical properties of the ICT32-F components.

	Minimum Value	Terminator		Coupler		Compliance
		Sample 1	Sample 2	Sample 1	Sample 2	
Yield Strength (MPa)	350	432.8	432.7	442.2	441.7	Comply
Tensile Strength (MPa)	550	625.8	628.6	647.3	638.8	Comply

Table 47: Tensile Test Results of the mechanical connection using ICT32-F.

	ACI 318 Min. Limit	BS 8110 Min. Limit	Test Results		Compliance
			Sample 1	Sample 2	
Breaking Load (kN)	554.9	462.4	568.4	577.4	Comply
Breaking Stress (MPa)	690.0	575	706.7	717.9	Comply

- **Remarks:**
  1. Grade 75 (BS500C) Ø32 steel rebars are used in the tensile tests.
  2. Test results comply with the specifications of ACI 318 and BS 8110.
  3. Fracture in all tests occurred in the steel reinforcing bar.

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Material test certificate showing the geometrical characteristics and mechanical properties of INCON ICT32-M - Bar Terminator.

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Description: ICT32-M Rebar terminator Test Certificate

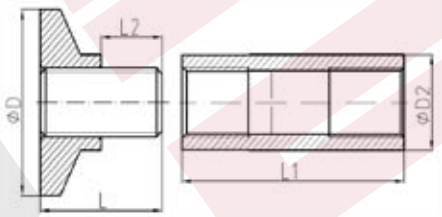

Table 60: Dimensions of the ICT32-M Rebar terminator in (mm).

Dimension	Required Range		Sample No.									
	Min.	Max.	1	2	3	4	5	6	7	8	9	10
L1	109	111	110.2	110.1	110.2	110.3	110.2	110.2	110.1	110.2	110.2	110.2
D2	167.5	169.5	168.3	168.2	168.1	168.5	168.2	168.1	168.5	168.2	168.1	168.4
L2	33.5	35	33.7	33.8	33.6	33.8	33.8	33.6	33.8	33.6	33.9	33.7
D	103	107	105.7	105.6	105.4	105.2	105.7	105.6	105.2	104.9	104.8	105.2
L	78	80	79.2	79.3	79.1	79	79.2	79.1	79	78.8	78.5	78.9

Table 61: Mechanical properties of the ICT32-M components.

	Minimum Value	Terminator		Coupler		Compliance
		Sample 1	Sample 2	Sample 1	Sample 2	
Yield Strength (MPa)	350	432.8	432.7	442.2	441.7	Comply
Tensile Strength (MPa)	550	625.8	628.6	647.3	638.8	Comply

Table 62: Tensile Test Results of the mechanical connection using ICT32-M.

	ACI 318 Min. Limit	BS 8110 Min. Limit	Test Results		Compliance
			Sample 1	Sample 2	
Breaking Load (kN)	554.9	462.4	521.4	535.1	Comply
Breaking Stress (MPa)	690.0	575	648.3	665.3	Comply

- **Remarks:**
  1. Grade 75 (BS500C) Ø32 steel rebars are used in the tensile tests.
  2. Test results comply with the specifications of ACI 318 and BS 8110.
  3. Fracture in all tests occurred in the steel reinforcing bar.

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AXIAL TENSILE BEHAVIOR OF INCON MECHANICAL SPLICES

The tensile capacity and load-deformation behavior of INCON mechanical splices were comprehensively examined by carrying out an extensive experimental program at Western University in Canada. The results revealed that INCON mechanical devices maintained the ductile behavior of the splice and enhanced its performance.

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- **Axial Behavior of Mechanical Connections Constructed with INCON Couplers:**

Stress-strain relationship of the examined mechanical splices made with INCON ICP position couplers is characterized by the favorable ductile response as illustrated in Fig. 1. All splices exhibited a linear elastic behavior up to yielding point beyond which the incremental modulus of elasticity suddenly drops. At a strain of 0.011, gradual stress increase was detected in the specimens reflecting the occurrence of strain hardening in the steel bars. Failure happened at a strain value of approximately 0.024 by fracture of one of the two connected reinforcing bars while the coupler remained intact. Relative slip between couplers and the embedded steel bars was acceptable and passed the ACI requirements in all specimens. Yielding of the tested mechanical connections occurred at a higher value compared to the measured yield strength of the corresponding steel bars. Ultimate capacity of the examined mechanical splices was slightly higher than their counterparts determined from performing tensile tests on continuous steel bars. These results attest that INCON ICP position couplers maintain the ductile behavior of the mechanical connections and are suitable for use in reinforced concrete structures as specified by ACI 318 and CSA A23.3 standards.

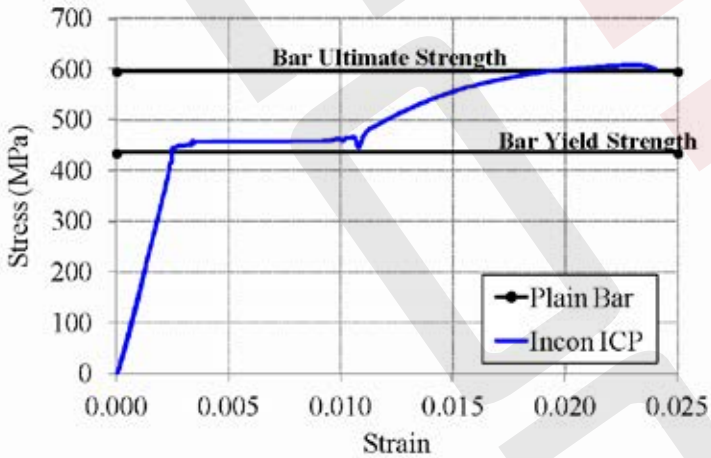

Figure 1: Stress-Strain Relationship of INCON ICP Mechanical Connections.

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- **Typical Failure Mode of the Mechanical Connections:**

Figures 4 through 7 show failure of the tested specimens by rupture of the steel rebar away from the coupler.

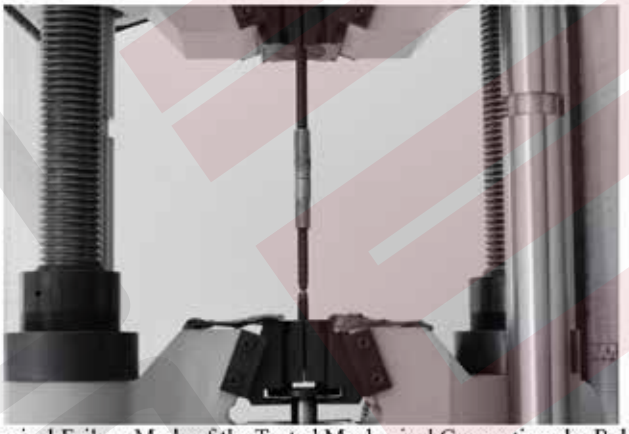

Figure 4: Typical Failure Mode of the Tested Mechanical Connections by Rebar Fracture.

Figure 5: Typical Failure Mode of the Tested Mechanical Connections by Rebar Fracture.

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Failure of INCON mechanical splices is reached by fracture of steel bars.

CAPACITY AND DEFORMATION BEHAVIOR OF FULL SCALE BEAMS

Actual capacity, stress distribution and deformation behavior of full scale beams reinforced with INCON mechanical splices are evaluated in the highly equipped structural lab of Western University in Canada. Strains and deformations along the beam span were continuously monitored and cracking pattern was recorded at various load levels. All specimens exhibited inelastic deformation and visible flexural cracks before crushing of concrete indicating a ductile mode of failure.

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- **Flexural Behavior of RC Beams Constructed with INCON Couplers:**

Figure 2 illustrates the load-deflection relationship for the tested beams that were designed in accordance with CSA A23.3-04. The curves have been normalized by the peak load of the corresponding control beams which were constructed with the same reinforcement ratio but with continuous bars. Overall, INCON ICP position couplers allowed the tension reinforcement to undergo sufficient inelastic deformation such that beam failure was initiated by concrete crushing in all cases. Beams constructed with mechanically connected reinforcement demonstrated cracking patterns that similar the control beams, displaying thin and well distributed cracks within the constant moment region as indicated in Fig. 3.

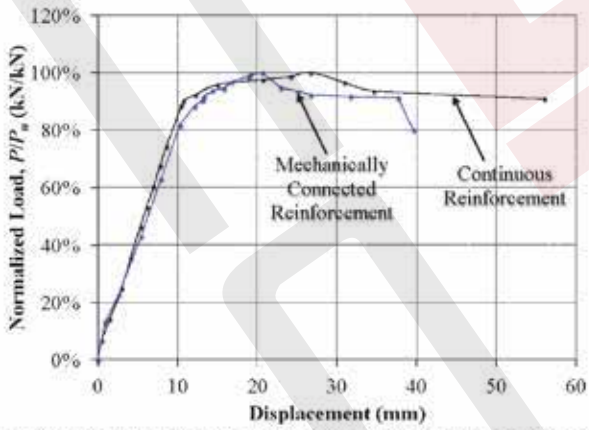

Figure 2: Typical Load-Deflection Curves of the Examined Beams.

Figure 3: Typical Cracking Pattern Indicating Ductile Mode of Failure.

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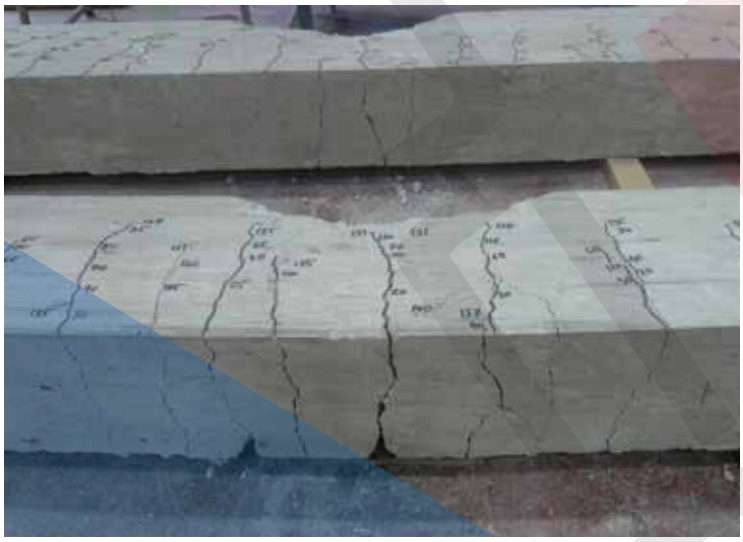
Test setup showing the specimen before applying the displacement controlled two point loading scheme.

Strain gauges and LVDT devices are connected along the beam span to track the full flexural performance of the beam at all load levels.



Typical cracking pattern of the beam specimens reinforced with INCON mechanical splices. Flexural cracks were developed and propagated along the beam before crushing of concrete.

Close up view of the coupler inside the concrete beam after the test was performed. Slip was not observed in any of the tested specimens. Notice the strain gauge wires extending out of the coupler.

Portion of the reinforced concrete beams tested as part of the experimental program that took place at Western University in Canada.

Exposed INCON couplers after failure of the beam. The couplers are in an excellent condition with no slip recorded between the coupler and the embedded steel bars.

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