APPENDIX "B" to ENGINEERING GUIDE

CINTEC

REINFORCEMENT SYSTEMS

Salient Points for use of Cintec Reinforcement Systems

Email: solutions@cintec.com

www.cintec.com

Salient Points for Use of Cintec Reinforcement Systems

Cintec's anchoring and reinforcement system "Presstec" grout is **CEMENTATIOUS.** This all natural, proprietary grout is of high strength with no additives and very good bond capacity (65 psi). See MSDS sheet Page 16.

Cintec's anchoring and reinforcement system can be **INSTALLED IN WET OR DUSTY CONDITIONS**. This is very important, as many sites do not provide "ideal" installation conditions with respect to moisture, dust presence or precision hole creation and the failure of the installer to create these ideal conditions may lead to anchoring failure with other systems. The presence of water or dust or even less than exact hole diameters is of no consequence – in fact, Cintec anchors and reinforcement can and have been successfully installed under water.

Cintec's anchoring and reinforcement system can only be **INSTALLED BY CINTEC TRAINED AND CERTIFIED** installers. As part of our quality control, extensive training of all installers is mandatory by Cintec personnel. Cintec product is only available to the project via Cintec Reinforcement Systems thus eliminating the possibility of contractors obtaining product independently and installing with less than qualified people.

Cintec's anchoring and reinforcement system has been **TESTED TO BE FIREPROOF.** A major and common application of Cintec anchors is for seismic upgrading and as such the fireproof characteristics of this product are critical. Often, earthquakes result in fire and any anchoring system not fireproof and resistant to high heat conditions could easily result in anchoring failure and possible human injury or death.

Cintec's anchoring and reinforcement system is **PULLOUT CAPACITY ENGINEERED** to required load capacity. All Cintec anchors and reinforcements are custom made and project specific to address required capacities. We do not use a "one size fits all" approach in selection and manufacturing of anchoring solutions. Please visit the engineering aid section following for extensive information and design criteria.

Cintec's anchoring and reinforcement system has been **TESTED TO 150 FREEZE/THAW CYCLES.** Public Works and Government Services Canada (PWGSC) commissioned and paid for thorough testing of Cintec product for Pull Out and Freeze Thaw by the University of Manitoba – Structural Department. As a result, Cintec product is "sole sourced" on many federal projects.

Cintec's anchoring and reinforcement system provides both **ADHESIVE AND MECHANICAL** attachment. Unlike other systems that offer only one or the other attachment system, Cintec's patented system provides adhesive attachment through it's grout bonding and mechanical through it's expandable sock system.

Cintec's anchoring and reinforcement system has been **TESTED TO RESIST SEISMIC** action. As stated earlier, seismic upgrading of structures – worldwide is a major and common application of the Cintec system.

Cintec's anchoring and reinforcement system **DOES NOT RESULT IN BRITTLE FAILURE.** Although very important, this factor is often overlooked in anchoring solutions. Simply stated, brittle failure is experienced in systems that hold… then fail. Cintec's progressive failure (by design) allows for release when critical loads are reached but not instant total failure. A rough analogy might be the difference between a blow out versus a slow leak in a car tire.

For more information see ENGINEERS GUIDE available at www.cintec.com

CINTEC - GENERAL SPECIFICATIONS

- ✓ Cintec's anchoring and reinforcement system "Presstec" grout is **CEMENTATIOUS**.
- ✓ Cintec's anchoring and reinforcement system can be **INSTALLED IN WET OR DUSTY CONDITIONS**.
- ✓ Cintec's anchoring and reinforcement system has been **TESTED TO BE FIREPROOF.**
- ✓ Cintec's anchoring and reinforcement system is **PULLOUT CAPACITY ENGINEERED** to required load capacity.
- ✓ Cintec's anchoring and reinforcement system has been **TESTED TO 150 FREEZE/THAW CYCLES.**
- ✓ Cintec's anchoring and reinforcement system provides both **ADHESIVE AND MECHANICAL** attachment.
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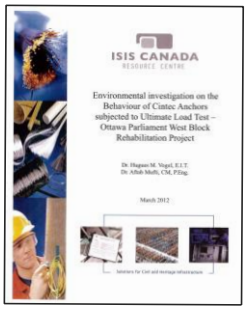


The ISIS Canada Research Network (ISIS) was established in 1995 under the leadership of Dr. Sami Rizkalla to advance the civil engineering profession in Canada to a world leadership position through the use of advance composite materials and the application of structural health monitoring (SHM) to civil infrastructure, such as bridges. The Network—headquartered at the University of Manitoba—comprises 14 Canadian universities (five of them western), 30 principal investigators (engineering professors), 185 researchers and 50 to 75 government and industry partners.

Pull Out / Freeze Thaw Testing of Cintec Reinforcement System.

In 2012 Public Works and Government Services Canada (PWGSC) commissioned the ISIS Canada Research Network to extensively test the Cintec Reinforcement System as reassurance of the product suitability for use in it's seismic upgrades and restorative efforts with respect to its structures. Cover Left

The main objective of the study outlined by PWGSC was to evaluate the performance of Cintec anchors in a material similar to the one found in the outer wythe of the West Block building, while accounting for the influence of weather conditions in the Canadian climate. The objective translates into two major benchmarks for the program:

[1] **CONDITIONG** – subject the samples to weathering criteria listed in the relevant North American Standards with consideration for other international standards.
[2] **TESTING** – evaluating the pullout behaviour of anchors in both control and conditioned samples under static loads.

Successful test results were responsible for the following comments made by the testing principals:

"This ductile behaviour provided by the Cintec repair technique is strongly advantageous because it provides ample warning of impending failure while sustaining a surcharge comparable to the capacity of the anchor." **

"This damage is contained in the vicinity of the rod as well as at the top of the grouted hole. It does not extend towards the interface to affect the bond between the fabric sock and the stonework. The result underlines another advantage of the Cintec anchorage system for rehabilitating structures similar to the West Block building on Parliament Hill." **

"The Cintec rehabilitation technique is resilient despite the consideration of thermal weathering." **

** Dr Hugues M. Vogel, E.I.T & Dr. Aftab Mufti, CM, P.Eng.

CONSTRUCTING EXCELLENCE
bre

BRE is a world leading multi-disciplinary building science centre with a mission to improve the built environment through research and knowledge generation. Building a better world together.

Fire testing of Cintec's remedial cavity wall ties.

"In the latest test in our fire test rig with a static dead load on each tie of 1.3 kN your tie survived a two-hour test without failure of any of the three replicate samples." *

"All three samples are now placed in the upper half of the wall and would have reached several hundred degrees in the part of the tie nearest the fire face." *

"This indicates that this tie system can, when installed using the correct techniques, be recommended for repair work to buildings having a fire period requirement of up to 2hrs." *

* R. C. de Vekey - Head of Masonry Structures Section, Structural Design Division, Geotechnics and Structural Group

JRC
EUROPEAN COMMISSION

JOINT RESEARCH CENTRE (JRC) is the European Commission's science and knowledge service which employs scientists to carry out research in order to provide independent scientific advice and support to EU policy. Located in Ispra, Northern Italy it is firmly established as one of Europe's leading research campuses.

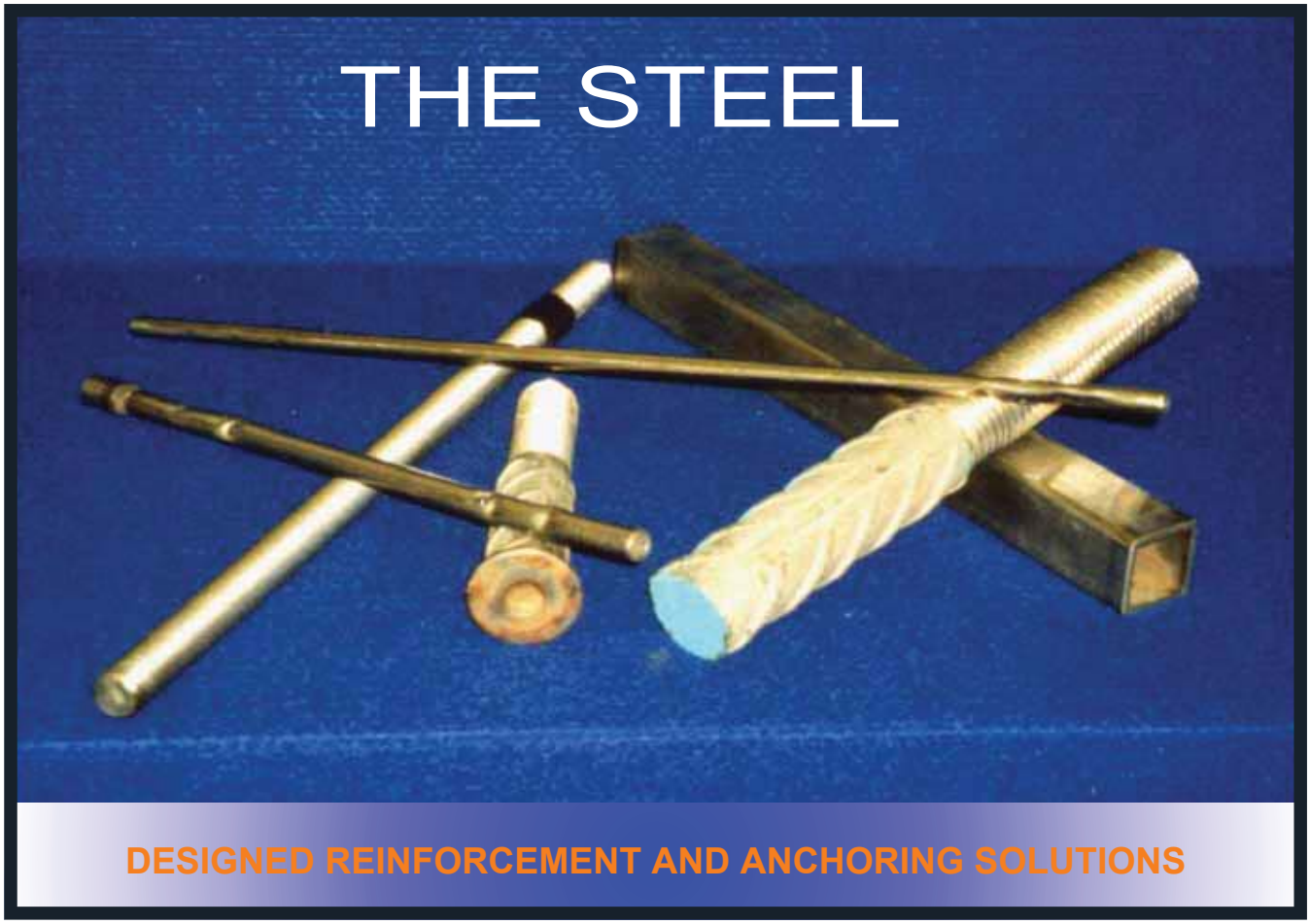
Seismic Testing of Cintec Reinforcement System.

Physical testing aimed specifically at seismic loading has taken place in the reaction wall laboratory of the Joint Research Centre in Italy.

Pseudo-dynamic and cyclic tests were carried out on a full-scale model of part of the cloisters of the São Vicente de Fora Monastery, in Lisbon - Portugal. The research was aimed at characterizing the non-linear behaviour of stone block structures under earthquake loading and also at assessing the effectiveness of retrofitting Cintec anchors.

The retrofitted model demonstrated that the continuous bond Cintec anchors performed far better than pre-compression ties.

It was apparent that observed cracking was 'better distributed' within the structure. The tests provided strong evidence for the 'applicability and effectiveness of such a kind of retrofitting in terms of deformation capacity and strength of the model.'

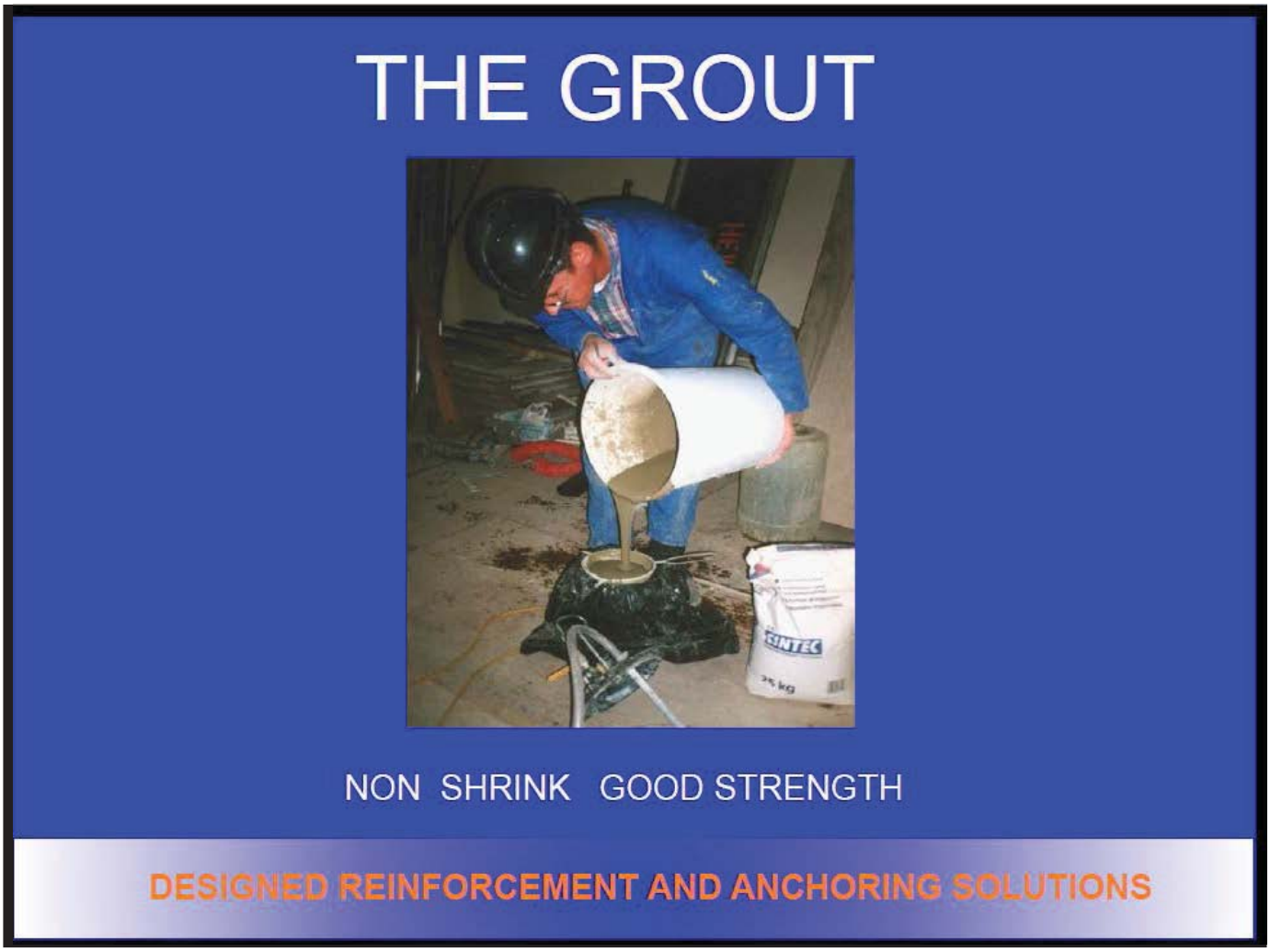


The anchor or reinforcement consists of three components - steel, sock and grout. The first is the reinforcing bar which comes in a variety of forms such as solid, hollow, round or square. Steel configuration is determined by project requirements such as load and application. It is, in most cases, stainless-steel Type 304 but we also use Type 316 for greater corrosion resistance and Type 2205 where higher strengths are needed. Cintec manufactures to the specific requirements of the project and therefore may use other types of stainless steel as well.

For more information see ENGINEERS GUIDE available at www.cintec.com

The second component of the Cintec Reinforcement System is the sock.The sock is a woven polyester sleeve that can expand horizontally but not longitudinally. Redundant to the process once inflated and the grout has set, the sock is critical in the installation procedures to contain and retain the grout. Wetting the sock, prior to inflation, “conditions” it to allow the bonding grout milk to flow through yet traps the micro cement particles and prevents uncontrolled grout flow. This facilitates an even expansion along its entire length for bonding with substrate where contact is made and expansion of system into voids when possible. Manufactured by Cintec, to stringent standards, this proprietary sock is available in 1” to 12” diameter and unlimited length.

For more information see ENGINEERS GUIDE available at www.cintec.com



The grout is the third component of the Cintec Reinforcement System and is a specially engineered Mineral Bound Injection Grout with no artificial additives. This cementitious grout consists of very fine particles (micro cement) that can be injected over considerable distances. It is non shrink, non expansive and impervious to absorption when set. The patented grout is manufactured in Germany to Cintec standards. Stringent mixing and injection procedures are provided as part of Cintec's Quality Control program and must be implement by Cintec certified installers only. Use of any other grout, in the Cintec Reinforcement system, that has not been pre-approved by Cintec is not allowed and voids any warranty.

For more information see ENGINEERS GUIDE available at www.cintec.com

PRESSTEC ©GROUT BOND QUICK CALCULATION

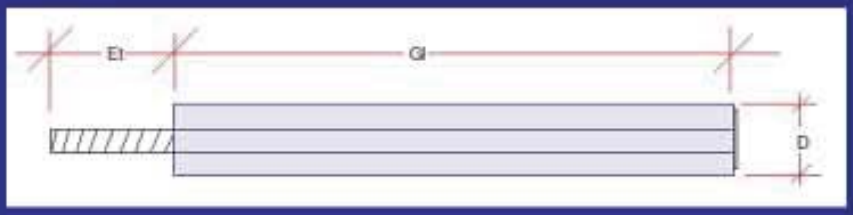
GROUT - PRESSTEC 2000 ©

TYPICAL MEAN VALUES

	1 DAY	7 DAY	28 DAY
TENSION	835 psi / 5.75 Mpa	1060 psi / 7.3 Mpa	1150 psi / 7.9 Mpa
COMPRESSION	6550 psi / 45 Mpa	8840 psi / 61 Mpa	9625 psi / 66 Mpa

APPROXIMATLY 70% AFTER 24 HOURS

PULL OUT BOND STRENGTH



Bond capacity = π X D X L X 65lbs

Where D is core hole diameter , Gl is grouted length and 65lbs is bond per square inch

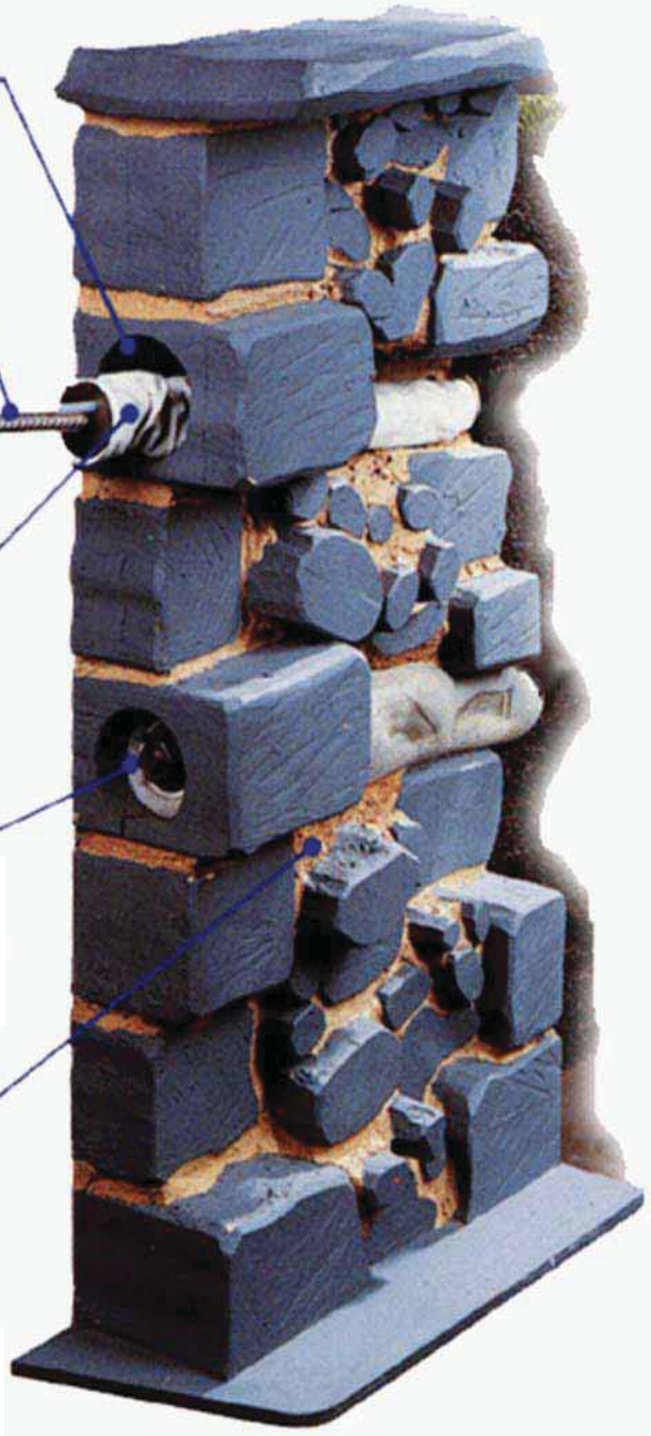
Assume: D is 2 inch , Gl is 6 inches

Therefore: 3.14 X 2 X 6 X 65 **2,450 lbs bond pull out for this anchor.**

DESIGNED REINFORCEMENT AND ANCHORING SOLUTIONS

For more information see ENGINEERS GUIDE available at www.cintec.com

MOCK-UP of CINTEC ANCHOR or REINFORCEMENT



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IN-SITU CINTEC ANCHOR or REINFORCEMENT

ACTUAL PHOTO

The Cintec Reinforcement System attaches in two ways. When the sock, containing grout milk, is able to come in contact with the substrate, it adheres with a bond strength of 65 psi. When the expanded sock is not able to contact the substrate, then the low injection pressure causes the sock (grout) to expand horizontally into the void resulting in a mechanical attachment. The high compressive grout strength (9,000 psi) ensures an attachment with progressive failure rather than brittle failure potential.

For more information see ENGINEERS GUIDE available at www.cintec.com

All Cintec anchors are custom made. Whatever the Engineer / Architect / Contractor requires to satisfy project needs is what we manufacture. Configuration is determined based on load requirements, application and site conditions. This customization ensures that specific project needs are satisfied as opposed to a compromised solution selection based on “off the shelf” availability.

For more information see ENGINEERS GUIDE available at www.cintec.com

CALCULATION OF ANCHOR DESIGN

Determine application: Is the anchor to act as a:
A - Stitching anchor for brick or masonry (usually CHS but may be SRT for higher loads)
B - Wall reinforcing anchor (usually SRT but may be HSS or other configuration)
C - Wall anchor used for attaching to something i.e.: header, beam etc. (usually SRT but end treatments can be defined by Engineer/ Architect)

Determine loads to be placed on the anchor:
A - Shear
B - Tensile
C - Bending Moment
D - Pull Out (bond failure)

Substrate capacity will usually be less than designed anchor capacity.

Wall (substrate) thickness must be determined as anchor lengths are predicated on this information. Stitching anchors are usually 4” [100 mm] less in length than total wall thickness (embed length). Anchors used for attaching are usually wall thickness less 2” [50 mm] (embed length) plus the amount of protrusion needed for end treatment.

The following pages are from our Engineering Manual which can be found on our website www.cintec.com.

Page 63-66 – Locate stainless steel configuration (CHS, HHS or SRT) and pick size from table so that all values equal or exceed determined loads.

Page 86 – Hole diameter selected from table based on style and diameter of steel to be used. (Note length limitations)

Page 75- 82– Using the embed lengths and hole diameter previously found, locate corresponding Pull Out Strength. Straight extrapolation for longer lengths is acceptable. If pull out is less than needed, diameter of cored hole may be increased.

The above is a good general determination of anchor needs. Any load other than direct tension pull out should be looked at by a Cintec engineer. A second opinion never hurts.

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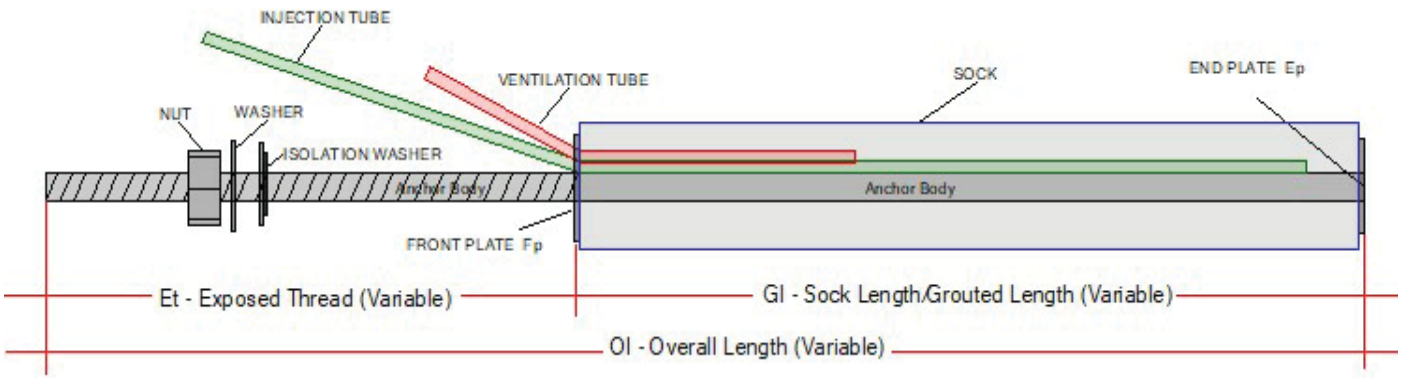
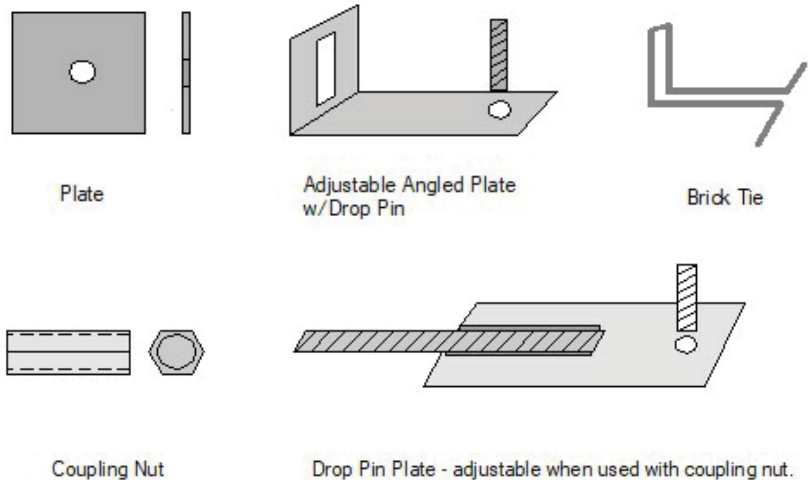
Cintec Generic SRT



Accessories



CINTEC TERMINOLOGY

Accessory - end treatment that can be attached to an anchor

Anchor Body - the steel part of the anchor. Usually stainless steel and may be hollow, solid round, square, or other configuration.

Nut - hexagonal with same ID as body and usually of same material.

Plate (End) - on most anchors. Usually 1/2" smaller diameter than the core/ sock diameter. Has hole in centre the size of body so it can be welded / thread-locked in place.

Plate (Front) - on some anchors. Usually 1/2" smaller diameter than the core/ sock diameter. Has hole in centre the size of body so it can be welded / thread-locked in place. May also have "port (s)" to accommodate injection / ventilation / other tubes.

Sock - polyester , woven tube usually size matched to the core hole diameter... but NOT always

Tube (Injection) - tube that is glued in place and used to INJECT the anchor sock. It is the longest tube if two or more tubes are present and identified with a sticker with green writing.

Tube (ventilation) - also called "emergency" allows air in system to escape and can also be used if absolutely necessary to inflate anchor. It is glued in place and is the shortest tube if two or more tubes are present and identified with a sticker with red writing.

Washer - also called flat or fender washer.

Washer (Isolation) - also called bonded washer, used to prevent galvanic action between dissimilar materials

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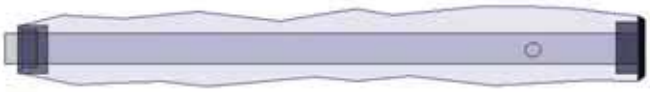
WHAT "TYPE" TO USE

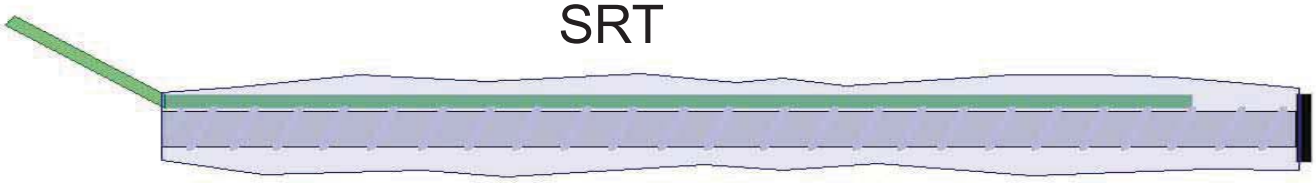
CHS



CHS (Circular Hollow Section)

Often referred to as a **STITCHING ANCHOR**. Stainless Steel 304 / 316. Body diameter of 3/8" (10mm) or 1/2" (12mm). They are typically installed perpendicular to wall face. Used primarily to consolidate exterior to interior masonry wall faces as well as multi-wythe brick. Installation in a ¾" (20mm) or 1" (25mm) hole, respectively, with a length of no more than 39" (1000mm). Typically installed in a Domino 5 pattern. Various end treatments are possible for specific project requirements and applications.

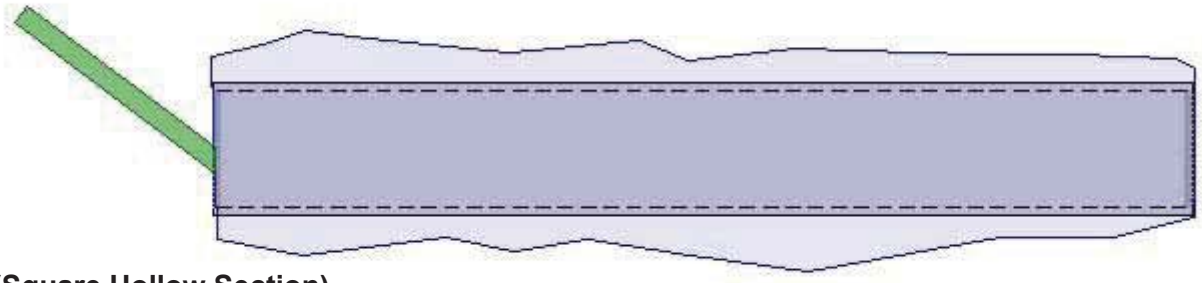
SRT



SRT (Solid Rod-Threaded)

Inplane or Reinforcement run parallel with the structures face and may be installed vertically, horizontally or on an incline. Stainless Steel 304 / 316 /2205 and 17-4PH are commonly used but other grades may be used per project requirements. Possibly the most widely used of the Cintec Reinforcement System, it's primary purpose is in strengthening, cladding stabilization and seismic upgrading. Body diameter of ¼" (6mm) to over 2 ½" (65mm) with sock / core hole diameters of ¾" (20mm) to 12" (300mm). No length restrictions - longest to date 147' (44.8m). This "type" of reinforcement may be **Post Tensioned** using a 2 sock system. Application and purpose dictates sizing and various end treatments are possible for specific project needs.

SHS



SHS (Square Hollow Section)

Moment Resisting, this body configuration is used where increased moment capacity is required while keeping the overall diameter of cored hole to a minimum. Stainless Steel 304 / 316 are commonly used but other grades may be considered per project requirements. It's primary purpose is as a support member and to transfer loads for applications such as shelf angles and joist attachment. Body diameter of 3/4" (20mm) to over 4" (100mm) with sock / core hole diameters of 1 1/2" (38mm) to 12" (300mm). No length restrictions. Application /purpose dictates sizing and various end treatments are possible for specific project needs.

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PATENTS

Since 1965 Cintec has strived to become the world leader in the design and manufacture of project specific designed cementitious anchoring and reinforcement systems. PATENS have been obtained worldwide and addition patents have been applied for and are pending. A partial list of Patents / Patents pending includes, but is not limited to: 2245121, 2764006, 0090895, 5216857, 116188, 1210495, DE19609914, 3608775, DE2315859.

THE SOCK

The fabric sleeve is specially woven polyester based tubular sock with expansion properties to suit the diameter of the bore hole and substrate. The mesh of the sock is designed to contain the aggregates of the mixed grout, while still allowing the cement enriched water (milk) to pass through the sock both sizing and bonding to the substrate. The sock is manufactured in sizes from 20mm to 300mm in diameter and is adjusted to suit each individual application.

THE GROUT

Presstec grout is a cementitious grout, a factory produced mix with graded aggregates and other constituents which when mixed with water produce a pumpable grout that exhibits good strength with no shrinkage. Presstec is made in accordance with the following DIN standards, which are comparable to ASTM standards. The Grout does not contain any resin binders.
DIN EN 197-1. DIN EN 196. DIN EN 932. DIN 4226. DIN EN 933.
DIN EN 1097. DIN EN 1367. DIN 18555. & DIN 18557

WARRANTY

Cintec warrants that for a period of 12 months from the date it sells a product it will, as its sole option and discretion, refund the purchase price, or replace such product if it contains a defect in material or workmanship. Absence of Cintec receipt of notification of any such a defect together with a copy of the original invoice within this 12-month period shall constitute a waiver of all claims with regard to such product.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANT-ABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Acceptance of order: Acceptance is limited to the express terms contained herein, and terms are subject to change by Cintec without notice. Additional or different terms proposed by customer are deemed material and are objected to and rejected, but such rejection shall not operate as a rejection of the offer unless it contains variances in the terms of the description, quantity, price or delivery schedule of the goods.

Indemnification: Cintec shall in no event be liable for, and customer hereby agrees to indemnify Cintec against all claims related to, special, direct, indirect, incidental, consequential, or any other damages arising out of or related to the sale, use, or inability to use the product by an approved contractor and or installer for the said project the product was designed for. Customer hereby agrees to indemnify Cintec for any costs, including attorney's fees, incurred by Cintec as a result, in whole or in part, of any violation by customer of any Federal, Provincial or local statue or regulation, or of any nationally accepted standard. It shall be customer's sole responsibility to comply with all applicable laws and regulations regarding the handling, use, transportation, or disposal of products upon taking possession of same.

Cintec's anchoring and reinforcement systems can only be **INSTALLED BY CINTEC TRAINED AND CERTIFIED** installers.

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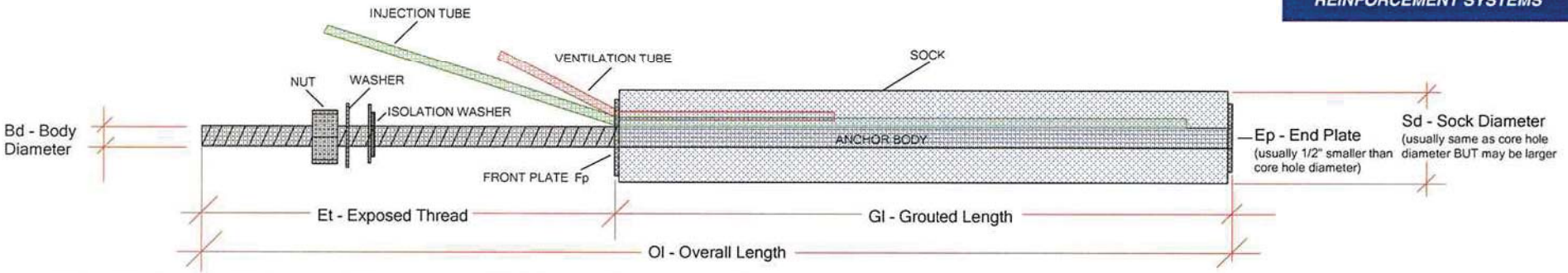
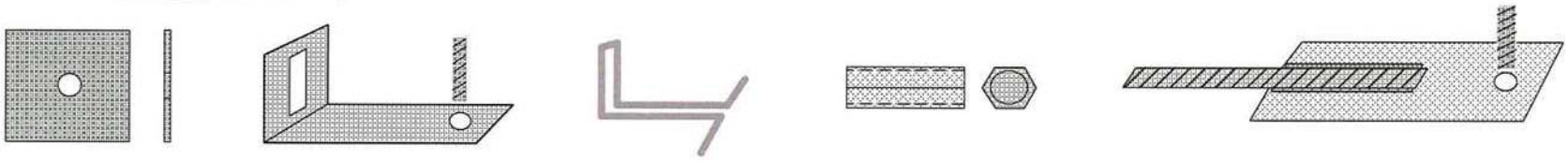
TYPICAL ANCHOR DESIGN & TERMINOLOGY



ACCESSORIES



Plate

Adjustable Angled Plate w/ Drop Pin

Brick Tie

Coupling Nut

Drop Pin Plate - adjustable when used with coupling nut.

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Washer - also called flat or fender washer.

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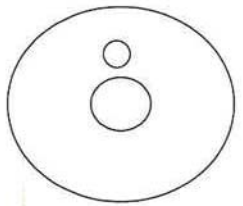
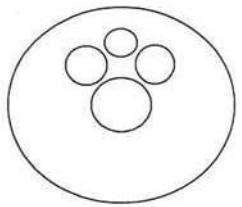
FRONT PLATES (Various)



Standard with single portl



Custom with several ports.

NOTES