Mr. Isaac Mak, Head of Engineering of HILTI (Hong Kong) Ltd., presented in The Hong Kong Polytechnic University on 7/3/2018 [Paul Chan]

Mechanical installation on concrete structures uses anchor bolts. Long, large and heavy mechanical facilities such as lift rails in lift shafts, air ducts in buildings and jet fans in tunnels are hung at elevations with the anchor bolts fastening their steel structure with the concrete surface. A few rightly sized anchor bolts can hold tonnes of weight securely in the air, or the improperly use of anchor bolts can lead to fall of objects and lethal consequences of loss of life, health, production and reputation. Anchor bolts may be small and light in size; yet their right selection and installation can never be neglected.

Since anchor bolts hold things and hold human lives, they must be right in quality, design and installation in order to warrant safety and reliability.

**Principles**

Anchor bolts can be classified into three (3) principle types, namely Friction, Keying and Bonding.

*Friction – Expansion*

This type of anchor bolts is represented by torque-controlled expansion anchors and push-in / deformation-controlled anchors. The former anchors character the application of torque on the nut which results in the tensile force on the bolt, pulling the expansion sleeves and thus expanding the wedges into the concrete member. In the latter anchors, conversely, the expansion takes place over a distance that is
predetermined by the geometry of the anchor in the expansion state. Inside the bolt is an expansion plug which, upon being pushed into the borehole, pushes the anchor body to expand inside the borehole. Both torque- and deformation-controlled anchors exert an expansion force against the concrete member of the borehole as a result of the displacement of a cone relative to a sleeve, permitting the longitudinal force to be transferred to the anchor by friction. Simultaneously, this expansion force causes permanent local deformation of the anchor bolts.

**Keying – Undercut**

This type of anchor bolts characterizes the bolt tip diameter expands above the borehole diameter. Upon installation, the bolt with cone is driven into the borehole and the sleeves at the bolt tip are pushed by the cone to expand towards the concrete member. This results in a mechanical interlock between the anchor bolt and the undercut concrete member.

**Bonding – Chemical**

This type of anchor bolts characterizes the usage of chemicals to bond themselves to the concrete member. The synthetic resin is poured into the pocket where the adhesive anchor embeds and infiltrates into the pores of the concrete member. After it has hardened and cured, a local keying action in addition to the bond forms.

**Failures**

Failures can happen. They are principally caused by either tensile or shear load. In tensile load, pull-out failure, concrete failure, and steel failure may occur. Shear load may cause concrete and steel failure to happen.

Pull-out failure is found in the chemical anchors, which cause is often unclean pocket. Chemical anchors demand high standard of pocket cleanliness in order to warrant proper adhesion to the concrete member in the pocket wall. After drilling, the pocket is to be blown three (3) times by dust pump and then surface polished three (3) times by steel brush for ensuring the pocket is contaminated by no dust particle during the chemical is filled into the pocket with the bolt inserted. If the pocket is not properly cleaned, the trapped dust particles may reduce the surface area of the bonding of the chemical, compromising the bond strength.

Concrete failure under tensile load is the dislodgement of the concrete member on which the anchor bolt anchors. This is caused by the decay of the strength of the concrete in result of age in conjunction with the application of excessive tensile load on the anchor bolt.

Concrete failure under shear load, conversely, can be divided into break-out and pry-out. If the anchor bolt is installed too close to the edge of the concrete member, break-out may occur whereby the edge of the concrete member from the pocket top to the depth approximate to the length of the anchor bolt may shear along the highest shear force and break. Alternatively, if the anchor bolt in anchored far from an edge, pry-out failure may happen whereby the concrete member around the pocket may shear...
along the highest shear force from the concrete surface to the bottom of the anchor bolt.

Steel failure can happen under tensile load and shear load. The former and the latter failure refer to the anchor bolt breaks along its cross section upon subject to a tensile load and the section of the bolt above the concrete surface shears from the bolt centreline respectively. It may occur if both the chemical bonding and the applied installation torque are excessive.

**Cracked Concrete**

A concrete slab bends upon subject to an external load. The top surface or the floor, to which the external load is applied, is in compression; conversely the bottom surface or the ceiling is in tension, and the tensile force pulls the concrete at the bottom apart and induces cracks. These cracks are micro in size and as small as 0.3 mm; yet they compromise the load-taking capacity of an anchor bolt. Extra attention is to be paid for choosing the suitable anchor bolts for anchoring objects on the ceiling.

**Design**

**Material**

Combating against corrosion, the anchor bolts are either galvanised or made of corrosion-resistant material.

Galvanised anchor bolts are the anchor bolts coated with 5 µm thick of zinc by electrolysis. Their relatively thin zinc coating permits the galvanised anchor bolts to be suitable for moderate environments. For harsher environments such as high humidity and permanently outdoor, the anchor bolts adopted should be hop-dip galvanised, whereby the anchor bolts were immersed into a molten zinc bath to receive a coating of 45 µm in thickness.

For more critical and corrosive environments, anchor bolts made of A2 and A4 stainless steel are suitable. A2 and A4 stainless steel for anchor bolts is equivalent to ASTM grade A304 and A316 material respectively. ASTM grade A316, is the highest corrosion-resistant commercial product in the market and, considering the rainfall environment in Hong Kong which results in 2 to 3 µm of coating erosion per annum, the local regulator for building safety, Buildings Department (BD), approves only the A4 stainless steel-made anchor bolts for outdoor fixtures. Seaside applications should also adopt A4 stainless steel.

Even so, the A2 and A4 steel materials degrade before nitrogen oxide (NO) and chlorine (Cl₂). Should anchor bolts be required to withstand the presence of NO and Cl₂, High Corrosive Resistant (HCR) material should be adopted. HCR is an alloy of copper and stainless steel, enabling the material to resist the chemical reaction of NO and Cl₂.

**Design and Spacing**
Installing anchor bolts in series does not warrant the total weight-taking capacity is the sum of each anchor bolt. If an anchor bolt locates too close to its neighbour, the concrete zones of bearing the loading of the anchor bolt, in a cone geometry, overlaps which compromises the concrete member load-bearing capacity. The cone flat is 1.5 times the embedment depth in radius on the concrete member surface. This means that to avoid overlapping the cone, the anchor bolts should be spaced minimum three (3) times of the embedment depth.

Overall, the maximum anchor capacity is determined by the anchor bolt material, anchor bolt spacing and concrete strength, and the factor with the least value prevails.

Anchor bolts suitable for seismic applications are under development. They are designed for installation on cracked concrete and tested in accordance with the required performances in seismic conditions in ACI 318 Building Code of American Concrete Institute.

Performance Requirement

To warrant the performance of an anchor bolt, its design must satisfy the requirements of Eurocode 2 / EN 1992 under European Committee for Standardization it must obtain European Technical Approval by the compliance with European Technical Approval Guideline under European Organization for Technical Approval, as represented by the “CE mark” on the product. They qualify an anchor bolt is rightly designed and constructed and hence fit for purpose.

The use of anchor bolts for fixing installations on structures shall be subject to BD approval and BD only accept the anchor bolts for application on cracked concrete irrespective of the actual installed condition. In other words, only use the anchor bolts remarked “Tensile Zone”, which means designed for applying on cracked concrete, for BD submission.

Anchor bolts are vigorously tested at shop to assure their quality and performance. By the testing of vast samples, an anchor bolt loading capacity curve is plotted following normal distribution. The 95-percentile vale is Characteristic Resistance, which is also the guaranteed performance of the anchor bolt and 1.5 times of Design Resistance. For sizing the suitable anchor bolts, the required loading shall adopt Recommended Loads which is half of Design Resistance or one-third of Characteristic Resistance. It is the BD requirement that Recommended Loads shall embed a factor of safety of 3.

Even under Recommended Loads of the same anchor bolt, the permissible loads for non-cracked concrete are higher than cracked concrete. Designer should choose the correct permissible loads according to the concrete installed is cracked or non-cracked.

Installation

With the correct selection of anchor bolts with the right specification, quality and design, proper installation is prerequisite for the anchor bolts to function as expected. The boring of the hole for the insertion of the anchor bolt must be in correct diameter and depth. Then the borehole is to be thoroughly cleaned and removed of dust and debris. If otherwise, the debris may obstruct the friction and keying types of anchor
bolts from reaching the borehole bottom and the dust may compromise the bonding of the chemical anchor bolts as described above.

For torque-controlled expansion anchors, even though the borehole provides the full embedment depth and is thoroughly cleaned, the installation is complete only with the correct application of torque. It is a common mistake that the torque-controlled expansion anchors are excessively torqued, which causes the wedges to over-expand in the concrete member and results in reduced load-taking capacity. It is essential to torque a torque-controlled expansion anchor with a torque wrench.

For deformation-controlled anchors, the common installation mistake is the expansion plug inside the anchor is not pushed to the right depth, resulting in insufficient expansion of the anchor inside the borehole. An effective solution of ensuring sufficient advancement of the expansion plug is to use the correct manual setting tool.

For adhesive anchors, in addition to the stringent cleanliness of the borehole as described, they can only be installed in dry condition and they take 12 hours to cure the synthetic resins.

The anchor bolts qualified for use in Hong Kong have been tested by the independent laboratories accredited under Hong Kong Laboratory Accreditation Scheme. Besides, BD may require the anchor bolts installed to be subject to load test on site. For each anchor bolt type used, either 1% of the total number installed or five (5) whichever lower, is tested at 1.5 times of Recommended Load.

Since installation is so critical to the integrity of the anchoring systems, the installer must be competent for the task and perform the installation with the correct procedures and tools at all time. Therefore, training is provided to the installers and qualification is granted to them to demonstrate their installation competence should their assessment on their knowledge and skills be satisfactory.

Remarks

Although small in physical size, the impact of the anchor bolts on integrity of systems and safety is significant and great effort has been made to ensure the anchor bolts, which can hold tonnes of weights at elevation safely, can be relied upon. The supply end of the anchor bolt products is backed by stringent design, testing, quality control and assurance, while the user end must size, space and install them correctly in order to finish the file mile of safe use of anchors.

IMechE-HKB thanks Mr. Isaac Mak, Head of Engineering and Ms. Fiona Kwong, Public Relations and Event Manager of HILTI (Hong Kong) Ltd. for their generous support to the evening lecture.

*** END ***

Encl.
WHT
ANCHOR DESIGN AND APPROVAL

Engineering Department
Hilti Hong Kong Ltd.
Operations in more than 120 countries

23,385 employees (at the end of 2015)

120 nationalities in the global team

60 new products released (2016)

10,000 products in the entire product portfolio
BASIC ANCHOR DESIGN
M&E CONSULTANTS ARE RELEVANT TO ANCHORS IN…..
CAPTURED LATELY.....
HAPPENING LATELY.....

【本報訊】繼上月將軍澳發生吊橋倒塌女傷命後，日前何文田豪宅半山壹號一街民裝修單位，又發生吊橋機構曲柄下壓傷兩戶主事件。該房間原本是戶主6歲女兒的睡房，幸女童仍未受傷，雖一度被吊橋機構曲柄下壓，沒任何損害。戶主其後發現該吊橋機構沒有特別鋼索固定在鋼管，質疑安全有問題，將向消費者權益及法律師向設計公司討回公道。

記者：張國威 董善華 鄧國民

【本報訊】銀行業界對現時港樓樓價猛升表示擔心，擔心樓價的持續猛升，可能對銀行業造成財務壓力。日前，香港銀行公會在一份報告中指出，樓價猛升對銀行業的財務影響可能非常重大，特別是對於那些資本充足率較低的銀行。報告指出，樓價猛升可能導致銀行的貸款資產價值下降，使銀行的資本充足率下降，增加銀行的財務風險。
ANCHOR BOLT HOLDS THINGS ... CAN ALSO HOLD HUMAN LIVES!

3 key factors to consider.....

PRODUCT is safe & reliable

DESIGN it right

INSTALL it right

Safety & Productivity
AGENDA

▪ Introduction on Anchor Bolt Theory
  ▪ Material and Design Consideration
  ▪ Anchor Performance Requirement
  ▪ Anchor Installation
  ▪ Reference from recent E&M / Civil project
  ▪ Q&A
THE 3 WORKING PRINCIPLES - DEFINITION

Friction- Expansion
The anchor expands into the concrete and is kept by friction

Keying- Undercut
At a certain point the anchor has a bigger diameter then the borehole itself

Bonding- Chemical
Bonding occurs with chemical anchors; a micro keying effect keeps the element in the borehole

Friction
Expansion

Keying
Undercut

Bonding
Chemical

Torque control
Deformation control

Mechanical Interlock

Adhesive
BASIC ANCHOR THEORY (1) – WORKING PRINCIPLES

Follow-up expansion
Torque-controlled anchor
Undercut anchor
(e.g. HSL, HST-3, HSA, HDA, HSC)

Rigid type anchors
Displacement-controlled anchor
Adhesive anchor (e.g. HKD, HKV)

Anchor Design Resistance

Characteristic Resistance (Ultimate Resistance)

Load – Displacement Curve
## FAILURE MODES

<table>
<thead>
<tr>
<th>Tensile Load</th>
<th>Concrete failure</th>
<th>Steel failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pull out failure</td>
<td>[Image]</td>
<td>[Image]</td>
</tr>
</tbody>
</table>

### Shear Load

- breakout
- pryout
Reason No. 1 for Cracks:

external loads (dead loads, changing loads, wind, snow, seismic impact, changing temperatures, etc.)

However the cause for these cracks is in the load bearing principle of reinforced concrete!!
AGENDA

- Introduction on Anchor Bolt Theory
- Material and Design Consideration
- Anchor Performance Requirement
- Anchor installation
- Reference from recent E&M / Civil project
- Q&A
Protecting a component from corrosion is a measure taken to avoid damage by corrosion with the aim of increasing the component’s service life expectancy.

**Corrosion Resistance**

<table>
<thead>
<tr>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galvanized 5μm</td>
<td>Hot Dipped Galvanized Sherardized 45μm</td>
</tr>
<tr>
<td>A2 Stainless Steel</td>
<td>A4 Stainless Steel</td>
</tr>
<tr>
<td>HCR</td>
<td></td>
</tr>
</tbody>
</table>

- Indoors with low humidity
- Outdoors for temporary applications
- Damp indoor conditions
- Slightly corrosive outdoor atmosphere
- Occasional exposure to condensation
- Indoors with heavy condensation
- Non-corrosive conditions
- Indoors with heavy condensation
- Moderately corrosive conditions
- Highly corrosive conditions

**Selection Criteria Against Corrosion**

- Common for permanent fixing
CRITICAL SPACING & EDGE DISTANCE

tension capacity = 10kN

tension capacity = 30kN ?

Base plate

Concrete
CON E EFT – T ENSI ON – O VERLAPPED C O NE

$S_{crn} = 3 \times hef$

$C_{crn} = 1.5 \times hef$

$hef = \text{effective embedment depth}$
CRITICAL SPACING AND EDGE DISTANCE
Anchor Seminar for IMechE, Mar. 07, 2018

Max. Anchor Capacity

Steel Failure Cone Failure Splitting Failure Pull-out Failure

ANCHOR CAPACITY - CANNIKIN LAW (木桶效应)
AGENDA

- Introduction on Anchor Bolt Theory
- Material and Design Consideration
- Anchor Performance Requirement
- Anchor installation
- Reference from recent E&M / Civil project
- Q&A
DESIGN AND PRODUCT QUALIFICATION

Fixing Design

European Committee for Standardization (CEN)

Eurocode 2 EN 1992

CEN/TS 1992 4.x
“Design of fastenings for use in concrete“

Product qualification

European Organization for Technical Approval (EOTA)

European Technical Approval Guideline (ETAG)

ETAG001 Annex C

European Technical Approval (ETA)

Key

 Organization
 Guideline
 Code/Standard
 Approval

Applications
<table>
<thead>
<tr>
<th>For Cracked Concrete Anchor</th>
<th>For Non-Cracked Concrete Anchor</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Static load test for cracked concrete (A3/A4)</td>
<td>✓ BS5080 tensile and shear load test</td>
</tr>
<tr>
<td>- 0.3 crack width</td>
<td>✓ ETA assessment report</td>
</tr>
<tr>
<td>- 5% fractile of ultimate loads</td>
<td>✓ Calculation report according to ETAG001 Annex C design method</td>
</tr>
<tr>
<td>- 5 test sample for each set of test</td>
<td></td>
</tr>
</tbody>
</table>
Simplified design method

Simplified version of the design method according ETAG 001, Annex C or EOTA Technical Report TR 029. Design resistance according data given in the relevant European Technical Approval (ETA):

- Influence of concrete strength
- Influence of edge distance
- Influence of spacing
- Valid for a group of two anchors. (The method may also be applied for anchor groups with more than two anchors or more than one edge. The influencing factors must then be considered for each edge distance and spacing. The calculated design loads are then on the safe side. They will be lower than the exact values according ETAG 001, Annex C. To avoid this, it is recommended to use the anchor design software PROFIS anchor)

The design method is based on the following simplification:

- No different loads are acting on individual anchors (no eccentricity)

The differences to the design method given in the guideline are shown in the following.

\[ N_{Rd,0} = N_{Rd,0}^0 \cdot f_b \cdot f_{1,N} \cdot f_{2,N} \cdot f_{3,N} \cdot f_{4,N} \]

\[ N_{Rd,0}^0 \]

Basic design concrete cone resistance

- \( f_b \) influence of concrete strength
- \( f_{1,N} \), \( f_{2,N} \) influence of edge distance
- \( f_{3,N} \) influence of anchor spacing
- \( f_{4,N} \) influence of dense reinforcement

** Values given in the respective tables in this manual.
**How to Read the Loading Tables**

**HILTI**

### Design Resistance VS Factored Load

- **Design Resistance** has a factor of safety (FOS) of 1.5.
- **Recommended loads** have a factor of safety (FOS) of 3.

### Characteristic resistance = Guaranteed performance

**HSL-3**

**Heavy duty anchor**

- **Anchor size**: Various sizes are listed.
- **Tensile V_u** and **Shear V_u** for both non-cracked and cracked concrete are provided.

### Design Resistance VS Factored Load

- **Design Resistance** has a factor of safety (FOS) of 1.5.
- **Recommended Loads** have a factor of safety (FOS) of 3.

### Rec. Load VS Unfactored Load

- **Recommended Load** has a factor of safety (FOS) of 3.

---

**Anchor Seminar for IMechE, Mar. 07, 2018**
## CRACKED CONCRETE? SHOCK LOADING?

### HSL-3 Heavy duty anchor

<table>
<thead>
<tr>
<th>Anchor size</th>
<th>Non-cracked concrete</th>
<th>Cracked concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile N_{T,un} [kN]</td>
<td>M6</td>
<td>M10</td>
</tr>
<tr>
<td>31.1</td>
<td>30.2</td>
<td>47.1</td>
</tr>
<tr>
<td>Shear V_{S,un} [kN]</td>
<td>M6</td>
<td>M10</td>
</tr>
<tr>
<td>43.2</td>
<td>42.0</td>
<td>69.4</td>
</tr>
<tr>
<td>HSL-3, HSL-3-B, HSL-3-SH, HSL-3-OH [kN]</td>
<td>M6</td>
<td>M10</td>
</tr>
<tr>
<td>23.6</td>
<td>23.5</td>
<td>38.1</td>
</tr>
<tr>
<td>Characteristic resistance</td>
<td>Non-cracked concrete</td>
<td>Cracked concrete</td>
</tr>
<tr>
<td>Anchor size</td>
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### Design resistance

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<tr>
<td>Tensile N_{T,un} [kN]</td>
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</tr>
<tr>
<td>16.6</td>
<td>16.5</td>
<td>20.5</td>
</tr>
<tr>
<td>Shear V_{S,un} [kN]</td>
<td>M6</td>
<td>M10</td>
</tr>
<tr>
<td>24.9</td>
<td>23.8</td>
<td>40.1</td>
</tr>
<tr>
<td>HSL-3, HSL-3-B, HSL-3-SH, HSL-3-OH [kN]</td>
<td>M6</td>
<td>M10</td>
</tr>
<tr>
<td>20.9</td>
<td>27.3</td>
<td>43.4</td>
</tr>
</tbody>
</table>

### Recommended loads

<table>
<thead>
<tr>
<th>Anchor size</th>
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<th>Cracked concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile N_{T,un} [kN]</td>
<td>M6</td>
<td>M10</td>
</tr>
<tr>
<td>7.8</td>
<td>7.9</td>
<td>12.9</td>
</tr>
<tr>
<td>Shear V_{S,un} [kN]</td>
<td>M6</td>
<td>M10</td>
</tr>
<tr>
<td>30.4</td>
<td>29.5</td>
<td>43.9</td>
</tr>
<tr>
<td>HSL-3, HSL-3-B, HSL-3-SH, HSL-3-OH [kN]</td>
<td>M6</td>
<td>M10</td>
</tr>
<tr>
<td>10.4</td>
<td>10.4</td>
<td>18.5</td>
</tr>
<tr>
<td>HSL-3, HSL-3-B, HSL-3-SH, HSL-3-OH [kN]</td>
<td>M6</td>
<td>M10</td>
</tr>
<tr>
<td>8.7</td>
<td>11.6</td>
<td>13.1</td>
</tr>
</tbody>
</table>

---

*(a) HSL-3-SH and HSL-3-SH is only available up to M12
(b) HSL-3-0 is only available up to M20
(c) With overall global safety factor γ = 3. The recommended loads vary according to the safety factor requirement from national regulations.*
HOW TO READ THE LOADING TABLES?

Design Load

Design Working Load
(Total FOS = 3, BD requirement)

Rel. frequency

$S_m$

$\gamma_F$ x 2

Anchor Resistance

Mean Resistance

$\gamma_M$ ÷ 1.5

5%

Design Resistance

Characteristic Resistance

Load [kN]

Responsibility of the User

Responsibility of HILTI
AGENDA

▪ Introduction on Anchor Bolt Theory
▪ Material and Design Consideration
▪ Anchor Performance Requirement
▪ Anchor Installation
▪ Reference from recent E&M / Civil project
▪ Q&A
CLASS (1) TORQUE-CONTROLLED EXPANSION ANCHOR

HSA | HST setting operations

1. [Image of drill bit and screw being inserted]
2. [Image of drill bit withdrawing as screw expands]
3. [Image of anchor fully inserted into wall]
4. [Image of anchor tightening]
CLASS (1) TORQUE-CONTROLLED EXPANSION ANCHOR

HSA | HST quality checking and inspection

Before applying torque  After applying torque  Over torqued

Standard embedment  Reduced embedment  Incorrect setting

For HSA stud anchor only

Anchor Seminar for IMechE, Mar. 07, 2018
CLASS (2) DEFORMATION-CONTROLLED EXPANSION ANCHOR

HKD | HKV setting operations

Necessary Tools

Manual setting tool
HSD-G

Mechanical setting tool
HSD-M

Anchor Seminar for IMechE, Mar. 07, 2018
HKD | HKV quality checking and inspection

Check for the right setting tool

Check setting depth

Flare feature, only for HKD-S/-SR

Easy setting for HKD-E/-ER | HKV
HOW TO ENSURE ANCHOR IS SAFE? FROM LABORS TRAINING

Installation Card Training

Certificate of Competency

10,000+ certificate issued since 2005
FROM LABORS TRAINING....

Training class includes:

1. Anchor fastening theory
2. Installation safety precaution
3. Hands-on and demo
4. Quiz
FROM ON-SITE TEST....

Scope of Accreditation

<table>
<thead>
<tr>
<th>TEST CATEGORY</th>
<th>ITEM, MATERIAL, OR PROJECT TESTED</th>
<th>SPECIFIC TEST OR PROPERTY MEASURED</th>
<th>SPECIFICATION, STANDARD METHOD OR TECHNIQUE USED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Materials</td>
<td>Concrete (diagnostic)</td>
<td>Compressive strength</td>
<td>In-house method PS-01</td>
</tr>
<tr>
<td></td>
<td>Steeled fixings (anchor bolts and rod bars)</td>
<td>Tension preload test of anchor bolts and dowel bars in the force range 320 – 100 KN &amp; 600 – 600 KN</td>
<td>In-house method PS-DPG-001 (by incremental loading) BS 1187: Part 1: 1995 Cl. 6 &amp; 7.3.2 with modification (by incremental loading)</td>
</tr>
</tbody>
</table>
Test load = Factored Design Load Capacity x 1.5

<table>
<thead>
<tr>
<th>Anchor size</th>
<th>Non-cracked concrete</th>
<th>Cracked concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M8</td>
<td>M10</td>
</tr>
<tr>
<td>Tensile $N_{tot}\text{a)}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HST</td>
<td>3.0</td>
<td>5.3</td>
</tr>
<tr>
<td>HST-R</td>
<td>3.0</td>
<td>5.3</td>
</tr>
<tr>
<td>HST-HCR</td>
<td>3.0</td>
<td>5.3</td>
</tr>
<tr>
<td>Shear $V_{tot}\text{a)}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HST</td>
<td>4.7</td>
<td>7.8</td>
</tr>
<tr>
<td>HST-R</td>
<td>4.3</td>
<td>6.7</td>
</tr>
<tr>
<td>HST-HCR</td>
<td>4.3</td>
<td>6.7</td>
</tr>
</tbody>
</table>

Recommended loads

Includes FOS = 3

\(\gamma = 3\), The recommended loads vary according to the safety factor requirement from national regulations.
AGENDA

- Introduction on Anchor Bolt Theory
- Material and Design Consideration
- Anchor Performance Requirement
- Anchor installation
- Reference from recent E&M / Civil project
- Q&A
Why HST3-R is suitable

- ETAG approved
- Suitable for cracked and non-cracked application
- With shorter embedment option
- With dynamic load test
- Test for full concrete grades

*Recommended load is based on cracked concrete C25/30, with overall factor of safety=3*
*New HST3 M10 to M16 are approved with higher tension load of 30% to 67% increase, shear load up to 27% increase, compared to HST.*
Why HUS-HR is suitable

- Fast fixing
- Medium loading
- ETAG approved
- Suitable for cracked and non-cracked application
- Can be unscrewed out
- Suitable for brick application
CAST-IN YOUR SUCCESS!

Why go for Hilti Anchor Channel (HAC)?
WHAT ARE THE COMMON ISSUES OF POST-DRILLED METHOD?

1. Dust
2. Rebar hits & re-drilling
3. Falling object
4. Work-at-height
WHAT IS THE TURNING POINT?
REGULAR AND CONSISTENT FASTENING POINTS

Along the 3 corridors (60m long) in each floor!
(Blue area)
FROM POST-DRILLED TO CAST-IN
HILTI ANCHOR CHANNEL SYSTEM (HAC)
A PROVEN PRACTICAL APPROACH

Anchor Seminar for IMechE, Mar. 07, 2018

"Cast-In" method proven to boost construction site efficiency and safety

Enhancing workers’ safety at construction design and planning

The government has announced its focus on increasing funding supply at the annual Shadow Address, aiming to provide over €400,000 million through various local supply initiatives. While the construction industry is growing continuously, the increasing demand and tight schedule of projects has prompted the construction industry to adopt innovative solutions to enhance safety and boost productivity.

A new technology known as Cast-In Channel designs have been brought to the market by the innovation team at Techno-Steel to bring to the market a new innovative forming method for EA (End Anchors). Considering the property owners (developers) preference on construction quality and high level of cost control, Gamma Construction, the main contractor, found Cast-In Channel designs in the solution to ensure a safer and dustless working environment, which proves to be more productive.

The Cast-In Channel technology has been implemented in a project, such as a multi-storey building in the facade industry and geothermal lining in diverse industries.

A dust-free environment, no more hole-drilling at height

The bounded and unbounded installation space in common construction, make traditional point drilled Anchor panel difficult to apply to this project. We have been looking for a future-proof solution since the beginning of this project. Thanks for the Cast-In Channel designs in the answer,” said Victor Tra, Deputy Project Manager at Gamma Construction. Developed by Techno-Steel, a leading manufacturer of concrete protection anchor fastening systems, the Cast-In Channel enables the new Anchor mounting height, as well as possible span and work fatigue. Since the channel is cast into concrete, workers will only need to use the beam from it and insert a bolt to bolt for less fatigue. This simplified procedure can streamline work procedures and help prevent re-occurring problems caused by re-hitting issues, it also solves the problem of uneven installation space by restricting the usage of seasoned working platforms and allowing workers to perform other tasks.

Hilti Cast-In Channel method procedures

The channel contains six series, "Quite 35% of the usual load has been used for the same task. Moreover, holes needed to be drilled for this project was significantly reduced by over 80%, which helped the future to maintain and improved working conditions."

Workers: it is much safer and faster for us!

Workers have reported the efficiency of the Cast-In Channel anchor system is more successful than Hilti’s standard Anchor Panel system, which dramatically reduces the risk of injury. The process is also much safer,” said Mr. Liu, a foreman worker at the data center project. "Working in a pressure demanding environment, health and safety always come first, while we are now safer, free from muscle strain for more hole drilling. More importantly, the chances of getting injured had also significantly reduced."

Victor Tra looks forward to a wider application of technology in construction industry. "The satisfying results demonstrated how we can bring Cast-In Channel to life. We hope the whole industry will pull hand to promote a safer working culture, and the Cast-In method is definitely a great move for all of us to bring the safety performance to the next level."
WE LEARNT FROM THE GLOBAL BEST PRACTICE OF USING HAC CHANNEL

Curtain wall
- US
- Switzerland
- Germany
- China
- **Hong Kong**

E&M services
- Sweden - Pharmaceutical plant & hospital
- Saudi Arabia – Refinery plant
- China – Railway
- **Hong Kong – Data center**

Elevator
- Switzerland
- Germany
- India
- Saudi Arabia
- China
- **Hong Kong**
Q&A