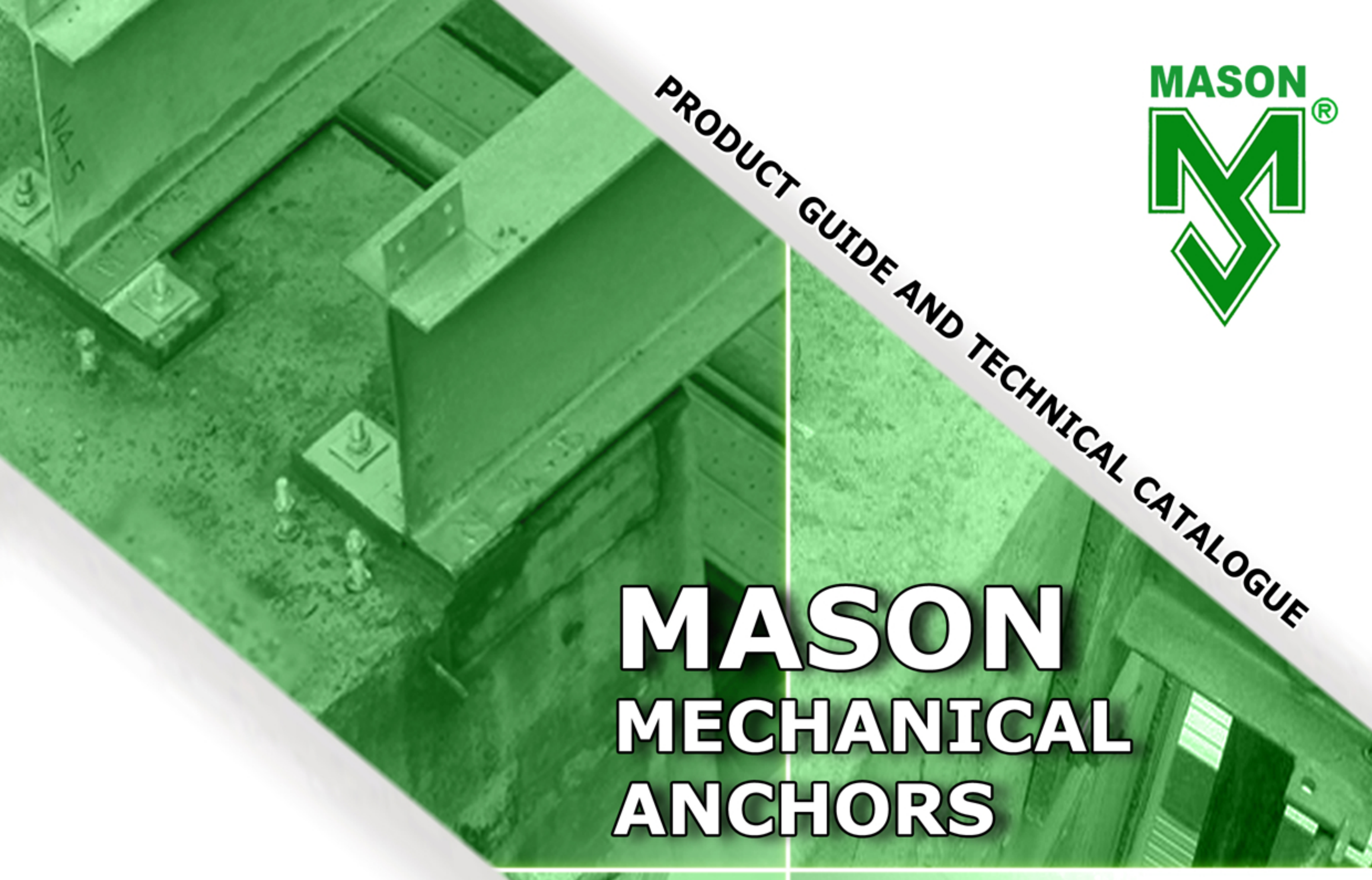


MASON

PRODUCT GUIDE AND TECHNICAL CATALOGUE

MASON MECHANICAL ANCHORS

ISO 9001 BSMI

TÜV MANAGEMENT SERVICE ISO 9002

ETA CE

UL

QMI REGISTERED

FM

CNLA

HOUSING & DEVELOPMENT BOARD

SETSCO

COMPANY PROFILE

ABOUT US

Fasten Enterprises Pte Ltd (Group) was incepted in 1977, with the sole objective of providing high quality and reliable fastening system alongside with other construction and engineering products and service for various usages across different industries in major cities and countries around the world.

Over the years, the company has matured and evolved. We have established well-interconnected sales networks in many countries across South East Asia (SEA). Through those sales networks, we have trained more than 150 dedicated professionals across different countries and industries with a wide spectrum of expertise.

With continuous commitment to total quality management and business excellence, Fasten Enterprises Pte Ltd (Group) was able to establish our presence as a global leader in the SEA region through collective and collaborative effort with our valuable customers and business partners. We are able to provide a wide-range of products and services that are designed to enhance productivity, while offering the benefits of safety and efficiency.

At Fasten Enterprises Pte Ltd (Group), we pledged to build better societies and to share a greater environmental responsibility to ensure that the current resources are able to meet the needs of our future generations. We adapt to changes rapidly and continuously strive to provide innovative products geared to the market's requirements, and foster excellent business relationships with our business partners and customers.

OUR MISSION STATEMENT

Fasten Enterprises Pte Ltd (Group) is a global leader that is committed to establishing long-term relationships based on integrity, performance, value, and customer satisfaction. To exceed industry expectations and gain reputable recognitions, we are committed to providing professional solutions that are cost-effective and efficient to meet the ever-changing needs of our society and valuable customers.

OUR PARTICIPATION IN MAJOR PROJECTS

MARINA BAY SANDS



GARDEN BY THE BAY



SINGAPORE SPORT HUB



CHANGI AIRPORT TERMINAL 1, 2, 3 & 4



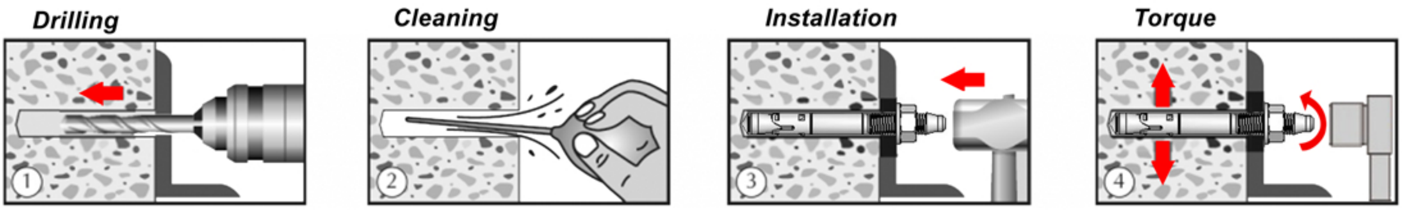
SINGAPORE HDBs & MRT STATIONS



EXPANSION ANCHORS - Technical Overview

All mechanical anchors for use in concrete works on the same basic principle: (1) Drill a specific sized hole (2) Clean the drilled hole (3) Insert the anchor into the pre-drilled hole (4) Expand the anchor via displacement or torque to be larger than the predrilled hole (5) The frictional force generated from the anchor and concrete will resist the pull out force. As an anchor is loaded to its ultimate loading capacity, displacement of the mechanical anchor in relative to the base material will occur. The amount of displacement will be affected by the anchor preload, the design of the mechanical anchor and the base material.

INSTALLATION



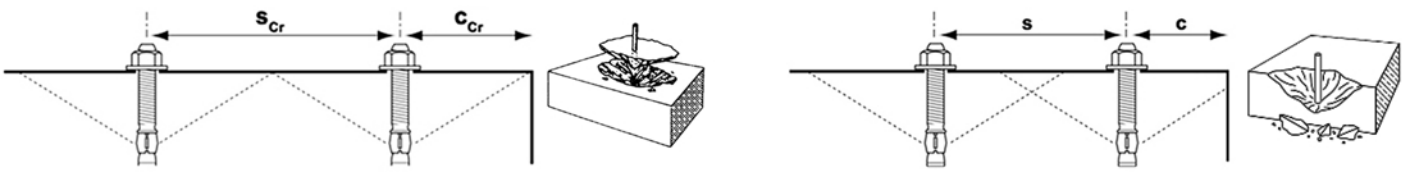
It is essential that all anchors are installed correctly as specified in the installation procedure to achieve the stated performance values.

Drilling: Appropriate tools & equipment must be used to meet the required drilling diameter and embedment depth.

Cleaning of the Hole: The holes are required to be brushed and blown out to remove the maximum amount of dust and debris.

Installation of the Anchor: The Anchor must be installed in accordance to the technical specification.

Installation torque: Applying tightening torque in accordance to the technical specification sizes would ensure a clamping force that is greater than the stipulated working loads. The applied tightening torque must not exceed the installation torque as it will over stress both the anchor and the base material; which may result in the steel failure of the anchor. .



Edge and Spacing distances: Mechanical expansion anchor transmit expansion forces by locally compressing the base material. The forces are exerted at the point of expansion not over the total length of the fixing. The performance of the anchor is related to the projected area within the concrete cone. As the embedment depth increases, the concrete cone size will increase; thus, improving the performance of the anchor. There must be minimal influence between the based material edge distance and spacing distance with another anchor. Any reduction in the projected area will result in decrease in performance. Where there is a requirement to call for the reduction of spacing or edge distances, a reduction factor should be applied to the recommended load resistance of the anchor.

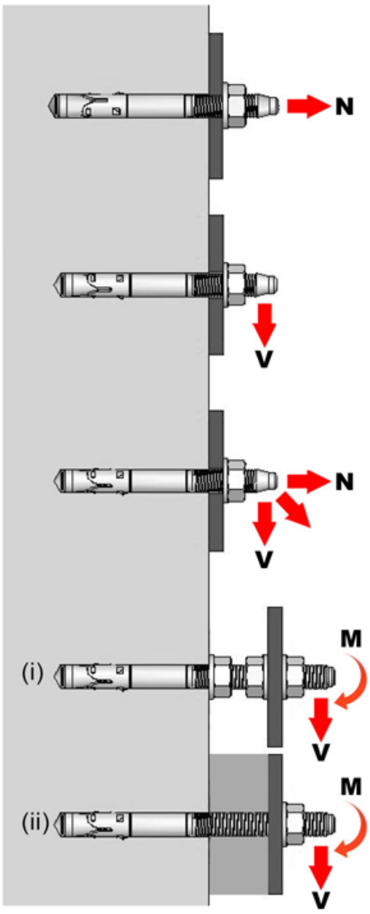
Use of serrated or adequated washers for slotted holes: When fixing anchor bolts through slotted holes it is important to ensure that there is adequate surface contact between the washer and the fixture to guarantee positive clamping force.

BASE MATERIAL

It is important to understand the difference in installing anchors into different base materials. The process and holding values will differ depending on the based material used. On-site testing should be arranged to verify and confirm the suitability and loading capacity of the selected anchor.

MASON MECHANICAL ANCHOR

LOAD DIRECTION



During the selection of an appropriate anchor, all direction of loads applied must be taken into consideration.

Tensile pullout loads, N: Pullout loads are applied along the axis of the fixing. Common examples are dead loads applied on ceiling applications or wind loads on anchor used to fix brackets on to vertical surfaces. Pullout resistance is influenced by the anchorage depth of drilled hole and tightening torque.

Shear loads, V: Shear loads are applied at right angles to the axis of a fixing and directly against the face of the load bearing structure. Shear resistance is influenced by the steel shear strength of the anchor material and the compressive strength of the load bearing structure.

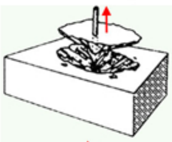
Combined loads: Combined loads are the combination of pullout and shear loads. If the angle of combined load is within 10 degrees of pure shear or pullout load, then the safe working load for the direction may be taken into consideration. Otherwise the applied combination loads should be resolved into its pullout and shear load.

Offset (stand-off) loads: It is also known as 'Lever Arm' applications are applied at right angles on the fixing axis but are offset from the surface. There are two types as
(i) Clamped to the wall and
(ii) Filled with mortar layer (grouting layer)
In all situation the deflection of the anchor bolt due to bending moment needs to be considered as well as the shear capacity of the bolt.

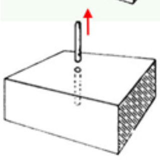
MODE OF FAILURE

Tensile Load, N | *Shear Load, V*

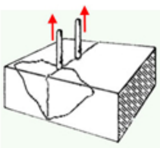
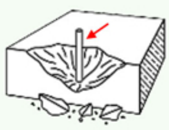
The following mode of failure can occur when an anchor is loaded to its ultimate capacity:



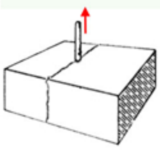
a) Concrete cone failure
- Anchor is loaded to its ultimate tensile capacity.
- Applied load is greater than the compessive strength of base material.
- Anchors installed at a shallow embedment depth.



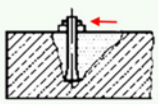
b) Anchor pullout (Slippage) failure
- Incorrect installation or an anchor is loaded to its ultimate capacity.

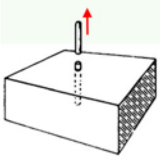
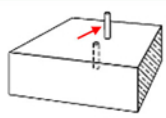
c) Disruption failure
- Incorrect base material dimensioning.
- Anchors installed close to an unsupported edge (free edge).
- An anchor installed close to another anchor (less than recommended spacing).
- High expansion mechanism by the applied load.



d) Splitting failure
- Insufficient base material dimensioning include the thickness and the width.



e) Concrete pry-out failure
- Anchor is loaded to its ultimate shear capacity.
- Applied load is greater than the compessive strength of base material.
- Anchors installed at a shallow embedment depth.

f) Anchor material (steel) failure
- Insufficient anchor bolt material resistance.
- Loads exceed steel yield strength.

MASON MECHANICAL ANCHOR

CORROSION RESISTANCE

MASON Mechanical Anchor comes with various types of plating, coating or materials so as to meet the required corrosion resistance.

QUALITY ASSURANCE

MASON Mechanical Anchors are produced in accordance to the strict control of ISO 9001, ISO 9002 and the German TUV Certification. Our quality assurance processes require every product produced be inspected not only by the machinery operator but also by our quality assurance team.

ISO 9001 BSMI · TÜV ISO 9002 · ETA · CE · UL · QMI REGISTERED · FM · CNLA · HOUSING & DEVELOPMENT BOARD · SETSCO · ASIAN INSTITUTE OF TECHNOLOGY 1959

QUICK SELECTION GUIDE

Anchor Types (H - Heavy Duty, M- Medium Duty, L - Light Duty)			Fastening Base Materials							Coatings & Anchor Materials					Page
			(1) Solid Concrete	Lightweight Concrete	(2) AAC	(2) Hollow-core Concrete	Solid Brick	Hollow Brick	(2) Gypsum Board	Galvanized Carbon Steel	Yellow Zinc Chrome Carbon Steel	(3) Hot Dipped Galv. Carbon Steel	SUS 304 (A2)	SUS 316 (A4)	No.
H M L		Wedge Anchor	★							★		★	★	★	1
H M L		Set Anchor	★							★	★	★	★	★	6
M L		Sleeve Anchor	★	★	★		★			★		★	★	★	11
M L		Hammer Hit Anchor	★							★	★	★	★	★	14
M L		Drop In Anchor	★							★		★	★	★	17
L		Tie Wire Anchor	★	★			★			★	★	★	★	★	22
L		Hammer Drive Anchor	★	★	★	★	★	★		★ Zinc Alloy Body					23
L		Nylon Anchor	★	★	★		★	★		★ Nylon Plug			★ Nylon Plug	★ Nylon Plug	24
L		Gravity Anchor				★			★	★		★			25

(1) Non-cracked concrete compressive strength minimum C20/25 (Cylindrical test sample 20 N/mm² and Cube test sample 25 N/mm²).
(2) On site demo-installation and pullout testing may be required to verify the suitability of anchor and fastening base.
(3) Non-stock items. Please check for stock availability.

WEDGE ANCHOR

- Medium to heavy duty fixing
- Simple and quick installation

Carbon steel (Galvanised to 5 micron)
Carbon steel (Hot-dipped galvanised)

Stainless steel A2-70 (SUS 304)
Stainless steel A4-70 (SUS 316)

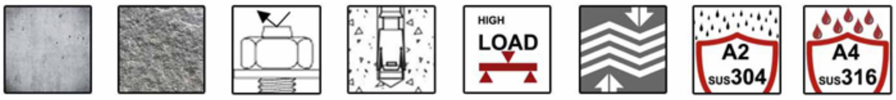
European Technical Approval

HOUSING & DEVELOPMENT BOARD
HDB Approved Material

SETSCO Tested

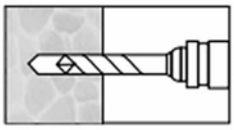
King Mongkut Institute of Technology Ladkrabang Thailand Tested

ISO Quality Certified Product

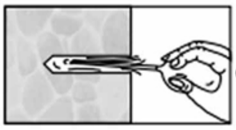


Concrete | Hard Stone | Anti-Thread Damaged Dot Point | Anti-Rotation Expansion Clip | High Load | Vibration Resistance | Corrosion Resistance | Higher Corrosion Resistance

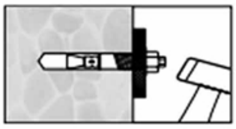
SETTING PROCEDURES



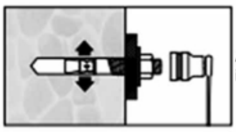
Drill a hole of required diameter and depth.



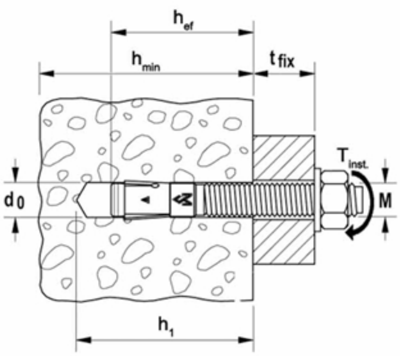
Clean the drilled hole.



Drive anchor into the drilled hole.



Apply the required installation torque.



SELECTION CHART

Anchor Size	(mm)		M6		M8			
Anchor diameter x length	M x L	mm	6 x 65	6 x 85	8 x 65	8 x 80	8 x 90	8 x 120
Thread length	L_1	mm	30	50	30	40	55	85
Max Fixture Thickness	t_{fix}	mm	10	25	15	30	40	65

Anchor Size	(mm)		M10					
Anchor diameter x length	M x L	mm	10 x 65	10 x 80	10 x 90	10 x 100	10 x 120	10 x 140
Thread length	L_1	mm	25	35	45	55	75	95
Max Fixture Thickness	t_{fix}	mm	10	15	25	35	55	75

Anchor Size	(mm)		M12						
Anchor diameter x length	M x L	mm	12 x 80	12 x 90	12 x 100	12 x 110	12 x 120	12 x 140	12 x 150
Thread length	L_1	mm	30	40	50	60	70	90	100
Max Fixture Thickness	t_{fix}	mm	10	10	20	30	40	60	70

Anchor Size	(mm)		M16						
Anchor diameter x length	M x L	mm	16x100	16x110	16x125	16x145	16x160	16x180	16x220
Thread length	L_1	mm	40	55	65	85	95	95	150
Max Fixture Thickness	t_{fix}	mm	10	20	25	45	60	80	160

Anchor Size	(mm)		M20		
Anchor diameter x length	M x L	mm	20 x 145	20 x 160	20 x 200
Thread length	L_1	mm	85	95	100
Max Fixture Thickness	t_{fix}	mm	35	35	100

SETTING PARAMETERS

Anchor Size	(mm)		M6	M8	M10	M12	M16	M20
Anchor diameter	M	(mm)	6	8	10	12	16	20
Drill bit diameter	d_0	(mm)	6	8	10	12	16	20
Depth of Drilled Hole	h_1	(mm)	55	65	80	95	115	140
Effective Anchorage Depth	h_{ef}	(mm)	35	45	60	70	85	100
Min. Base Material Thickness	h_{min}	(mm)	80	100	120	140	170	200
Minimum edge distance	c_{min}	(mm)	35	50	60	60	80	140
Critical edge distance	c_{cr}	(mm)	68	72	90	105	128	152
Minimum spacing distance	s_{min}	(mm)	35	50	60	60	80	100
Critical spacing distance	s_{cr}	(mm)	100	135	180	210	255	300
Installation torque	$T_{inst.}$	(Nm)	10	20	45	65	130	180

WEDGE ANCHOR

Basic Loading Data For Single Anchor

- Non-cracked concrete C20/25, $f_{ck,cube}$ = 25 N/mm²
- Correct setting
- No spacing and edge distance influence

Tensile Resistance

Anchor Size	(mm)	M6	M8	M10	M12	M16	M20
Ultimate Strength	$N_{Ru,m}$ (kN)	9.1	16.2	22.5	28.8	47.6	71.4
Characteristic Strength	N_{Rk} (kN)	7.6	13.5	18.7	24.0	39.7	59.5
Design Strength	N_{Rd} (kN)	4.2	7.5	10.4	13.3	22.0	33.0
Recommended Strength	N_{Rec} (kN)	3.0	5.3	7.4	9.5	15.7	23.6

$N_{Rd} = N_{Rk} / \gamma_{Mc,N}$ [$\gamma_{Mc,N}$ = 1.8]

$N_{Rec} = N_{Rk} / \gamma_{Mc,N} \cdot \gamma_F$ [$\gamma_{Mc,N}$ = 1.8] [γ_F = 1.4]

Shear Resistance

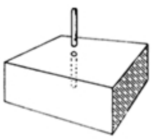
Anchor Size	(mm)	M6	M8	M10	M12	M16	M20
Ultimate Strength	$V_{Ru,m}$ (kN)	6.3	13.5	21.9	33.0	51.0	73.2
Characteristic Strength	V_{Rk} (kN)	5.2	11.2	18.2	27.5	42.5	61.0
Design Strength	V_{Rd} (kN)	3.5	7.5	12.2	18.3	32.7	46.9
Recommended Strength	V_{Rec} (kN)	2.5	5.3	8.7	13.1	23.4	33.5

$V_{Rd} = V_{Rk} / \gamma_{Ms,V}$ [$\gamma_{Ms,V}$ = 1.5]

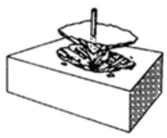
$V_{Rec} = V_{Rk} / \gamma_{Ms,V} \cdot \gamma_F$ [$\gamma_{Ms,V}$ = 1.5] [γ_F = 1.4]

TENSILE - Concrete Capacity CC Design Method

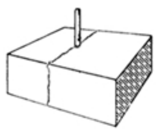
Design tensile resistance $N_{Rd} = \min (N_{Rd,p} ; N_{Rd,c} ; N_{Rd,sp} ; N_{Rd,s})$



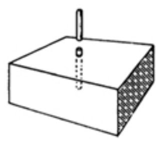
$N_{Rd,p} = N^0_{Rd,p} * f_B$



$N_{Rd,c} = N^0_{Rd,c} * f_{1,N} * f_{2,N} * f_{3,N} * f_B$



$N_{Rd,sp} = N^0_{Rd,c} * f_{1,sp} * f_{2,sp} * f_{3,sp} * f_B$



$N_{Rd,s}$

Design Pull-out Resistance, $N_{Rd,p}$

Anchor Size		M6	M8	M10	M12	M16	M20
$N^0_{Rd,p}$	(kN)	4.2	7.5	10.4	13.3	22.0	33.0

Design Concrete Cone Resistance, $N_{Rd,c}$
Design Splitting Resistance, $N_{Rd,sp}$

Anchor Size		M6	M8	M10	M12	M16	M20
$N^0_{Rd,c}$	(kN)	5.8	10.3	14.4	18.5	24.8	37.2

Design Steel Resistance, $N_{Rd,s}$

Anchor Size		M6	M8	M10	M12	M16	M20
$N_{Rd,s}$ (property class 5.8)	(kN)	5.6	8.7	13.8	20.1	34.1	40.8
$N_{Rd,s}$ (property class 8.8)	(kN)	7.8	12.2	19.3	28.1	47.8	57.2
$N_{Rd,s}$ (stainless steel A4-70)	(kN)	7.2	11.7	18.6	27.0	41.9	56.0

WEDGE ANCHOR

INFLUENCING FACTORS

Influence of Concrete Strength

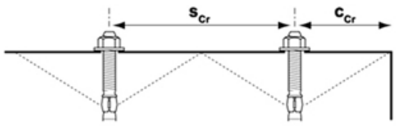
Concrete Strength Designation (ENV 206)	C 20/25	C 25/30	C 30/37	C 35/45	C 40/50	C 45/55	C 50/60
$f_B = (f_{ck.cube} / 25N/mm^2)$	1.00	1.10	1.22	1.34	1.41	1.48	1.55

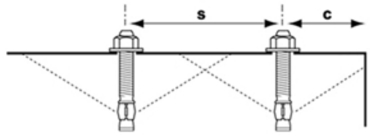
$f_{ck,cube}$ = 150mm concrete cube compressive strength

Influence of edge distance[1)]

c/c_{cr}	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$f_{1,N} = 0.7 + 0.3 * c/c_{cr} = 1$ $f_{1,sp} = 0.7 + 0.3 * c/c_{cr} = 1$	0.73	0.76	0.79	0.82	0.85	0.88	0.91	0.94	0.97	1.00
$f_{2,N} = 0.5 * (1 + c/c_{cr}) = 1$ $f_{2,sp} = 0.5 * (1 + c/c_{cr}) = 1$	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00

1) The above influencing factors must apply for every edge distance smaller than critical edge distance c_{cr}. Actual edge distance shall not be smaller than minimum edge distance c_{min}.





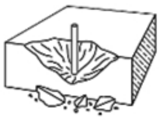
Influence of anchor spacing [2)]

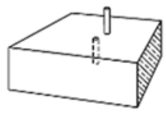
s/s_{cr}	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$f_{3,N} = 0.5 * (1 + s/s_{cr,N}) = 1$ $f_{3,sp} = 0.5 * (1 + s/s_{cr,sp}) = 1$	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00

2) The above influencing factors must apply for every anchor spacing smaller than critical spacing distance s_{cr}. Actual anchor spacing distance shall not be smaller than minimum spacing distance s_{min}.

SHEAR - Concrete Capacity CC Design Method

Design shear resistance V_{Rd} = **min** ($V_{Rd,c}$; $V_{Rd,cp}$; $V_{Rd,s}$)





$V_{Rd,c} = V^0_{Rd,c} * f_{\beta} * f_{sc} * f_B$	$V_{Rd,cp} = V^0_{Rd,cp} * f_{1,N} * f_{2,N} * f_{3,N} * f_B$	$V_{Rd,s}$

Design Concrete Edge Resistance, $V_{Rd,c}$

Anchor Size		M6	M8	M10	M12	M16	M20
$V^0_{Rd,c}$	(kN)	2.2	2.4	4.6	9.6	11.0	15.1

Design Concrete Pryout Resistance, $V_{Rd,cp}$

Anchor Size		M6	M8	M10	M12	M16	M20
$V^0_{Rd,cp}$	(kN)	5.7	12.3	19.9	30.0	46.4	66.5

Design Steel Resistance, $V_{Rd,s}$

Anchor Size		M6	M8	M10	M12	M16	M20
$V_{Rd,s}$ (property class 5.8)	(kN)	3.5	7.5	12.2	18.3	32.7	46.9
$V_{Rd,s}$ (property class 8.8)	(kN)	6.5	11.2	18.8	28.0	44.0	67.2
$V_{Rd,s}$ (stainless steel A4-70)	(kN)	6.0	10.4	16.0	24.0	38.5	41.7

Mason

WEDGE ANCHOR

INFLUENCING FACTORS

Influence of Concrete Strength

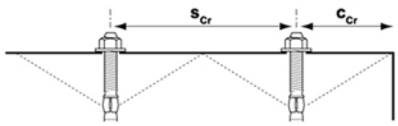
Concrete Strength Designation (ENV 206)	C 20/25	C 25/30	C 30/37	C 35/45	C 40/50	C 45/55	C 50/60
$f_B = (f_{ck.cube} / 25N/mm^2)$	1.00	1.10	1.22	1.34	1.41	1.48	1.55

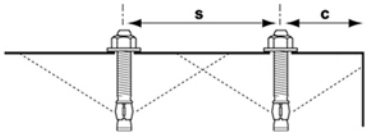
$f_{ck,cube}$ = 150mm concrete cube compressive strength

Influence of edge distance[1)]

c/c_{cr}	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$f_{1,N} = 0.7 + 0.3 * c/c_{cr} = 1$	0.73	0.76	0.79	0.82	0.85	0.88	0.91	0.94	0.97	1.00
$f_{2,N} = 0.5 * (1 + c/c_{cr}) = 1$	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00

1) The above influencing factors must apply for every edge distance smaller than critical edge distance c_{cr}. Actual edge distance shall not be smaller than minimum edge distance c_{min}.



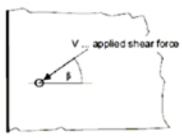


Influence of anchor spacing [2)]

s/s_{cr}	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$f_{3,N} = 0.5 * (1 + s/s_{cr,N}) = 1$	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00

2) The above influencing factors must apply for every anchor spacing smaller than critical spacing distance s_{cr}. Actual anchor spacing distance shall not be smaller than minimum spacing distance s_{min}.

Influence of shear loading angle

Angle β	0°	10°	20°	30°	40°	50°	60°	70°	80°	=90°
f_β 	1.00	1.01	1.05	1.13	1.24	1.40	1.64	1.97	2.32	2.50

Influence of anchoring spacing and edge distance for concrete edge resistance

Formula for single-anchor fastening influenced only by edge

$$f_{sc} = \frac{c}{c_{min}} \sqrt{\frac{c}{c_{min}}}$$

For Single Anchor

C/C_{min}	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
f_{sc}	1.0	1.3	1.7	2.0	2.4	2.8	3.3	3.7	4.2	4.7	5.2	5.7	6.3	6.8	7.4	8.0

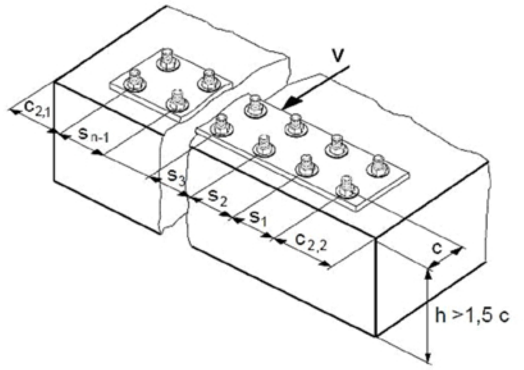
WEDGE ANCHOR

Formula for two-anchor fastening valid for S<3c

$$f_{sc} = \frac{3c+s}{6c_{min}}\sqrt{\frac{c}{c_{min}}}$$

General formula for n-anchor fastening (edge plus n-1 spacing) only valid where s_1 to s_{n-1} are all < 3c and c_2 > 1.5c

$$f_{sc} = \frac{3c+s_1+s_2+\cdots+s_{n-1}}{3nc_{min}}\sqrt{\frac{c}{c_{min}}}$$



Note: It is assumed that only the row of anchors closed to the free concrete edge carries the centric shear load.

For 2 anchors

S/C$_{min}$ \ C/C$_{min}$	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
1.0	0.67	0.84	1.03	1.22	1.43	1.65	1.88	2.12	2.36	2.62	2.89	3.16	3.44	3.73	4.03	4.33
1.5	0.75	0.93	1.12	1.33	1.54	1.77	2.00	2.25	2.50	2.76	3.03	3.31	3.60	3.89	4.19	4.50
2.0	0.83	1.02	1.22	1.43	1.65	1.89	2.13	2.38	2.63	2.90	3.18	3.46	3.75	4.05	4.35	4.67
2.5	0.92	1.11	1.32	1.54	1.77	2.00	2.25	2.50	2.77	3.04	3.32	3.61	3.90	4.21	4.52	4.83
3.0	1.00	1.20	1.42	1.64	1.88	2.12	2.37	2.63	2.90	3.18	3.46	3.76	4.06	4.36	4.68	5.00
3.5		1.30	1.52	1.75	1.99	2.24	2.50	2.76	3.04	3.32	3.61	3.91	4.21	4.52	4.84	5.17
4.0			1.62	1.86	2.10	2.36	2.62	2.89	3.17	3.46	3.75	4.05	4.36	4.68	5.00	5.33
4.5				1.96	2.21	2.47	2.74	3.02	3.31	3.60	3.90	4.20	4.52	4.84	5.17	5.50
5.0					2.33	2.59	2.87	3.15	3.44	3.74	4.04	4.35	4.67	5.00	5.33	5.67
5.5						2.71	2.99	3.28	3.57	3.88	4.19	4.50	4.82	5.15	5.49	5.83
6.0						2.83	3.11	3.41	3.71	4.02	4.33	4.65	4.98	5.31	5.65	6.00
6.5							3.24	3.54	3.84	4.16	4.47	4.80	5.13	5.47	5.82	6.17
7.0								3.67	3.98	4.29	4.62	4.95	5.29	5.63	5.98	6.33
7.5									4.11	4.43	4.76	5.10	5.44	5.79	6.14	6.50
8.0										4.57	4.91	5.25	5.59	5.95	6.30	6.67
8.5											5.05	5.40	5.75	6.10	6.47	6.83
9.0											5.20	5.55	5.90	6.26	6.63	7.00
9.5												5.69	6.05	6.42	6.79	7.17
10.0													6.21	6.58	6.95	7.33
10.5														6.74	7.12	7.50
11.0															7.28	7.67
11.5																7.83
12.0																8.00

COMBINED LOAD - Tension and Shear

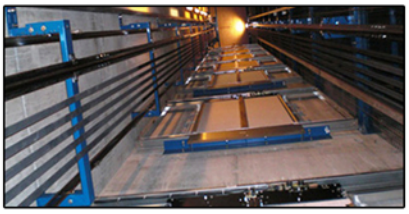
$\beta_N = N_{sd} / N_{Rd} \leq 1$ (N_{sd} =Tensile design action)

$\beta_V = V_{sd} / V_{Rd} \leq 1$ (V_{sd} = Shear design action)

Design check: $\beta_N + \beta_V \leq 1.2$ or $\beta_N^{\alpha} + \beta_V^{\alpha} \leq 1$ (α = 1.5 for all failure mode)

SET ANCHOR

- Medium to heavy duty applications
- Vibration (Live Load) resistance
- Versatile and durable



Carbon steel (Galvanised to 5 micron)
Carbon steel (Hot-dipped galvanised)
Carbon steel (Yellow zinc chromate)

Stainless steel A2-70 (SUS 304)
Stainless steel A4-70 (SUS 316)

Hammer set tool

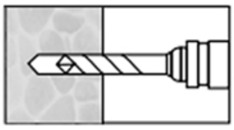
SETSCO Tested

AIT Thailand Tested

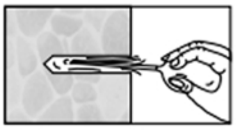
ISO Quality Certified Product

Concrete | Hard Stone | Heavy Duty Expansion Sleeve | Anti-Loose Spring Lock Washer | High Load | Vibration Resistance | Corrosion Resistance | Higher Corrosion Resistance

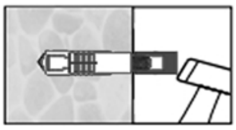
SETTING PROCEDURES



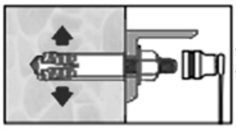
Drill a hole of required diameter and depth.



Clean the drilled hole.



Drive anchor into the drilled hole. Expand the sleeve with the setting tool.



Tighten the anchor to the specified torque.

SELECTION CHART

Designation		Anchor Size	Thread Length	Expansion Sleeve Length
		(mm)	(mm)	(mm)
MSA	6 x 50	6	25	28
MSA	8 x 60	8	25	35
MSA	8 x 65	8	25	35
MSA	10 x 70	10	30	40
MSA	10 x 80	10	40	40
MSA	12 x 100	12	50	50
MSA	12 x 120	12	70	50
MSA	16 x 100	16	40	60
MSA	16 x 120	16	60	60
MSA	16 x 160	16	100	60
MSA	20 x 160	20	80	80
MSA	20 x 200	20	100	80
MSA	20 x 250	20	150	100
MSA	24 x 200	24	100	110

SETTING PARAMETERS

Anchor Size	(mm)		M6	M8	M10	M12	M16	M20	M24
Expansion sleeve dia.	D	(mm)	9.5	12	14	17.3	21.7	25.4	32
Drill bit diameter	d_0	(mm)	10	12	14.5	18	22	26	33
Effective anchorage depth	h_{ef}	(mm)	30	40	50	60	70	110	125
Minimum edge distance	c_{min}	(mm)	50	60	73	90	110	130	165
Critical edge distance	c_{cr}	(mm)	120	144	174	216	264	312	396
Minimum spacing distance	s_{min}	(mm)	50	60	73	90	110	130	165
Critical spacing distance	s_{cr}	(mm)	100	120	145	180	220	260	330
Installation torque	$T_{inst.}$	(Nm)	10	20	45	65	130	180	200

SET ANCHOR

Basic Loading Data For Single Anchor

- Non-cracked concrete C20/25, $f_{ck,cube}$ = 25 N/mm²
- Correct setting
- No spacing and edge distance influence

Tensile Resistance

Anchor Size	(mm)	M6	M8	M10	M12	M16	M20	M24
Ultimate Strength	$N_{Ru,m}$ (kN)	9.1	12.9	21.1	36.8	45.9	55.1	91.3
Characteristic Strength	N_{Rk} (kN)	7.3	10.3	16.9	29.4	36.7	44.1	73.0
Design Strength	N_{Rd} (kN)	4.1	5.7	9.4	16.3	20.4	24.5	40.5
Recommended Strength	N_{Rec} (kN)	2.9	4.1	6.7	11.7	14.6	17.5	29.0

$N_{Rd} = N_{Rk} / \gamma_{Mc,N}$ [$\gamma_{Mc,N} = 1.8$]

$N_{Rec} = N_{Rk} / \gamma_{Mc,N} \cdot \gamma_F$ [$\gamma_{Mc,N} = 1.8$] [$\gamma_F = 1.4$]

Shear Resistance

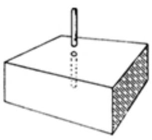
Anchor Size	(mm)	M6	M8	M10	M12	M16	M20	M24
Ultimate Strength	$V_{Ru,m}$ (kN)	6.0	10.0	14.8	25.5	39.0	64.0	75.0
Characteristic Strength	V_{Rk} (kN)	5.7	9.5	14.1	24.2	37.1	60.8	71.3
Design Strength	V_{Rd} (kN)	3.8	6.3	9.4	16.1	24.7	40.5	47.5
Recommended Strength	V_{Rec} (kN)	2.7	4.5	6.3	11.5	17.6	28.9	33.9

$V_{Rd} = V_{Rk} / \gamma_{Ms,V}$ [$\gamma_{Ms,V} = 1.5$]

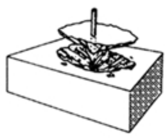
$V_{Rec} = V_{Rk} / \gamma_{Ms,V} \cdot \gamma_F$ [$\gamma_{Ms,V} = 1.5$] [$\gamma_F = 1.4$]

TENSILE - Concrete Capacity CC Design Method

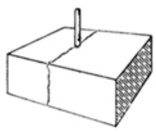
Design tensile resistance $N_{Rd} = \min (N_{Rd,p} ; N_{Rd,c} ; N_{Rd,sp} ; N_{Rd,s})$



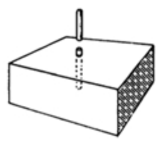
$N_{Rd,p} = N^0_{Rd,p} * f_B$



$N_{Rd,c} = N^0_{Rd,c} * f_{1,N} * f_{2,N} * f_{3,N} * f_B$



$N_{Rd,sp} = N^0_{Rd,c} * f_{1,sp} * f_{2,sp} * f_{3,sp} * f_B$



$N_{Rd,s}$

Design Pull-out Resistance, $N_{Rd,p}$

Anchor Size		M6	M8	M10	M12	M16	M20	M24
$N^0_{Rd,p}$	(kN)	4.1	5.7	9.4	16.3	20.4	24.5	40.5

Design Concrete Cone Resistance, $N_{Rd,c}$
Design Splitting Resistance, $N_{Rd,sp}$

Anchor Size		M6	M8	M10	M12	M16	M20	M24
$N^0_{Rd,c}$	(kN)	5.6	7.9	13.0	22.6	28.2	33.9	56.2

Design Steel Resistance, $N_{Rd,s}$

Anchor Size		M6	M8	M10	M12	M16	M20	M24
$N_{Rd,s}$ (property class 5.8)	(kN)	5.6	8.7	13.8	20.1	34.1	40.8	75.0
$N_{Rd,s}$ (stainless steel A4-70)	(kN)	7.2	11.7	18.6	27.0	41.9	56.0	82.0

SET ANCHOR

INFLUENCING FACTORS

Influence of Concrete Strength

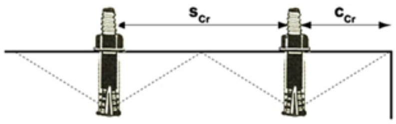
Concrete Strength Designation (ENV 206)	C 20/25	C 25/30	C 30/37	C 35/45	C 40/50	C 45/55	C 50/60
$f_B = (f_{ck.cube} / 25N/mm^2)$	1.00	1.10	1.22	1.34	1.41	1.48	1.55

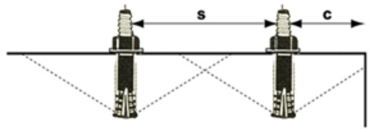
$f_{ck,cube}$ = 150mm concrete cube compressive strength

Influence of edge distance[1)]

c/c_{cr}	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$f_{1,N} = 0.7 + 0.3 * c/c_{cr} = 1$ $f_{1,sp} = 0.7 + 0.3 * c/c_{cr} = 1$	0.73	0.76	0.79	0.82	0.85	0.88	0.91	0.94	0.97	1.00
$f_{2,N} = 0.5 * (1 + c/c_{cr}) = 1$ $f_{2,sp} = 0.5 * (1 + c/c_{cr}) = 1$	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00

1) The above influencing factors must apply for every edge distance smaller than critical edge distance c_{cr}. Actual edge distance shall not be smaller than minimum edge distance c_{min}.





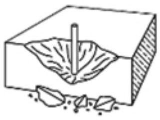
Influence of anchor spacing [2)]

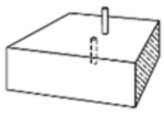
s/s_{cr}	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$f_{3,N} = 0.5 * (1 + s/s_{cr,N}) = 1$ $f_{3,sp} = 0.5 * (1 + s/s_{cr,sp}) = 1$	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00

2) The above influencing factors must apply for every anchor spacing smaller than critical spacing distance s_{cr}. Actual anchor spacing distance shall not be smaller than minimum spacing distance s_{min}.

SHEAR - Concrete Capacity CC Design Method

Design shear resistance $V_{Rd} = \min (V_{Rd,c} ; V_{Rd,cp} ; V_{Rd,s})$





$V_{Rd,c} = V^0_{Rd,c} * f_{\beta} * f_{sc} * f_B$	$V_{Rd,cp} = V^0_{Rd,cp} * f_{1,N} * f_{2,N} * f_{3,N} * f_B$	$V_{Rd,s}$

Design Concrete Edge Resistance, $V_{Rd,c}$

Anchor Size		M6	M8	M10	M12	M16	M20	M24
$V^0_{Rd,c}$	(kN)	1.5	2.5	4.2	6.4	9.8	16.1	18.8

Design Concrete Pryout Resistance, $V_{Rd,cp}$

Anchor Size		M6	M8	M10	M12	M16	M20	M24
$V^0_{Rd,cp}$	(kN)	5.5	9.1	13.5	23.2	35.5	58.2	68.2

Design Steel Resistance, $V_{Rd,s}$

Anchor Size		M6	M8	M10	M12	M16	M20	M24
$V_{Rd,s}$ (property class 5.8)	(kN)	3.5	7.5	12.2	18.3	32.7	46.9	50.2
$V_{Rd,s}$ (stainless steel A4-70)	(kN)	6.0	10.4	16.0	24.0	38.5	41.7	55.6

SET ANCHOR

INFLUENCING FACTORS

Influence of Concrete Strength

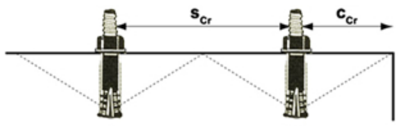
Concrete Strength Designation (ENV 206)	C 20/25	C 25/30	C 30/37	C 35/45	C 40/50	C 45/55	C 50/60
$f_B = (f_{ck.cube} / 25N/mm^2)$	1.00	1.10	1.22	1.34	1.41	1.48	1.55

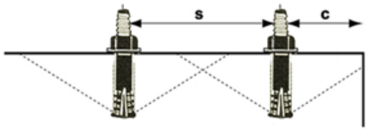
$f_{ck,cube}$ = 150mm concrete cube compressive strength

Influence of edge distance 1)

c/c_{cr}	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$f_{1,N} = 0.7 + 0.3 * c/c_{cr} = 1$	0.73	0.76	0.79	0.82	0.85	0.88	0.91	0.94	0.97	1.00
$f_{2,N} = 0.5 * (1 + c/c_{cr}) = 1$	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00

1) The above influencing factors must apply for every edge distance smaller than critical edge distance c_{cr}. Actual edge distance shall not be smaller than minimum edge distance c_{min}.



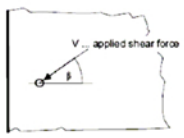


Influence of anchor spacing 2)

s/s_{cr}	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$f_{3,N} = 0.5 * (1 + s/s_{cr,N}) = 1$	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00

2) The above influencing factors must apply for every anchor spacing smaller than critical spacing distance s_{cr}. Actual anchor spacing distance shall not be smaller than minimum spacing distance s_{min}.

Influence of shear loading angle

Angle β	0°	10°	20°	30°	40°	50°	60°	70°	80°	=90°
f_β 	1.00	1.01	1.05	1.13	1.24	1.40	1.64	1.97	2.32	2.50

Influence of anchoring spacing and edge distance for concrete edge resistance

Formula for single-anchor fastening influenced only by edge

$$f_{sc} = \frac{c}{c_{min}} \sqrt{\frac{c}{c_{min}}}$$

For Single Anchor

C/C_{min}	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
f_{sc}	1.0	1.3	1.7	2.0	2.4	2.8	3.3	3.7	4.2	4.7	5.2	5.7	6.3	6.8	7.4	8.0

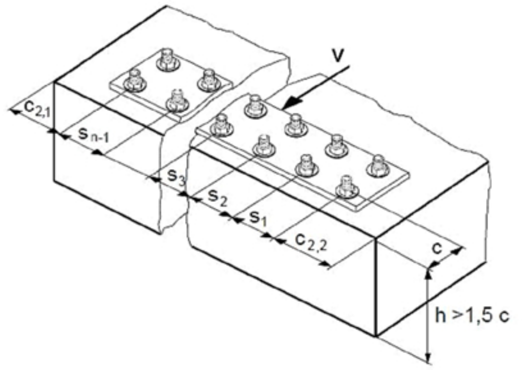
SET ANCHOR

Formula for two-anchor fastening valid for S<3c

$$f_{sc} = \frac{3c+s}{6c_{min}}\sqrt{\frac{c}{c_{min}}}$$

General formula for n-anchor fastening (edge plus n-1 spacing) only valid where s_1 to s_{n-1} are all < 3c and c_2 > 1.5c

$$f_{sc} = \frac{3c + s_1 + s_2 + \cdots + s_{n-1}}{3nc_{min}}\sqrt{\frac{c}{c_{min}}}$$



Note: It is assumed that only the row of anchors closed to the free concrete edge carries the centric shear load.

For 2 anchors

S/C$_{min}$ \ C/C$_{min}$	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
1.0	0.67	0.84	1.03	1.22	1.43	1.65	1.88	2.12	2.36	2.62	2.89	3.16	3.44	3.73	4.03	4.33
1.5	0.75	0.93	1.12	1.33	1.54	1.77	2.00	2.25	2.50	2.76	3.03	3.31	3.60	3.89	4.19	4.50
2.0	0.83	1.02	1.22	1.43	1.65	1.89	2.13	2.38	2.63	2.90	3.18	3.46	3.75	4.05	4.35	4.67
2.5	0.92	1.11	1.32	1.54	1.77	2.00	2.25	2.50	2.77	3.04	3.32	3.61	3.90	4.21	4.52	4.83
3.0	1.00	1.20	1.42	1.64	1.88	2.12	2.37	2.63	2.90	3.18	3.46	3.76	4.06	4.36	4.68	5.00
3.5		1.30	1.52	1.75	1.99	2.24	2.50	2.76	3.04	3.32	3.61	3.91	4.21	4.52	4.84	5.17
4.0			1.62	1.86	2.10	2.36	2.62	2.89	3.17	3.46	3.75	4.05	4.36	4.68	5.00	5.33
4.5				1.96	2.21	2.47	2.74	3.02	3.31	3.60	3.90	4.20	4.52	4.84	5.17	5.50
5.0					2.33	2.59	2.87	3.15	3.44	3.74	4.04	4.35	4.67	5.00	5.33	5.67
5.5						2.71	2.99	3.28	3.57	3.88	4.19	4.50	4.82	5.15	5.49	5.83
6.0						2.83	3.11	3.41	3.71	4.02	4.33	4.65	4.98	5.31	5.65	6.00
6.5							3.24	3.54	3.84	4.16	4.47	4.80	5.13	5.47	5.82	6.17
7.0								3.67	3.98	4.29	4.62	4.95	5.29	5.63	5.98	6.33
7.5									4.11	4.43	4.76	5.10	5.44	5.79	6.14	6.50
8.0										4.57	4.91	5.25	5.59	5.95	6.30	6.67
8.5											5.05	5.40	5.75	6.10	6.47	6.83
9.0											5.20	5.55	5.90	6.26	6.63	7.00
9.5												5.69	6.05	6.42	6.79	7.17
10.0													6.21	6.58	6.95	7.33
10.5														6.74	7.12	7.50
11.0															7.28	7.67
11.5																7.83
12.0																8.00

COMBINED LOAD - Tension and Shear

$\beta_N = N_{sd} / N_{Rd} \leq 1$ (N_{sd} =Tensile design action)

$\beta_V = V_{sd} / V_{Rd} \leq 1$ (V_{sd} = Shear design action)

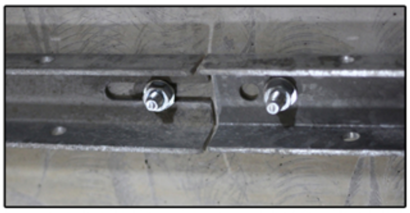
Design check: $\beta_N + \beta_V \leq 1.2$ or $\beta_N^{\alpha} + \beta_V^{\alpha} \leq 1$ (α = 1.5 for all failure mode)

SLEEVE ANCHOR

- Light to medium duty applications
- Fully assembled and ready to fix

Carbon steel (Galvanised to 5 micron)
Carbon steel (Hot-dipped galvanised)

Stainless steel A2-70 (SUS 304)
Stainless steel A4-70 (SUS 316)

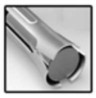


SETSCO Tested

ISO Quality Certified Product

Concrete

Solid Masonry



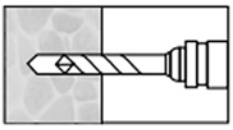
Easy Expansion Sleeve

Flanged Nut with Lock Washer

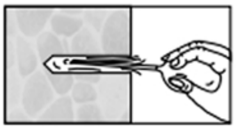
Corrosion Resistance

Higher Corrosion Resistance

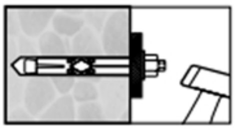
SETTING PROCEDURES



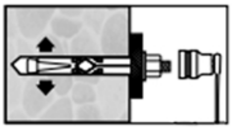
Drill a hole of required diameter and depth.



Clean the drilled hole.



Drive anchor into the drilled hole.



Apply the required installation torque.

SELECTION CHART

Designation		Anchor Size	Anchor Length	Max. Fixture Thickness t_{fix}
		(mm)	(mm)	(mm)
MSL	6.5 x 25	6.5	25	4
MSL	6.5 x 36	6.5	36	7
MSL	8 x 40	8	40	8
MSL	8 x 65	8	65	35
MSL	8 x 85	8	85	35
MSL	10 x 40	10	40	5
MSL	10 x 50	10	50	12
MSL	10 x 60	10	60	22
MSL	10 x 97	10	97	59
MSL	12 x 60	12	60	13
MSL	12 x 75	12	75	28
MSL	12 x 100	12	100	43
MSL	16 x 65	16	65	15
MSL	16 x 111	16	111	55
MSL	20 x 75	20	75	10
MSL	20 x 107	20	107	42

SETTING PARAMETERS

Anchor Size	(mm)		M6.5	M8	M10	M12	M16	M20
Anchor bolt diameter	d	(mm)	4	6	8	10	12	16
Drill bit diameter	d_1	(mm)	6.5	8	10	12	16	20
Effective anchorage Depth	h_{ef}	(mm)	25	35	40	50	55	60
Min. base material thickness	h_{min}	(mm)	35	45	50	65	70	75
Minimum edge distance	c_{min}	(mm)	25	35	40	50	55	60
Critical edge distance	c_{cr}	(mm)	35	50	55	70	75	80
Minimum spacing distance	s_{min}	(mm)	35	40	50	60	80	100
Critical spacing distance	s_{cr}	(mm)	75	105	120	150	165	180
Installation torque	$T_{inst.}$	(Nm)	3	7	13	20	80	122

SLEEVE ANCHOR

Basic Loading Data For Single Anchor In Concrete

- Non-cracked concrete C20/25, $f_{ck,cube}$ = 25 N/mm²
- Correct setting
- No spacing and edge distance influence

Tensile Resistance

Anchor Size	(mm)	M6.5	M8	M10	M12	M16	M20
Ultimate Strength	$N_{Ru,m}$ (kN)	5.0	8.0	9.5	13.0	16.0	18.0
Characteristic Strength	N_{Rk} (kN)	3.5	5.6	6.7	9.1	11.2	12.6
Design Strength	N_{Rd} (kN)	1.9	3.1	3.7	5.1	6.2	7.0
Recommended Strength	N_{Rec} (kN)	1.3	2.2	2.6	3.6	4.4	5.0

$N_{Rd} = N_{Rk} / \gamma_{Mc,N}$ [$\gamma_{Mc,N} = 1.8$]

$N_{Rec} = N_{Rk} / \gamma_{Mc,N} \cdot \gamma_F$ [$\gamma_{Mc,N} = 1.8$] [$\gamma_F = 1.4$]

Shear Resistance

Anchor Size	(mm)	M6.5	M8	M10	M12	M16	M20
Ultimate Strength	$V_{Ru,m}$ (kN)	3.9	6.2	10.5	16.6	24.0	45.0
Characteristic Strength	V_{Rk} (kN)	3.1	5.8	9.9	14.9	21.6	40.5
Design Strength	V_{Rd} (kN)	2.1	3.9	6.7	9.9	14.4	27.0
Recommended Strength	V_{Rec} (kN)	1.5	2.8	4.8	7.1	10.3	19.3

$V_{Rd} = V_{Rk} / \gamma_{Ms,V}$ [$\gamma_{Ms,V} = 1.5$]

$V_{Rec} = V_{Rk} / \gamma_{Ms,V} \cdot \gamma_F$ [$\gamma_{Ms,V} = 1.5$] [$\gamma_F = 1.4$]

Basic Loading Data For Single Anchor In Solid and Hollow Masonry Base Materials

- Brick strength DIN 105/ EN 771-1 $f_b \geq 12$ N/mm²
- Correct setting
- No spacing and edge distance influence

Recommended Loads

Anchor Size	(mm)	M6.5	M8	M10	M12	M16	M20
Tensile Strength	N_{Rec} (kN)	0.4	0.6	0.8	1.0	1.3	-
Shear Strength	V_{Rec} (kN)	0.7	0.9	1.1	1.4	1.6	-

Influence of Anchor Spacing, $f_{a,N}$

$f_{a,N} = 0.5 + s / (6 * h_{ef})$ Limits: $s_{min} \leq s \leq s_{cr}$ $s_{min} = 1.0 * h_{ef}$, $s_{cr} = 3.0 * h_{ef}$

Spacing, s (mm)	M6.5	M8	M10	M12	M16	M20
35	0.73					
40	0.77	0.69				
50	0.83	0.74	0.71			
60	0.90	0.79	0.75	0.70		
75	1.00	0.86	0.81	0.75		
80		0.88	0.83	0.77	0.74	
100		0.98	0.92	0.83	0.80	0.78
105		1.00	0.94	0.85	0.82	0.79
120			1.00	0.90	0.86	0.83
150				1.00	0.95	0.92
165					1.00	0.96
180						1.00

Influence of Edge Distance, $f_{e,N}$

$f_{e,N} = 0.29 + 0.47 * (c / h_{ef})$ Limits: $c_{min} \leq c \leq c_{cr}$ $c_{min} = 1.0 * h_{ef}$, $c_{cr} = 1.5 * h_{ef}$

Edge, c (mm)	M6.5	M8	M10	M12	M16	M20
25	0.76					
30	0.91					
35	1.00	0.76				
40		0.87	0.76			
45		0.98	0.86			
50		1.00	0.95	0.76		
55			1.00	0.84	0.76	
60				0.91	0.83	0.76
70				1.00	0.97	0.89
75					1.00	0.95
80						1.00

SLEEVE ANCHOR

Influence of anchoring spacing and edge distance for concrete edge resistance

Formula for single-anchor fastening influenced only by edge

$$f_{sc} = \frac{c}{c_{min}} \sqrt{\frac{c}{c_{min}}}$$

For Single Anchor

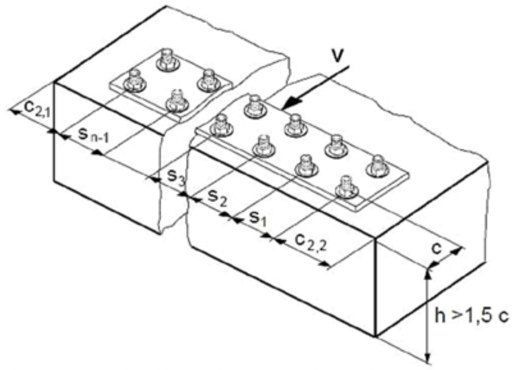
C/C_{min}	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
f_{sc}	1.0	1.3	1.7	2.0	2.4	2.8	3.3	3.7	4.2	4.7	5.2	5.7	6.3	6.8	7.4	8.0

Formula for two-anchor fastening valid for S<3c

$$f_{sc} = \frac{3c+s}{6c_{min}} \sqrt{\frac{c}{c_{min}}}$$

General formula for n-anchor fastening (edge plus n-1 spacing) only valid where s_1 to s_{n-1} are all < 3c and c_2 > 1.5c

$$f_{sc} = \frac{3c + s_1 + s_2 + \cdots + s_{n-1}}{3nc_{min}} \sqrt{\frac{c}{c_{min}}}$$



Note: It is assumed that only the row of anchors closed to the free concrete edge carries the centric shear load.

For 2 anchors

S/C_{min} \ C/C_{min}	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
1.0	0.67	0.84	1.03	1.22	1.43	1.65	1.88	2.12	2.36	2.62	2.89	3.16	3.44	3.73	4.03	4.33
1.5	0.75	0.93	1.12	1.33	1.54	1.77	2.00	2.25	2.50	2.76	3.03	3.31	3.60	3.89	4.19	4.50
2.0	0.83	1.02	1.22	1.43	1.65	1.89	2.13	2.38	2.63	2.90	3.18	3.46	3.75	4.05	4.35	4.67
2.5	0.92	1.11	1.32	1.54	1.77	2.00	2.25	2.50	2.77	3.04	3.32	3.61	3.90	4.21	4.52	4.83
3.0	1.00	1.20	1.42	1.64	1.88	2.12	2.37	2.63	2.90	3.18	3.46	3.76	4.06	4.36	4.68	5.00
3.5		1.30	1.52	1.75	1.99	2.24	2.50	2.76	3.04	3.32	3.61	3.91	4.21	4.52	4.84	5.17
4.0			1.62	1.86	2.10	2.36	2.62	2.89	3.17	3.46	3.75	4.05	4.36	4.68	5.00	5.33
4.5				1.96	2.21	2.47	2.74	3.02	3.31	3.60	3.90	4.20	4.52	4.84	5.17	5.50
5.0					2.33	2.59	2.87	3.15	3.44	3.74	4.04	4.35	4.67	5.00	5.33	5.67
5.5						2.71	2.99	3.28	3.57	3.88	4.19	4.50	4.82	5.15	5.49	5.83
6.0						2.83	3.11	3.41	3.71	4.02	4.33	4.65	4.98	5.31	5.65	6.00
6.5							3.24	3.54	3.84	4.16	4.47	4.80	5.13	5.47	5.82	6.17
7.0								3.67	3.98	4.29	4.62	4.95	5.29	5.63	5.98	6.33
7.5									4.11	4.43	4.76	5.10	5.44	5.79	6.14	6.50
8.0										4.57	4.91	5.25	5.59	5.95	6.30	6.67
8.5											5.05	5.40	5.75	6.10	6.47	6.83
9.0											5.20	5.55	5.90	6.26	6.63	7.00
9.5												5.69	6.05	6.42	6.79	7.17
10.0													6.21	6.58	6.95	7.33
10.5														6.74	7.12	7.50
11.0															7.28	7.67
11.5																7.83
12.0																8.00

HAMMER HIT ANCHOR

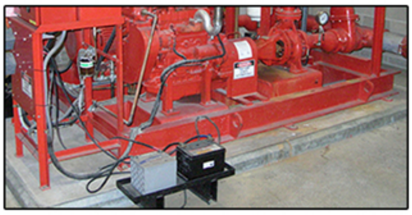
- Medium to Heavy duty applications
- Easy expansion without torque applying
- Expansion assured through hammering the hardended centre pin

Carbon steel (Galvanised to 5 micron)
Carbon steel (Hot-dipped galvanised)
Carbon steel (Yellow zinc chromate)

Stainless steel A2-70 (SUS 304)
Stainless steel A4-70 (SUS 316)

SETSCO Tested

ISO Quality Certified Product



Concrete

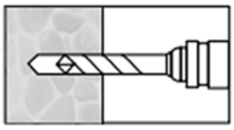
Easy Expansion with Grooves Maximize Grip

Hardened Centre Pin

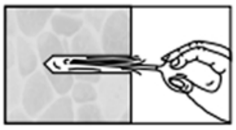
Corrosion Resistance

Higher Corrosion Resistance

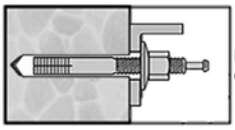
SETTING PROCEDURES



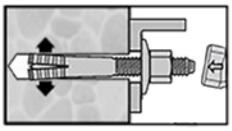
Drill a hole of required diameter and depth.



Clean the drilled hole.



Drive anchor into the drilled hole.



Hammer the centre pin to expand the anchor.

SELECTION CHART

Designation		Anchor Size (mm)	Anchor Length (mm)	Thread Length (mm)
MHH	6 x 45	6	45	15
MHH	6 x 60	6	60	20
MHH	8 x 50	8	50	20
MHH	8 x 70	8	70	25
MHH	10 x 50	10	50	20
MHH	10 x 60	10	60	25
MHH	10 x 80	10	80	25
MHH	10 x 90	10	90	30
MHH	10 x 100	10	100	30
MHH	10 x 120	10	120	30
MHH	12 x 60	12	60	20
MHH	12 x 70	12	70	25
MHH	12 x 90	12	90	30
MHH	12 x 100	12	100	30
MHH	12 x 120	12	120	50
MHH	16 x 100	16	100	40
MHH	16 x 120	16	120	40
MHH	16 x 150	16	150	40
MHH	20 x 130	20	130	50
MHH	20 x 150	20	150	50
MHH	20 x 190	20	190	50

SETTING PARAMETERS

Anchor Size	(mm)		M6	M8	M10	M12	M16	M20
Anchor Bolt diameter	d	(mm)	6	8	10	12	16	20
Drill bit diameter	d_0	(mm)	6.5	9	11	12.7	18	22
Effective Anchorage Depth	h_{ef}	(mm)	30	35	40	45	60	80
Minimum edge distance	c_{min}	(mm)	30	45	50	60	80	100
Critical edge distance	c_{cr}	(mm)	80	90	100	120	150	200
Minimum spacing distance	s_{min}	(mm)	35	40	50	60	80	100
Critical spacing distance	s_{cr}	(mm)	75	105	120	150	165	180

HAMMER HIT ANCHOR

Basic Loading Data For Single Anchor

- Non-cracked concrete C20/25, $f_{ck,cube}$ = 25 N/mm^2
- Correct setting
- No spacing and edge distance influence

Tensile Resistance

Anchor Size	(mm)		M6	M8	M10	M12	M16	M20
Ultimate Strength	$N_{Ru,m}$	(kN)	4.0	5.9	9.8	15.2	26.8	37.0
Characteristic Strength	N_{Rk}	(kN)	3.8	5.6	9.3	14.5	25.5	35.2
Design Strength	N_{Rd}	(kN)	2.1	3.1	5.2	8.1	14.2	19.6
Recommended Strength	N_{Rec}	(kN)	1.5	2.2	3.7	5.8	10.1	13.9

$N_{Rd} = N_{Rk} / \gamma_{Mc,N}$ [$\gamma_{Mc,N}$ = 1.8]

$N_{Rec} = N_{Rk} / \gamma_{Mc,N} \cdot \gamma_F$ [$\gamma_{Mc,N}$ = 1.8] [γ_F = 1.4]

Shear Resistance

Anchor Size	(mm)		M6	M8	M10	M12	M16	M20
Ultimate Strength	$V_{Ru,m}$	(kN)	5.4	8.5	13.6	19.8	40.8	62.6
Characteristic Strength	V_{Rk}	(kN)	5.1	8.1	12.9	18.9	38.9	59.6
Design Strength	V_{Rd}	(kN)	3.4	5.4	8.6	12.6	25.9	39.7
Recommended Strength	V_{Rec}	(kN)	2.4	3.9	6.1	9.0	18.5	28.4

$V_{Rd} = V_{Rk} / \gamma_{Ms,V}$ [$\gamma_{Ms,V}$ = 1.5]

$V_{Rec} = V_{Rk} / \gamma_{Ms,V} \cdot \gamma_F$ [$\gamma_{Ms,V}$ = 1.5] [γ_F = 1.4]

Influence of Anchor Spacing, $f_{a,N}$

$f_{a,N} = 0.5 + s / (6 * h_{ef})$ Limits: $s_{min} \le s \le s_{cr}$ $s_{min} = 1.0 * h_{ef}$, $s_{cr} = 3.0 * h_{ef}$

Spacing, s (mm)	M6	M8	M10	M12	M16	M20
35	0.73					
40	0.77	0.69				
50	0.83	0.74	0.71			
60	0.90	0.79	0.75	0.70		
75	1.00	0.86	0.81	0.75		
80		0.88	0.83	0.77	0.74	
100		0.98	0.92	0.83	0.80	0.78
105		1.00	0.94	0.85	0.82	0.79
120			1.00	0.90	0.86	0.83
150				1.00	0.95	0.92
165					1.00	0.96
180						1.00

Influence of Edge Distance, $f_{e,N}$

$f_{e,N} = 0.13 + 0.27 * (c / h_{ef})$ Limits: $c_{min} \le c \le c_{cr}$ $c_{min} = 1.0 * h_{ef}$, $c_{cr} = 1.5 * h_{ef}$

Edge, c (mm)	M6	M8	M10	M12	M16	M20
30	0.40					
40	0.53					
45	0.60	0.51				
50	0.67	0.57	0.50			
60	0.80	0.69	0.60	0.53		
80	1.00	0.91	0.80	0.71	0.53	
90		1.00	0.90	0.80	0.60	
100			1.00	0.89	0.67	0.50
120				1.00	0.80	0.60
150					1.00	0.75
180						0.90
200						1.00

Influence of anchoring spacing and edge distance for concrete edge resistance

Formula for single-anchor fastening influenced only by edge

$$f_{sc} = \frac{c}{c_{min}} \sqrt{\frac{c}{c_{min}}}$$

For Single Anchor

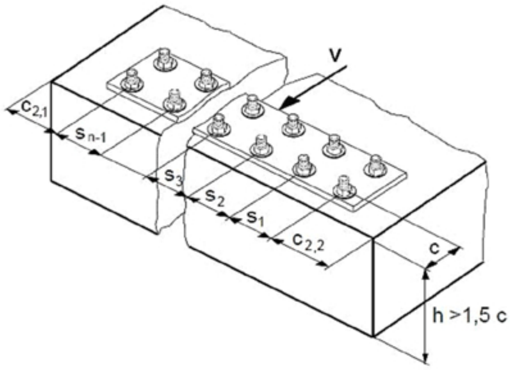
C/C_{min}	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
f_{sc}	1.0	1.3	1.7	2.0	2.4	2.8	3.3	3.7	4.2	4.7	5.2	5.7	6.3	6.8	7.4	8.0

Mason

HAMMER HIT ANCHOR

Formula for two-anchor fastening valid for S<3c

$$f_{sc} = \frac{3c+s}{6c_{min}}\sqrt{\frac{c}{c_{min}}}$$



General formula for n-anchor fastening (edge plus n-1 spacing) only valid where s_1 to s_{n-1} are all < 3c and c_2 > 1.5c

$$f_{sc} = \frac{3c + s_1 + s_2 + \cdots + s_{n-1}}{3nc_{min}}\sqrt{\frac{c}{c_{min}}}$$

Note: It is assumed that only the row of anchors closed to the free concrete edge carries the centric shear load.

For 2 anchors

S/C_{min} \ C/C_{min}	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
1.0	0.67	0.84	1.03	1.22	1.43	1.65	1.88	2.12	2.36	2.62	2.89	3.16	3.44	3.73	4.03	4.33
1.5	0.75	0.93	1.12	1.33	1.54	1.77	2.00	2.25	2.50	2.76	3.03	3.31	3.60	3.89	4.19	4.50
2.0	0.83	1.02	1.22	1.43	1.65	1.89	2.13	2.38	2.63	2.90	3.18	3.46	3.75	4.05	4.35	4.67
2.5	0.92	1.11	1.32	1.54	1.77	2.00	2.25	2.50	2.77	3.04	3.32	3.61	3.90	4.21	4.52	4.83
3.0	1.00	1.20	1.42	1.64	1.88	2.12	2.37	2.63	2.90	3.18	3.46	3.76	4.06	4.36	4.68	5.00
3.5		1.30	1.52	1.75	1.99	2.24	2.50	2.76	3.04	3.32	3.61	3.91	4.21	4.52	4.84	5.17
4.0			1.62	1.86	2.10	2.36	2.62	2.89	3.17	3.46	3.75	4.05	4.36	4.68	5.00	5.33
4.5				1.96	2.21	2.47	2.74	3.02	3.31	3.60	3.90	4.20	4.52	4.84	5.17	5.50
5.0					2.33	2.59	2.87	3.15	3.44	3.74	4.04	4.35	4.67	5.00	5.33	5.67
5.5						2.71	2.99	3.28	3.57	3.88	4.19	4.50	4.82	5.15	5.49	5.83
6.0						2.83	3.11	3.41	3.71	4.02	4.33	4.65	4.98	5.31	5.65	6.00
6.5							3.24	3.54	3.84	4.16	4.47	4.80	5.13	5.47	5.82	6.17
7.0								3.67	3.98	4.29	4.62	4.95	5.29	5.63	5.98	6.33
7.5									4.11	4.43	4.76	5.10	5.44	5.79	6.14	6.50
8.0										4.57	4.91	5.25	5.59	5.95	6.30	6.67
8.5											5.05	5.40	5.75	6.10	6.47	6.83
9.0											5.20	5.55	5.90	6.26	6.63	7.00
9.5												5.69	6.05	6.42	6.79	7.17
10.0													6.21	6.58	6.95	7.33
10.5														6.74	7.12	7.50
11.0															7.28	7.67
11.5																7.83
12.0																8.00

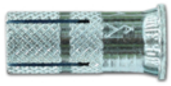
Mason

DROP IN ANCHOR

- Medium duty fastening with bolts or threaded rods
- Reliable setting with simple hammer set expansion plug
- Fire resistance
- Shallow embedment
- Economical anchor for everyday jobsite fixings
- Durable and versatile

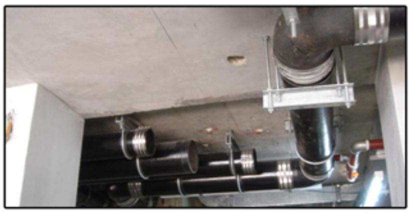
Carbon steel (Galvanised to 5 micron)
Carbon steel (Hot-dipped galvanised)
Stainless steel A2-70 (SUS 304)
Stainless steel A4-70 (SUS 316)

TYPE C without lip



TYPE H with lip

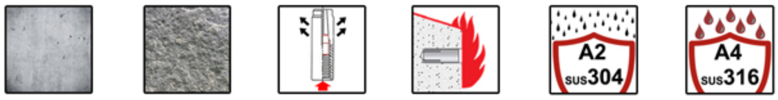
Hammer set tool



SETSCO Tested

AIT Thailand Tested

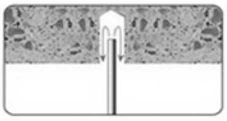
ISO Quality Certified Product



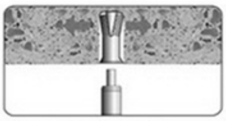
Concrete | Hard Stone | Built-in Expansion Plug | Fire Resistance | Corrosion Resistance | Higher Corrosion Resistance

SETTING PROCEDURES

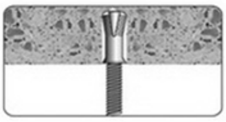
Drill a hole of required diameter and depth.



Clean the drilled hole.



Drive anchor into the drilled hole and expand the plug with the setting punch.



Insert threaded stud or bolt and tighten to required torque.

SELECTION CHART

Designation		Anchor Length	Internal Thread Length
		(mm)	(mm)
MDA	6 x 25	25	13
MDA	8 x 30	30	15
MDA	10 x 40	40	18
MDA	12 x 50	50	23
MDA	16 x 65	65	34
MDA	20 x 80	80	45
MDA	1 / 4” x 25	25	13
MDA	5 / 16” x 30	30	15
MDA	3 / 8” x 30	30	13
MDA	3 / 8” x 40	40	18
MDA	1 / 2” x 50	50	23
MDA	5 / 8” x 65	65	34
MDA	3 / 4” x 80	80	45

SETTING PARAMETERS

Anchor Internal Thread Size	(mm / inch)		M6 / 1/4”	M8 / 5/16”	M10/ 3/8”	M12/ 1/2"	M16/ 5/8”	M20 / 3/4"
Drill bit diameter	d_1	(mm)	8	10	12	16	20	25
Effective anchorage Depth	h_{ef}	(mm)	25	30	40	50	65	80
Min. base material thickness	h_{min}	(mm)	100	100	100	100	130	160
Minimum edge distance	c_{min}	(mm)	40	50	60	80	100	120
Critical edge distance	c_{cr}	(mm)	96	120	144	192	240	288
Minimum spacing distance	s_{min}	(mm)	40	50	60	80	100	120
Critical spacing distance	s_{cr}	(mm)	80	100	120	160	200	240
Installation torque	$T_{inst.}$	(Nm)	5	10	22	36	80	100

DROP IN ANCHOR

Basic Loading Data For Single Anchor

- Non-cracked concrete C20/25, $f_{ck,cube}$ = 25 N/mm²
- Correct setting
- No spacing and edge distance influence

Tensile Resistance

Anchor Size	(mm / inch)	M6 / 1/4”	M8 / 5/16”	M10 / 3/8”	M10 / 3/8”	M12 / 1/2"	M16 / 5/8”	M20 / 3/4"
Anchor Length	mm	25	30	30	40	50	65	80
Ultimate Strength	$N_{Ru,m}$ (kN)	8.5	11.0	12.8	17.0	27.0	45.9	59.5
Characteristic Strength	N_{Rk} (kN)	7.2	9.3	10.8	13.6	21.6	32.1	41.6
Design Strength	N_{Rd} (kN)	4.0	5.2	6.0	7.5	12.0	17.8	23.1
Recommended Strength	N_{Rec} (kN)	2.8	3.7	4.3	5.4	8.6	12.7	16.5

$N_{Rd} = N_{Rk} / \gamma_{Mc,N}$ [$\gamma_{Mc,N} = 1.8$]

$N_{Rec} = N_{Rk} / \gamma_{Mc,N} \cdot \gamma_F$ [$\gamma_{Mc,N} = 1.8$] [$\gamma_F = 1.4$]

Shear Resistance

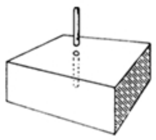
Anchor Size	(mm / inch)	M6 / 1/4”	M8 / 5/16”	M10 / 3/8”	M10 / 3/8”	M12 / 1/2"	M16 / 5/8”	M20 / 3/4"
Anchor Length	mm	25	30	30	40	50	65	80
Ultimate Strength	$V_{Ru,m}$ (kN)	3.8	7.3	7.7	7.7	20.0	36.4	46.8
Characteristic Strength	V_{Rk} (kN)	3.6	6.9	7.3	7.3	19.0	29.1	42.1
Design Strength	V_{Rd} (kN)	2.4	4.6	4.9	4.9	12.7	19.4	28.1
Recommended Strength	V_{Rec} (kN)	1.7	3.3	3.5	3.5	9.1	13.8	20.0

$V_{Rd} = V_{Rk} / \gamma_{Ms,V}$ [$\gamma_{Ms,V} = 1.5$]

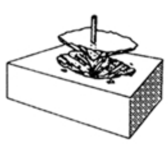
$V_{Rec} = V_{Rk} / \gamma_{Ms,V} \cdot \gamma_F$ [$\gamma_{Ms,V} = 1.5$] [$\gamma_F = 1.4$]

TENSILE - Concrete Capacity CC Design Method

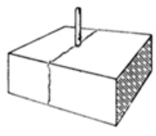
Design tensile resistance $N_{Rd} = \min (N_{Rd,p} ; N_{Rd,c} ; N_{Rd,sp} ; N_{Rd,s})$



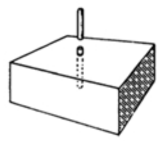
$N_{Rd,p} = N^0_{Rd,p} * f_B$



$N_{Rd,c} = N^0_{Rd,c} * f_{1,N} * f_{2,N} * f_{3,N} * f_B$



$N_{Rd,sp} = N^0_{Rd,c} * f_{1,sp} * f_{2,sp} * f_{3,sp} * f_B$



$N_{Rd,s}$

Design Pull-out Resistance, $N_{Rd,p}$

Anchor Size	(mm / inch)	M6 / 1/4”	M8 / 5/16”	M10 / 3/8”	M10 / 3/8”	M12 / 1/2"	M16 / 5/8”	M20 / 3/4"
Anchor Length	mm	25	30	30	40	50	65	80
$N^0_{Rd,p}$	(kN)	3.6	4.7	5.4	6.8	10.9	16.1	21.0

Design Concrete Cone Resistance, $N_{Rd,c}$
Design Splitting Resistance, $N_{Rd,sp}$

Anchor Size	(mm / inch)	M6 / 1/4”	M8 / 5/16”	M10 / 3/8”	M10 / 3/8”	M12 / 1/2"	M16 / 5/8”	M20 / 3/4"
Anchor Length	mm	25	30	30	40	50	65	80
$N^0_{Rd,c}$	(kN)	4.0	5.2	6.0	7.5	12.0	17.8	23.1

DROP IN ANCHOR

Design Steel Resistance, $N_{Rd,s}$

Anchor Size	(mm / inch)	M6 / 1/4”	M8 / 5/16”	M10 / 3/8”	M10 / 3/8”	M12 / 1/2"	M16 / 5/8”	M20 / 3/4"
Anchor Length	**mm**	**25**	**30**	**30**	**40**	**50**	**65**	**80**
$N_{Rd,s}$ (property class 5.8)	**(kN)**	5.5	10.0	12.8	12.8	26.1	40.2	67.5
$N_{Rd,s}$ (SS A4-70)	**(kN)**	6.1	9.1	11.6	11.6	23.7	36.5	61.4

INFLUENCING FACTORS

Influence of Concrete Strength

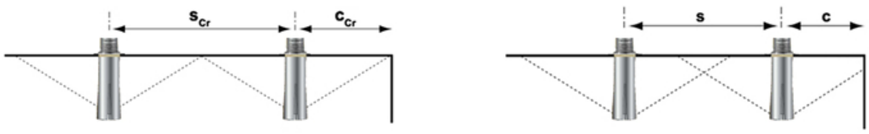
Concrete Strength Designation (ENV 206)	C 20/25	C 25/30	C 30/37	C 35/45	C 40/50	C 45/55	C 50/60
$f_B = (f_{ck.cube} / 25N/mm^2)$	1.00	1.10	1.22	1.34	1.41	1.48	1.55

$f_{ck,cube}$ = 150mm concrete cube compressive strength

Influence of edge distance[1)]

c/c_{cr}	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$f_{1,N} = 0.7 + 0.3 * c/c_{cr} = 1$ **$f_{1,sp} = 0.7 + 0.3 * c/c_{cr} = 1$**	0.73	0.76	0.79	0.82	0.85	0.88	0.91	0.94	0.97	1.00
$f_{2,N} = 0.5 * (1 + c/c_{cr}) = 1$ **$f_{2,sp} = 0.5 * (1 + c/c_{cr}) = 1$**	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00

1) The above influencing factors must apply for every edge distance smaller than critical edge distance c_{cr}. Actual edge distance shall not be smaller than minimum edge distance c_{min}.



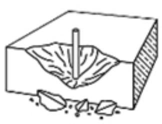
Influence of anchor spacing [2)]

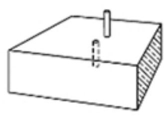
s/s_{cr}	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$f_{3,N} = 0.5 * (1 + s/s_{cr,N}) = 1$ **$f_{3,sp} = 0.5 * (1 + s/s_{cr,sp}) = 1$**	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00

2) The above influencing factors must apply for every anchor spacing smaller than critical spacing distance s_{cr}. Actual anchor spacing distance shall not be smaller than minimum spacing distance s_{min}.

SHEAR - Concrete Capacity CC Design Method

Design shear resistance $V_{Rd} = \min(V_{Rd,c} ; V_{Rd,cp} ; V_{Rd,s})$





$V_{Rd,c} = V^0_{Rd,c} * f_{\beta} * f_{sc} * f_B$	$V_{Rd,cp} = V^0_{Rd,cp} * f_{1,N} * f_{2,N} * f_{3,N} * f_B$	$V_{Rd,s}$

Design Concrete Edge Resistance, $V_{Rd,c}$

Anchor Size	(mm / inch)	M6 / 1/4”	M8 / 5/16”	M10 / 3/8”	M10 / 3/8”	M12 / 1/2"	M16 / 5/8”	M20 / 3/4"
Anchor Length	**mm**	**25**	**30**	**30**	**40**	**50**	**65**	**80**
$V^0_{Rd,c}$	**(kN)**	3.5	6.6	7.0	7.0	18.2	33.1	42.5

DROP IN ANCHOR

Design Concrete Pryout Resistance, $V_{Rd,cp}$

Anchor Size	(mm / inch)	M6 / 1/4"	M8 / 5/16"	M10 / 3/8"	M10 / 3/8"	M12 / 1/2"	M16 / 5/8"	M20 / 3/4"
Anchor Length	mm	25	30	30	40	50	65	80
$V^0_{Rd,cp}$	(kN)	4.9	9.2	9.8	9.8	20.0	36.4	46.8

Design Steel Resistance, $V_{Rd,s}$

Anchor Size	(mm / inch)	M6 / 1/4"	M8 / 5/16"	M10 / 3/8"	M10 / 3/8"	M12 / 1/2"	M16 / 5/8"	M20 / 3/4"
Anchor Length	mm	25	30	30	40	50	65	80
$V_{Rd,s}$ (property class 5.8)	(kN)	2.4	4.6	4.9	4.9	12.7	19.4	28.1
$V_{Rd,s}$ (SS A4-70)	(kN)	3.7	5.5	6.9	6.9	14.2	21.9	36.8

INFLUENCING FACTORS

Influence of Concrete Strength

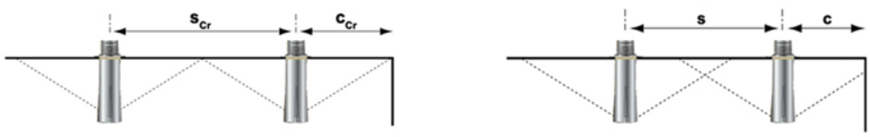
Concrete Strength Designation (ENV 206)	C 20/25	C 25/30	C 30/37	C 35/45	C 40/50	C 45/55	C 50/60
$f_B = (f_{ck.cube} / 25N/mm^2)$	1.00	1.10	1.22	1.34	1.41	1.48	1.55

$f_{ck,cube}$ = 150mm concrete cube compressive strength

Influence of edge distance[1)]

c/c_{cr}	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$f_{1,N} = 0.7 + 0.3 * c/c_{cr} = 1$	0.73	0.76	0.79	0.82	0.85	0.88	0.91	0.94	0.97	1.00
$f_{2,N} = 0.5 * (1 + c/c_{cr}) = 1$	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00

1) The above influencing factors must apply for every edge distance smaller than critical edge distance c_{cr}. Actual edge distance shall not be smaller than minimum edge distance c_{min}.

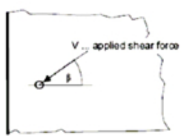


Influence of anchor spacing[2)]

s/s_{cr}	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$f_{3,N} = 0.5 * (1 + s/s_{cr,N}) = 1$	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00

2) The above influencing factors must apply for every anchor spacing smaller than critical spacing distance s_{cr}. Actual anchor spacing distance shall not be smaller than minimum spacing distance s_{min}.

Influence of shear loading angle

Angle β	0°	10°	20°	30°	40°	50°	60°	70°	80°	=90°
f_β 	1.00	1.01	1.05	1.13	1.24	1.40	1.64	1.97	2.32	2.50

Influence of anchoring spacing and edge distance for concrete edge resistance

Formula for single-anchor fastening influenced only by edge

$$f_{sc} = \frac{c}{c_{min}} \sqrt{\frac{c}{c_{min}}}$$

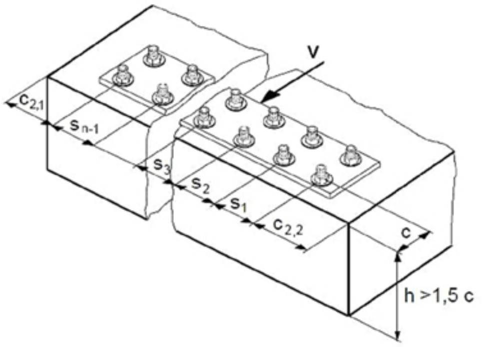
DROP IN ANCHOR

For Single Anchor

C/C_{min}	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
f_{sc}	1.0	1.3	1.7	2.0	2.4	2.8	3.3	3.7	4.2	4.7	5.2	5.7	6.3	6.8	7.4	8.0

Formula for two-anchor fastening valid for S<3c

$$f_{sc} = \frac{3c+s}{6c_{min}}\sqrt{\frac{c}{c_{min}}}$$



General formula for n-anchor fastening (edge plus n-1 spacing) only valid where s_1 to s_{n-1} are all < 3c and c_2 > 1.5c

$$f_{sc} = \frac{3c + s_1 + s_2 + \cdots + s_{n-1}}{3nc_{min}}\sqrt{\frac{c}{c_{min}}}$$

Note: It is assumed that only the row of anchors closed to the free concrete edge carries the centric shear load.

For 2 anchors

S/C_{min} \ C/C_{min}	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
1.0	0.67	0.84	1.03	1.22	1.43	1.65	1.88	2.12	2.36	2.62	2.89	3.16	3.44	3.73	4.03	4.33
1.5	0.75	0.93	1.12	1.33	1.54	1.77	2.00	2.25	2.50	2.76	3.03	3.31	3.60	3.89	4.19	4.50
2.0	0.83	1.02	1.22	1.43	1.65	1.89	2.13	2.38	2.63	2.90	3.18	3.46	3.75	4.05	4.35	4.67
2.5	0.92	1.11	1.32	1.54	1.77	2.00	2.25	2.50	2.77	3.04	3.32	3.61	3.90	4.21	4.52	4.83
3.0	1.00	1.20	1.42	1.64	1.88	2.12	2.37	2.63	2.90	3.18	3.46	3.76	4.06	4.36	4.68	5.00
3.5		1.30	1.52	1.75	1.99	2.24	2.50	2.76	3.04	3.32	3.61	3.91	4.21	4.52	4.84	5.17
4.0			1.62	1.86	2.10	2.36	2.62	2.89	3.17	3.46	3.75	4.05	4.36	4.68	5.00	5.33
4.5				1.96	2.21	2.47	2.74	3.02	3.31	3.60	3.90	4.20	4.52	4.84	5.17	5.50
5.0					2.33	2.59	2.87	3.15	3.44	3.74	4.04	4.35	4.67	5.00	5.33	5.67
5.5						2.71	2.99	3.28	3.57	3.88	4.19	4.50	4.82	5.15	5.49	5.83
6.0						2.83	3.11	3.41	3.71	4.02	4.33	4.65	4.98	5.31	5.65	6.00
6.5							3.24	3.54	3.84	4.16	4.47	4.80	5.13	5.47	5.82	6.17
7.0								3.67	3.98	4.29	4.62	4.95	5.29	5.63	5.98	6.33
7.5									4.11	4.43	4.76	5.10	5.44	5.79	6.14	6.50
8.0										4.57	4.91	5.25	5.59	5.95	6.30	6.67
8.5											5.05	5.40	5.75	6.10	6.47	6.83
9.0											5.20	5.55	5.90	6.26	6.63	7.00
9.5												5.69	6.05	6.42	6.79	7.17
10.0													6.21	6.58	6.95	7.33
10.5														6.74	7.12	7.50
11.0															7.28	7.67
11.5																7.83
12.0																8.00

COMBINED LOAD - Tension and Shear

$\beta_N = N_{sd} / N_{Rd} \leq 1$ (N_{sd} =Tensile design action)

$\beta_V = V_{sd} / V_{Rd} \leq 1$ (V_{sd} = Shear design action)

Design check: $\beta_N + \beta_V \leq 1.2$ or $\beta_N^{\alpha} + \beta_V^{\alpha} \leq 1$ (α = 1.5 for all failure mode)

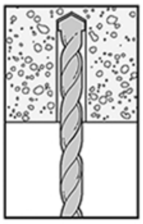
TIE WIRE ANCHOR

- Light duty applications
- Quick and easy installation
- Anchor easily can be set by pulling the head with a claw hammer
- Suitable for suspended ceiling and lightweight suspension anchor point

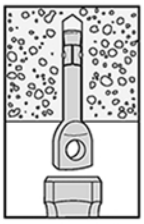
Carbon steel (Galvanised to 5 micron)
Carbon steel (Hot-dipped galvanised)
Carbon steel (Yellow zinc chromate)

Stainless steel A2-70 (SUS 304)
Stainless steel A4-70 (SUS 316)

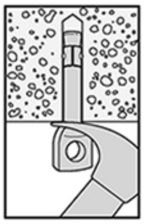
SETTING PROCEDURES



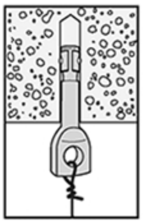
Drill a hole of required diameter and depth.



Drive the anchor into the drilled hole.



Set the anchor by prying/pulling the head with the claw end of the hammer.



Attach steel wire.

SELECTION CHART & SETTING PARAMETERS

Designation		Eye Size	Drill Diameter	Min. Embedment Depth
		(mm/inch)	(mm)	(mm)
MTW	6 x 60	6.3	6	35
MTW	6 x 66	6.3	6	42
MTW	10 x 85	9.0	10	50
MTW	1/4" X 2- 1/4"	7.0	1/4 "	29

ANCHOR SPACING & EDGE DISTANCE

Anchor Size	(mm)		M6	M10	1/4 "
Minimum edge distance	c_{min}	(mm)	30	50	32
Critical edge distance	c_{cr}	(mm)	72	120	77
Minimum spacing distance	s_{min}	(mm)	30	50	32
Critical spacing distance	s_{cr}	(mm)	60	100	64

Basic Loading Data For Single Anchor

- Non-cracked concrete C20/25, $f_{ck,cube}$ = 25 N/mm^2
- Correct setting
- No spacing and edge distance influence

Tensile Resistance

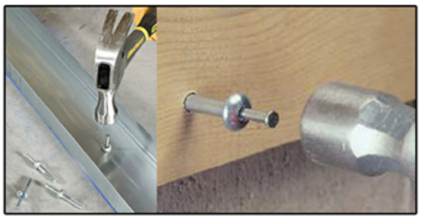
Anchor Size	(mm)		M6	M10	1/4 "
Ultimate Strength	$N_{Ru,m}$	(kN)	4.0	7.8	4.6
Characteristic Strength	N_{Rk}	(kN)	2.8	5.5	3.2
Design Strength	N_{Rd}	(kN)	1.5	3.0	1.8
Recommended Strength	N_{Rec}	(kN)	1.1	2.2	1.3

$N_{Rd} = N_{Rk} / \gamma_{Mc,N}$ [$\gamma_{Mc,N} = 1.8$]

$N_{Rec} = N_{Rk} / \gamma_{Mc,N} \cdot \gamma_F$ [$\gamma_{Mc,N} = 1.8$] [$\gamma_F = 1.4$]

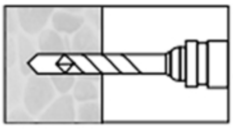
HAMMER DRIVE ANCHOR

- Light duty applications
- Fast and easy installation
- Hardended nail for easy expansion

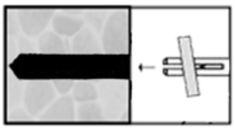


Zinc alloy anchor body
Hardended center nail

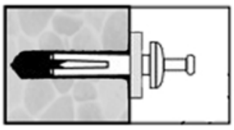
SETTING PROCEDURES



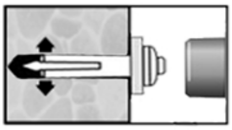
Drill a hole of required diameter and depth.



Insert anchor through the fixture hole.



Insert anchor into the hole.



Drive anchor with hammer until the centre nail is flush on top of the anchor.

SELECTION CHART & SETTING PARAMETERS

Designation		Anchor Size	Min. Embedment Depth for Max. t_{fix}	Max. Fixture Thickness (t_{fix})
		(inch)	(mm)	(mm)
MHD	5 x 22	3/16 x 7/8	16	6
MHD	6 x 20	1/4 x 3/4	16	4.5
MHD	6 x 25	1/4 x 1	20	6
MHD	6 x 30	1/4 x 1- 1/4	20	12
MHD	6 x 40	1/4 x 1- 1/2	25	19
MHD	6 x 50	1/4 x 2	25	30
MHD	6 x 65	1/4 x 2- 1/2	30	35

Basic Loading Data For Single Anchor

- Non-cracked concrete C20/25, $f_{ck,cube}$ = 25 N/mm²
- Correct setting
- No spacing and edge distance influence

Tensile Resistance

Anchor Size	(mm)	M5 x 22	M6 x 20	M6 x 25	M6 x 30	M6 x 40	M6 x 50	M6 x 65
Ultimate Strength	$N_{Ru,m}$ (kN)	1.9	2.3	2.8	3.1	3.5	3.5	3.5
Characteristic Strength	N_{Rk} (kN)	1.3	1.6	1.9	2.2	2.4	2.4	2.4
Design Strength	N_{Rd} (kN)	0.7	0.9	1.1	1.2	1.4	1.4	1.4
Recommended Strength	N_{Rec} (kN)	0.5	0.6	0.7	0.8	0.9	0.9	0.9

$N_{Rd} = N_{Rk} / \gamma_{Mc,N}$ [$\gamma_{Mc,N} = 1.8$]

$N_{Rec} = N_{Rk} / \gamma_{Mc,N} \cdot \gamma_F$ [$\gamma_{Mc,N} = 1.8$] [$\gamma_F = 1.4$]

Shear Resistance

Anchor Size	(mm)	M5 x 22	M6 x 20	M6 x 25	M6 x 30	M6 x 40	M6 x 50	M6 x 65
Ultimate Strength	$V_{Ru,m}$ (kN)	2.4	4.8	4.8	4.8	4.8	4.8	4.8
Characteristic Strength	V_{Rk} (kN)	1.2	2.4	2.4	2.4	2.4	2.4	2.4
Design Strength	V_{Rd} (kN)	0.8	1.6	1.6	1.6	1.6	1.6	1.6
Recommended Strength	V_{Rec} (kN)	0.5	1.1	1.1	1.1	1.1	1.1	1.1

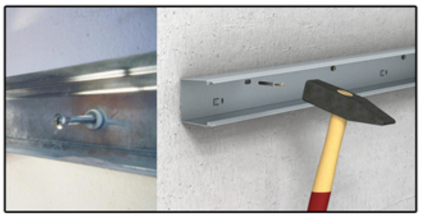
$V_{Rd} = V_{Rk} / \gamma_{Ms,V}$ [$\gamma_{Ms,V} = 1.5$]

$V_{Rec} = V_{Rk} / \gamma_{Ms,V} \cdot \gamma_F$ [$\gamma_{Ms,V} = 1.5$] [$\gamma_F = 1.4$]

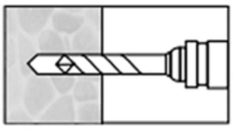
NYLON ANCHOR

- Light duty applications
- Pre-assembled quick and easy installation
- Removable fixing with phillip drive screw head
- Polymide (Nylon) plug for uniform expansion
- Temperature resistance -30 ^{0}C to +70 ^{0}C

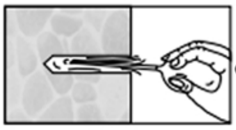
Carbon steel (Galvanised to 5 micron)
Stainless steel A2-70 (SUS 304)
Stainless steel A4-70 (SUS 316)



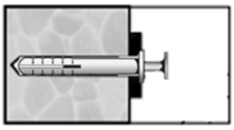
SETTING PROCEDURES



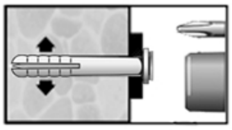
Drill a hole of required diameter and depth.



Clean the drilled hole.



Insert anchor into the hole.



Hammer or tighten the screw into the nylon anchor.

SELECTION CHART & SETTING PARAMETERS

Designation	Depth of Drilled Hole (h_0) (mm)	Min. Embedment Depth for Max. t_{fix} (mm)	Max. Fixture Thickness (t_{fix}) (mm)
MNA 5 x 35	40	28	7
MNA 6 x 45	50	28	17
MNA 6 x 60	60	28	32
MNA 6 x 72	72	28	44
MNA 8 x 56	56	34	22
MNA 8 x 72	72	34	38
MNA 8 x 100	100	34	66

Basic Loading Data For Single Anchor

- Non-cracked concrete C20/25, $f_{ck,cube}$ = 25 N/mm^2
- Correct setting
- No spacing and edge distance influence

Tensile Resistance

Anchor Size	(mm)	M5 x 35	M6 x 45	M6 x 60	M6 x 72	M8 x 56	M8 x 72	M8 x 100
Ultimate Strength	$N_{Ru,m}$ (kN)	1.0	1.9	1.9	1.9	2.4	2.4	2.4
Characteristic Strength	N_{Rk} (kN)	0.6	1.1	1.1	1.1	1.4	1.4	1.4
Design Strength	N_{Rd} (kN)	0.3	0.6	0.6	0.6	0.8	0.8	0.8
Recommended Strength	N_{Rec} (kN)	0.2	0.4	0.4	0.4	0.5	0.5	0.5

$N_{Rd} = N_{Rk} / \gamma_{Mc,N}$ [$\gamma_{Mc,N} = 1.8$]

$N_{Rec} = N_{Rk} / \gamma_{Mc,N} \cdot \gamma_F$ [$\gamma_{Mc,N} = 1.8$] [$\gamma_F = 1.4$]

Shear Resistance

Anchor Size	(mm)	M5 x 35	M6 x 45	M6 x 60	M6 x 72	M8 x 56	M8 x 72	M8 x 100
Ultimate Strength	$V_{Ru,m}$ (kN)	2.4	4.8	4.8	4.8	5.3	5.3	5.3
Characteristic Strength	V_{Rk} (kN)	1.2	2.4	2.4	2.4	2.6	2.6	2.6
Design Strength	V_{Rd} (kN)	0.8	1.6	1.6	1.6	1.7	1.7	1.7
Recommended Strength	V_{Rec} (kN)	0.5	1.1	1.1	1.1	1.2	1.2	1.2

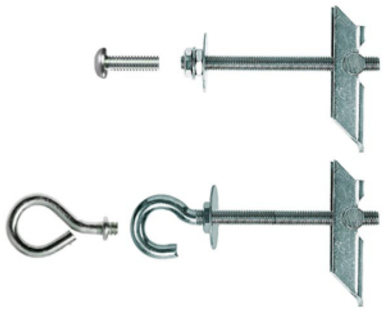
$V_{Rd} = V_{Rk} / \gamma_{Ms,V}$ [$\gamma_{Ms,V} = 1.5$]

$V_{Rec} = V_{Rk} / \gamma_{Ms,V} \cdot \gamma_F$ [$\gamma_{Ms,V} = 1.5$] [$\gamma_F = 1.4$]

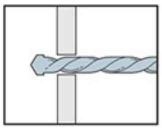
GRAVITY ANCHOR

- Light duty applications
- Simple fixing to cavity walls and ceiling
- Suitable for hollow-core concrete

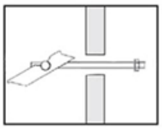
Carbon steel (Galvanised to 5 micron)
Carbon steel (Hot-dipped galvanised)
Different anchor head styles and stud length are available upon request.



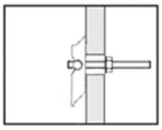
SETTING PROCEDURES



Drill a hole of required diameter.



Insert anchor through drilled hole.



Tighten the nut.

SETTING PARAMETERS & TECHNICAL DATA

Tensile Resistance

Designation		Hole Diameter	Min. Hollow Hole Size	Char. Strength	Design Strength	Rec. Strength
		(mm)	(mm)	(kN)	(kN)	(kN)
MGA	M8	20	80	3.4	1.9	1.3

Shear Resistance

Designation		Hole Diameter	Min. Hollow Hole Size	Char. Strength	Design Strength	Rec. Strength
		(mm)	(mm)	(kN)	(kN)	(kN)
MGA	M8	20	80	5.3	3.5	2.5

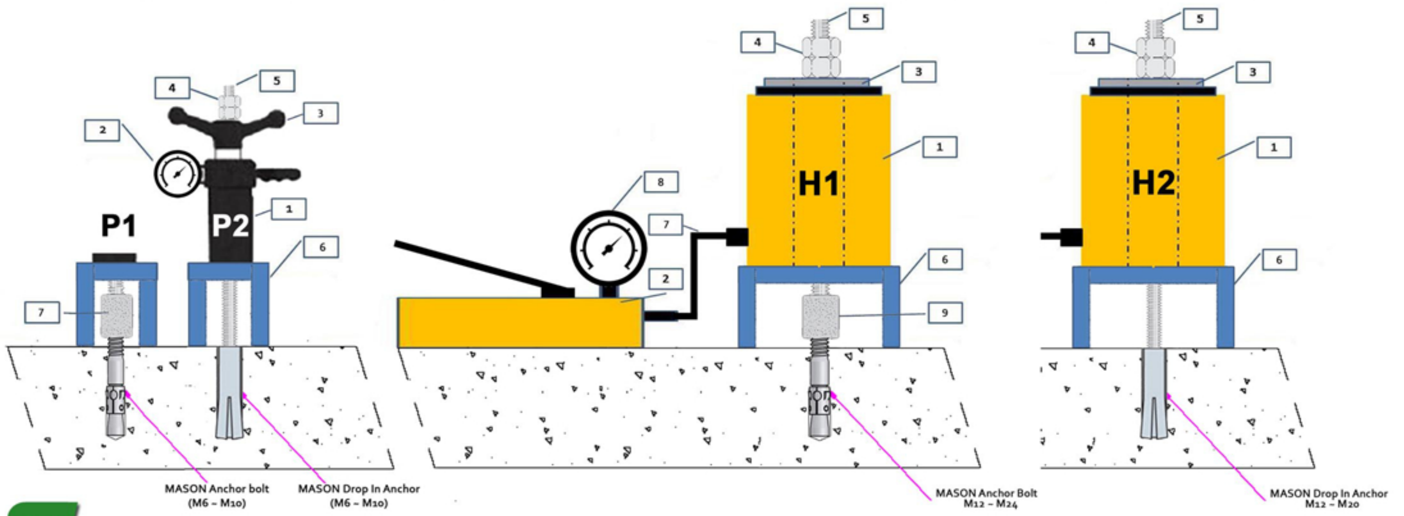
* The above data based on (Non-Cracked Concrete C20/ 25, $f_{ck,cube}$ = 25 N/mm^2).
Actual on site testing may be required when the anchors are fasten into various hallow base materials.

Tensile Pullout Test Method

1) Place the loading frame over the anchor bolt to be tested.
2i) To test anchor bolts, connect the threaded rod coupler to the anchor bolt.
2ii) To test drop in anchor, connect a high tensile threaded rod to the drop in anchor.
3) Place the suitable hollow plunger cylinder on the loading frame.
4) Connect the hydraulic hand pump, perssure gauge and hose assembly to the cylinder.
5) Apply the load gradually to the required proof load (design load for non-destructive testing) or ultimate load (for destructive testing).
6) Observe the mode of failure.
7) Record the achieved load and mode of failure.

Equipment List	Description
1	Centre pull portable hollow cylinder
2	Pressure gauge
3	Pressure control handle
4	Nuts and washers
5	High tensile threaded rod
6	Loading frame
7 (P1)	Threaded rod coupler

Equipment List	Description
1	Centre pull hollow plunger cylinder
2	Hydraulic hand pump
3	Metal washer plate
4	Nuts
5	High tensile threaded rod
6	Loading frame
7	Hydraulic hose
8	Pressure gauge
9 (H1)	Threaded rod coupler



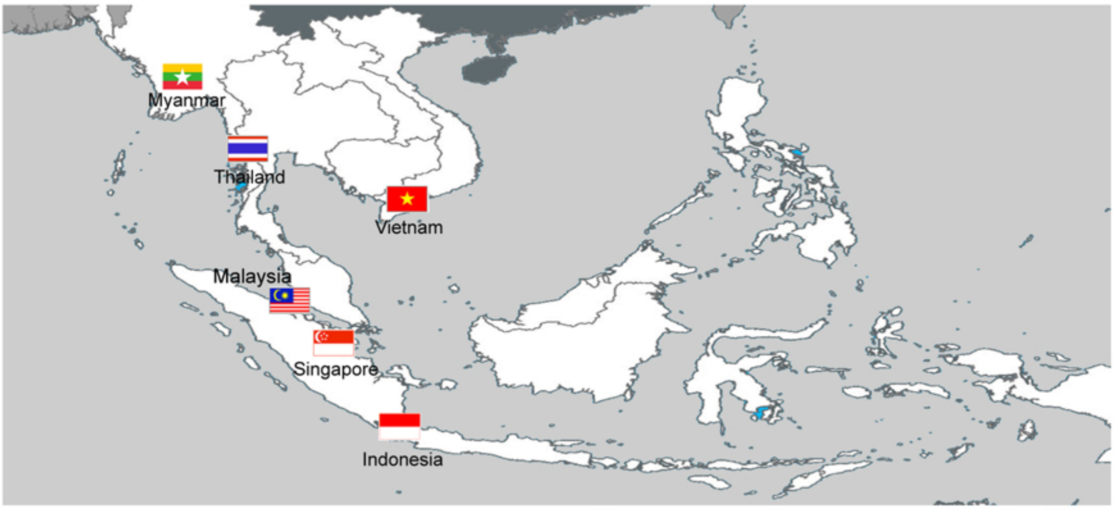
*** NOTES ***

*** DISCLAIMER ***

The information presented in this MASON MECHANCIAL ANCHOR PRODUCT GUIGE AND TECHNICAL CATALOGUE is based on numerous in-house test conducted by the FASTEN Technical & QA/QC Department and are all conducted in a controlled environment. The information and recommendations given in this document are based on the principles, formulae and safety factors set out in the MASON MECHANCIAL ANCHOR PRODUCT GUIGE AND TECHNICAL CATALOGUE and other data sheets that are believed to be correct at the time of writing. As national or international regulations do not cover all possible types of applications, on-site technical support and technical consulting services are required for different types of applications and base materials. Fasten Enterprises and companies are not obligated for direct, indirect, incidental or consequential damages, loses or expenses in connection with, or by reason of, the use of, or inability to use the products for any purpose.

Implied warranties of merchantability or fitness for a particular purpose are specifically excluded.

Regional Sales Network



SINGAPORE
FASTEN ENTERPRISES PTE LTD
COREFIX TECH SYSTEMS (S) PTE LTD
Main Office
No.3 Ang Mo Kio Street 62 #01-50/51
LINK@AMK Singapore 569139
Tel: (65) 6741 2998
Fax: (65) 6741 7606
Email: office@fasten.com.sg
Website: www.fasten.com.sg

FASTEN HARDWARE & ENGINEERING PTE LTD
Tel: (65) 6732 2998
Fax: (65) 6235 2998
Email: office@fastenhardware.com.sg

MALAYSIA (KL)
CF BUILDING PRODUCTS SDN. BHD.
No. 17, Jalan Perusahaan 6/2A,
Kawasan Perusahaan
Selesa Jaya,Balakong 43300
Seri Kembangan, Selangor Darul Ehsan, Malaysia
Tel: (603) 8962 2591/92/93 Fax: (603) 8962 2598
Email: confast@fasten.com.sg

EC MASON INDUSTRIES (M) SDN. BHD.
No. 17, Jalan Perusahaan 6/2A,
Kawasan Perusahaan
Selesa Jaya,Balakong 43300
Seri Kembangan, Selangor Darul Ehsan, Malaysia
Tel: (603) 8962 2591/92/93 Fax: (603) 8962 2598
Email: ecmason@fasten.com.sg

THAILAND
CONSTRUCTION FASTENERS (THAILAND) LTD
1184/23-24, Soi Paholyothin 32, Paholyothin Road,
Chandrakasem, Chatuchak, Bangkok 10900, Thailand.
Tel: (662) 561 0774/5 Fax: (662) 561 2590
Email: cfthailand@fasten.com.sg

VIETNAM
FASTEN ENTERPRISES (VIETNAM) PTE LTD
393 Nguyen Thai Binh, P.12,Q. Tan Binh,
TP.Ho Chi Minh City ,Vietnam
Tel: (84) 8 6281 6188 Fax: (84) 8 6281 6179
Email: vietnam@fasten.com.sg

INDONESIA
PT. CIPTA FASTENER INDONESIA (JKT)
RUKO MEGA GROSIR CEMPAKA MAS
Block N/15, Jl.Letjend Soeprapto, Samur Batu Kemayoran,
Jakarta Pusat 10640, Indonesia.
Tel: (021) 4287 9523 Fax: (021) 4288 0653
Email: sales@ciptafastener.com
Website : www.ciptafastener.com

SURABAYA
Ruko Rungkut Makmur, Jl. Raya Kali Rungkut No. 27 Blok D-3,
Surabaya 60293, Indonesia
Tel: (031) 879 5418/ 9 Fax: (031) 872 2113
Email : sales@ciptafastener.com

MAKASAR
Jl. Dr. Ratulangi No.250, Sulawesi Selatan,
Makasar 90133, Indonesia
Tel: (0411) 856751/ 873195 Fax: (0411) 851579

MYANMAR
CORE-FIX MYANMAR CO., LTD
Blk. B, Room 905, 9th Floor, Muditar Condo, Baho Road,
Ward (2), Mayangone Township, Yangon, Myanmar
Tel: (95) 9 9656 11878
Email: cfmyanmar@fasten.com.sg

Distributor:

SETSCO

SETSCO SERVICES PTE LTD

18 Teban Gardens Crescent
Singapore 608925
Tel : (65) 6566 7777
Fax: (65) 6566 7718
Website: www.setsco.com
Business Reg. No. 196900269D

Date : 13/07/2012

TEST REPORT

(This Report is issued subject to the terms & conditions set out below)

Your Ref. : Endorsed Sales Quotation No. 28006-CQ **Our Ref :** ST - 10590

Subject : Tensile Proof Load Testing on Mason Wedge Anchors M10x90mm, M12x120mm & M16x125mm installed onto concrete block (Grade 30)* as requested by Fasten Enterprises (Pte) Ltd.

Tested For : **FASTEN ENTERPRISES (PTE) LTD**
Block 171 Kallang Way #01-04
Kolam Ayer Industrial Estate
Singapore 349250
Attn : Mr. Thein Htike

Test Location : Block 171, Kallang Way, #01-04

Date of Test : 12th July 2012

Sample Description : A total of Nine (09) nos. of Mason Wedge Anchors installed were tested. The installation of the Mason Wedge Anchors was undertaken by the client on site.

Method of Test : **Adopted from BS 5080: Part 1: 1993**
Load was applied axially to the various sizes of Mason Wedge Anchors by a centre-pull hydraulic jack system to the ultimate load as advised by the client. The maximum load applied shall then be recorded and the mode of failure noted.

Note '' information provided by the client.*
Refer to the table on page 2 for test results and Appendix 1 - 3 for photographs.

Mike

ST-10590 (9-Bolts) Fasten/linda

Results : **Tensile Proof Load Test On M10, M12 & M16 Mason Wedge Anchors**

Sample Ref.	Test Member	Fixing Type	Nominal Dia. of Hole++ (mm)	Embedded Length++ (mm)	Depth of Hole++ (mm)	Applied Tensile Load (kN)	Observation After Test
T1	Mock-up Concrete Block ++ (Grade 30)	Mason Wedge Anchor M10 x 90mm	10	70	70	29.9	Bolt Fracture
T2						27.5	
T3						27.5	
T4		Mason Wedge Anchor M12 x 120mm	12	90	90	42.0	Bolt Fracture
T5						42.0	
T6						42.0	
T7		Mason Wedge Anchor M16 x 125mm	16	100	100	65.2	Concrete Failure
T8						73.2	
T9						69.2	

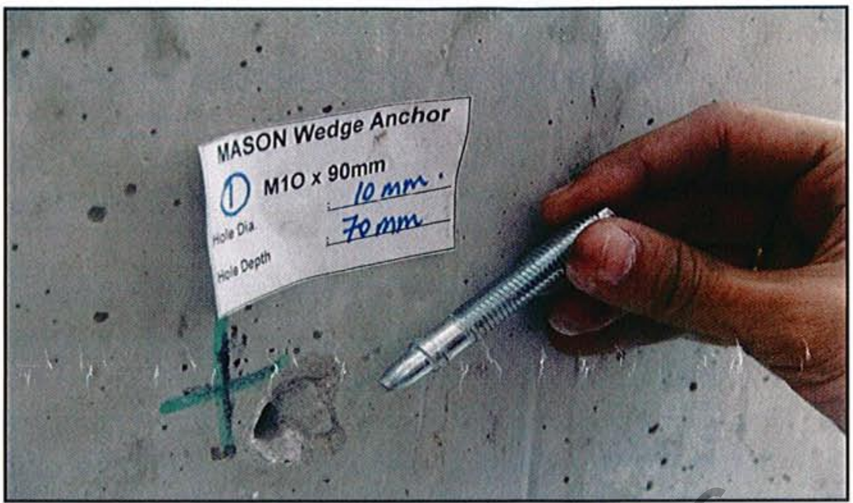
Note:- '++' - information provided by the client.

Witness(es) :

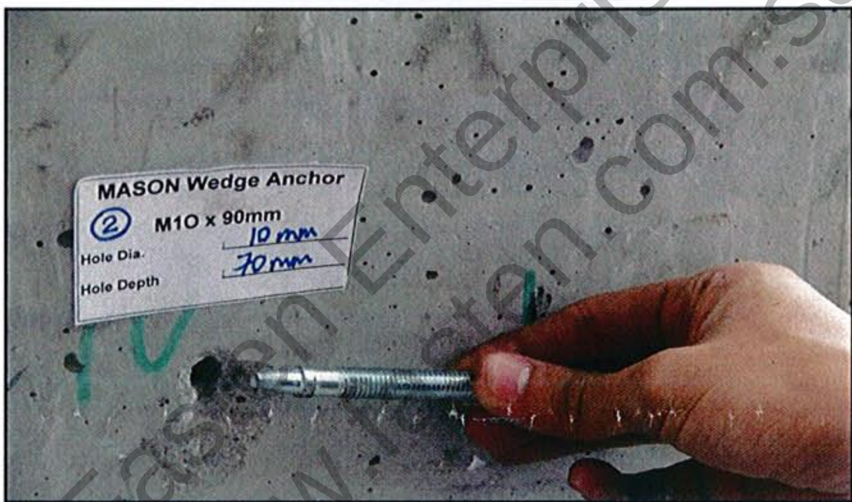
Thein Htike (Fasten Enterprises (Pte) Ltd)

Test Conducted By: Michael
Michael Gurusamy

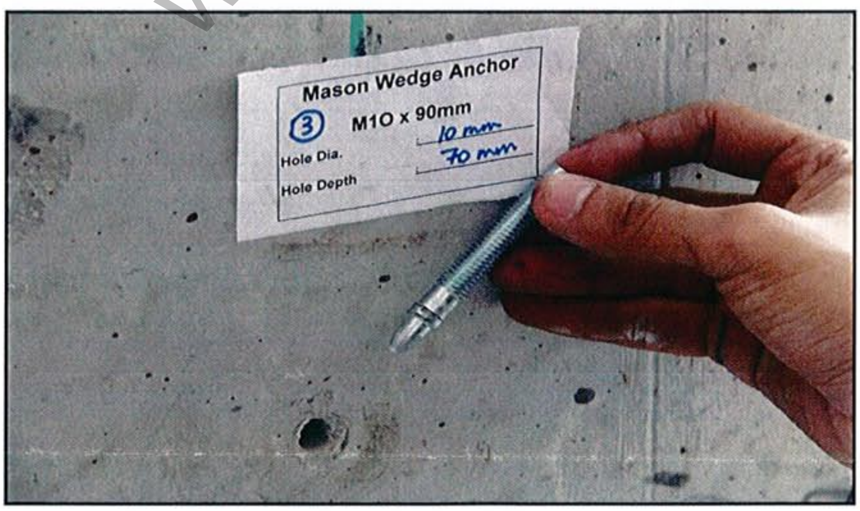
HOW YONG MENG
Principal Engineer
Structural & Integrity Testing Dept.
Construction Technology Division



T1 Wedge M10

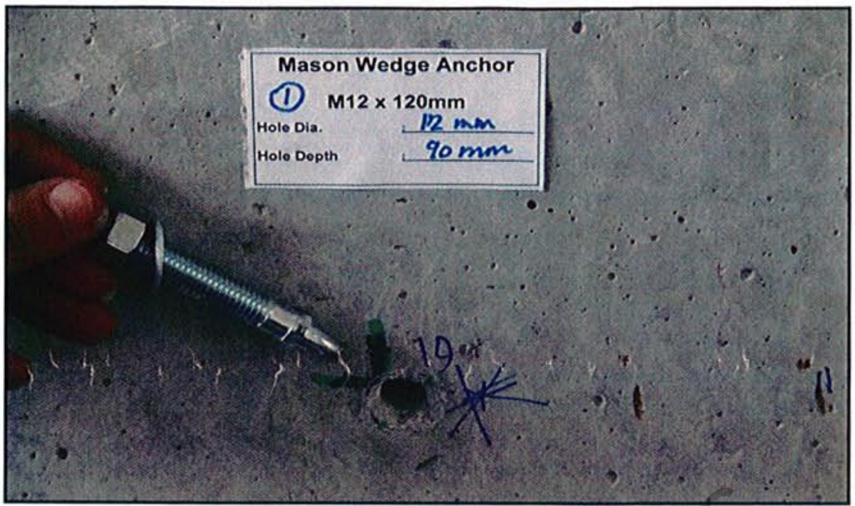


T2 Wedge M10

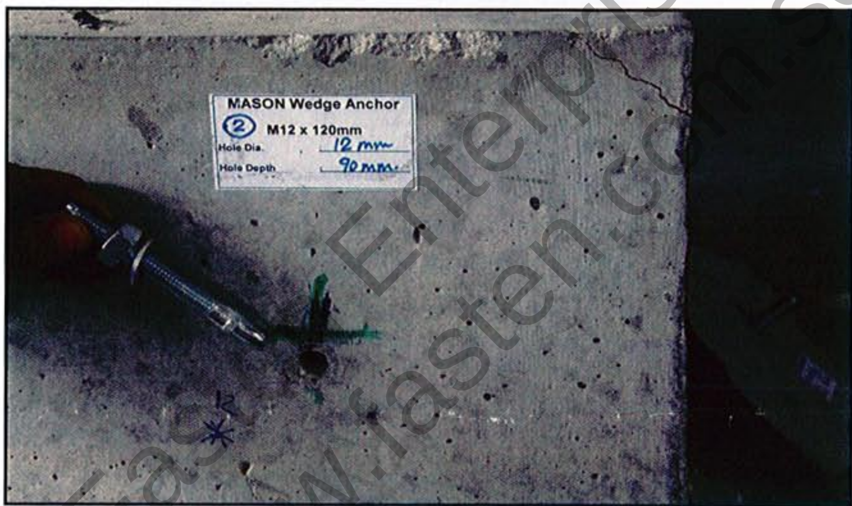


T3 Wedge M10

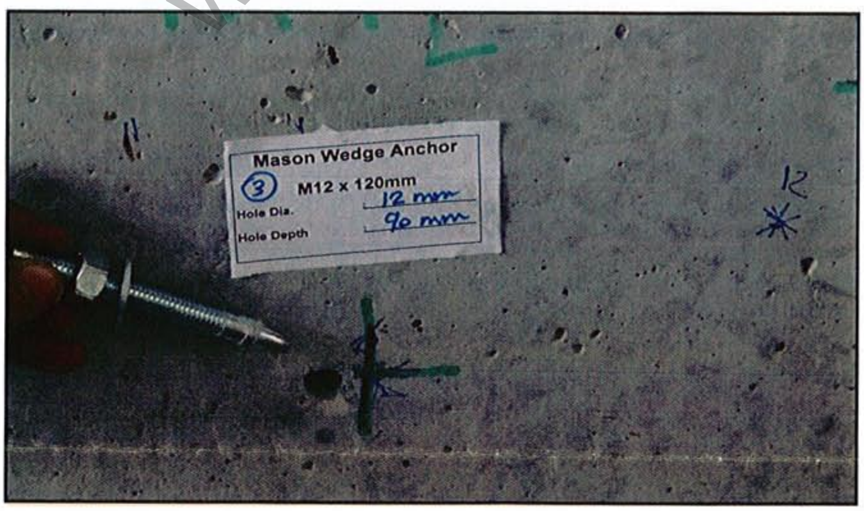
Mike



T4 Wedge M12

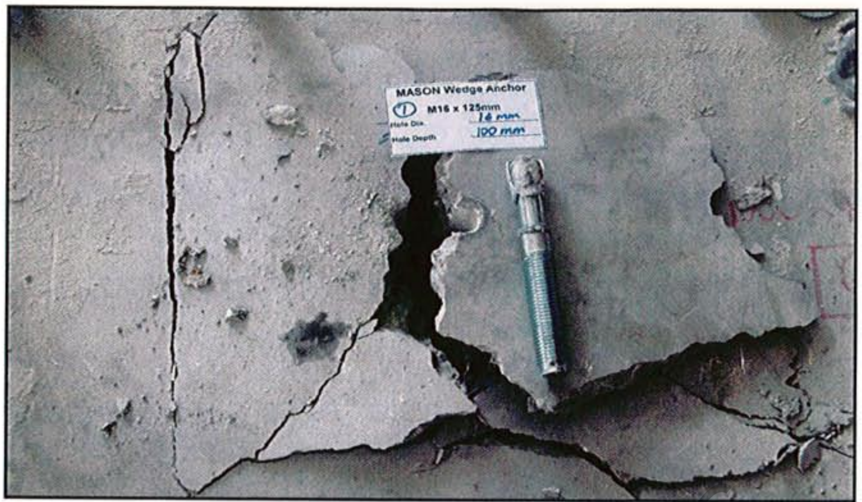


T5 Wedge M12

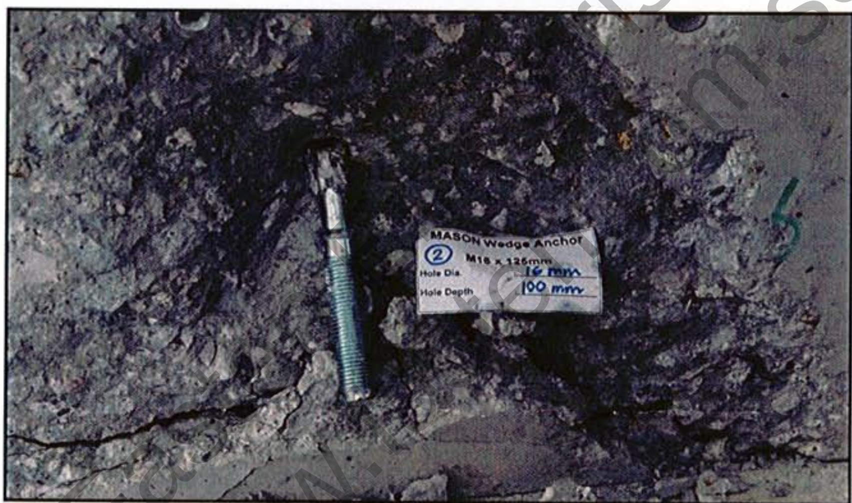


T6 Wedge M12

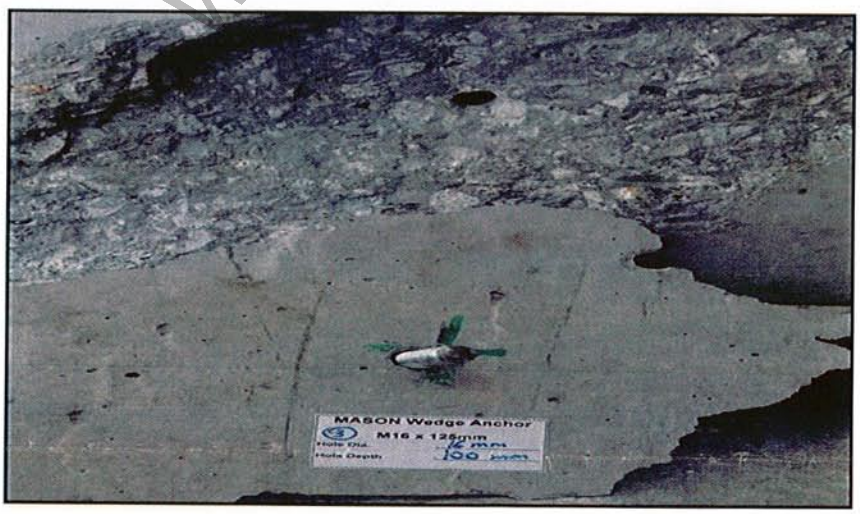
Mike



T7 Wedge M16



T8 Wedge M16



T9 Wedge M16

Mike

SETSCO SERVICES PTE LTD
18 Teban Gardens Crescent
Singapore 608925
Tel : (65) 6566 7777
Fax: (65) 6566 7718
Website: www.setsco.com
Business Reg. No. 196900269D

Date : 12 /04/ 2006

TEST REPORT

(This Report is issued subject to the terms & conditions set out below)

Your Ref : Endorsed Quotation:- 6906-CQ **Our Ref :** ST - 2122

Subject : Third Party Witnessing Of Shear test on M12 and M16 Mason wedge anchors installed into grade 30 (informed by the client) slab as requested by Fasten Enterprise (Pte) Ltd.

Witnessed For : **FASTEN ENTERPRISE (PTE) LTD**
Blk 171, Kallang Way , #01-04
Kolam Ayer Industrial Estate
Singapore 349250
Attn : Mr. Siang Peng Lam

Project Reference / : Yangon International Airport
Test Location : Blk 171, Kallang Way

Date of Test : 12th April 2006.

Sample Description : Two pieces each of M12 and M16 Mason wedge anchors installed into the concrete slab was subjected to Shear loading. The installation of the wedge anchors into the concrete slab was performed by the client.

Method of Test : **Shear Loading Test (adopted from BS 5080 : Part 2 : 1986*)**
A shear load was applied perpendicularly to the M12 and M16 wedge anchors installed by a centre-pull hydraulic jack system to the ultimate load. The maximum load applied and the mode of failure shall then be recorded.

Refer to the table on page 2 for test results while photographs of tested samples are presented in Appendix 1.
A copy of the calibration certificate of the equipment used are attached in Appendix 2.

* *List of deviation from BS 5080:Part1 & 2*
- *no displacement or deformation measurements were made as requested.*

ST-2122(Shear)/Fasten/hym

Results :

Table 1 : Shear Test on M12 and M16 Mason wedge anchors

Sample Ref.	Fixing Type	Embedded Length (mm)	Max. Applied load (kN)	Observation after test
M16/1	M16	110	60.0	anchor sheared off
M16/2	M16		65.0	
M12/1	M12	80	30.0	
M12/2	M12		35.0	

Witness (es) of test :-

Mr. Daniel Lau (Mero Asia)
Mr. Siang Peng Lam (Fasten)
Mr How Yong Meng (Setsco)

HOW YONG MENG
Executive Engineer
Structural Engineering Department

TAN HONG CHOON
Head, Structural Engineering Department
Construction Technology Division

ST-1967(Tensile)Meroasia

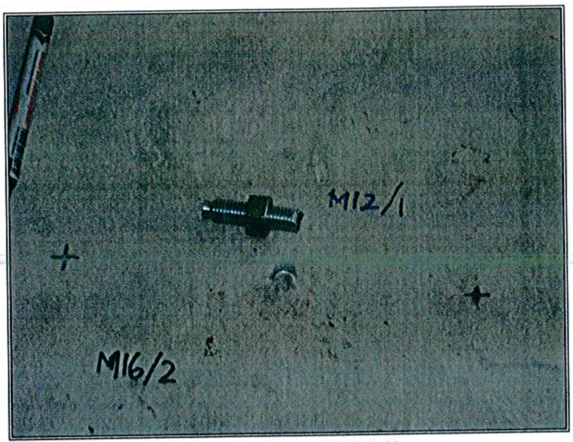
APPENDIX 1

Photographs Of Tested Samples

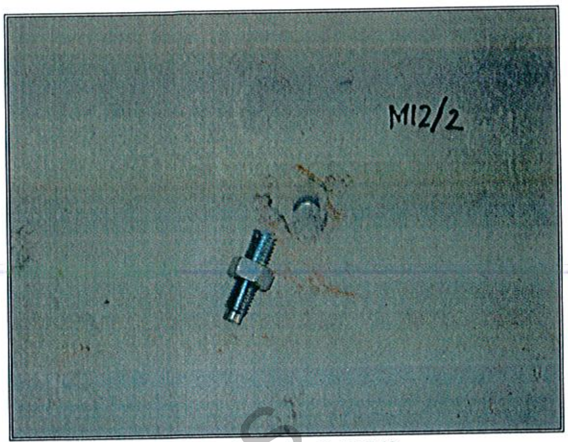
ANNEX 1

ST 2122

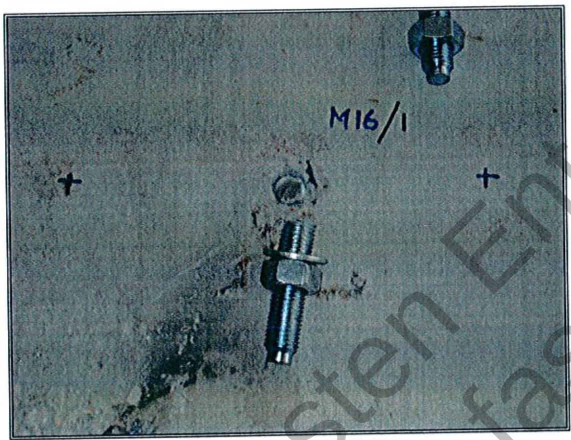
Photo
1/1



sample ref : M12/1



sample ref : M12/2



sample ref : M16/1

sample ref : M16/2

SETSCO

APPENDIX 2

Calibration Certificates Of Test Equipment Used

MW Group Pte. Ltd.
196 Pandan Loop • #02-21 Pantech Industrial Complex Singapore 128384
Tel: 65 - 6872 - 0811 • Fax: 65 - 6872 - 1811
E-mail: sales@mwgroup.com.sg
Website: www.mwgroup.com.sg

CERTIFICATE OF CALIBRATION

CLIENT	: FASTEN ENTERPRISES PTE LTD BLK 171, KALLANG WAY, #01-04 KOLAM AYER INDUSTRIAL ESTATE SINGAPORE 349250	DATE OF ISSUE	: 04/10/2005
		PAGE	: 1 OF 2
		CERTIFICATE NO	: 37497-S-P
INSTRUMENT	: PRESSURE GAUGE	MANUFACTURER	: ENERPAC
SERIAL NO	: 00/1956	DATE CALIBRATED	: 04/10/2005
RANGE	: 0 to 700 bar	MANUFACTURER RECOMMENDED DUE DATE	: 04/10/2006
DATE RECEIPT	: 28/09/2005		

The instrument was calibrated against a pressure balance Deadweight tester,
Budenberg 380HX
Base Serial Number : 22787
Piston/Cylinder Number : 061D
Traceability Referance : SPRING - MM 007925

Calibration of this instrument has been accomplished using standards maintained by MW Group Pte Ltd.
The standards used are traceable to the standards maintained by SPRING Singapore.

CALIBRATION TRACEABLE TO NATIONAL STANDARDS

The procedures and methods are also acceptable by the surveyors of the following societies :
- Det norske Veritas (Aberdeen) reference SSJ/BJM
- Lloyds Register (Aberdeen) reference GL/KC
- American Bureau of Shipping (Singapore) reference SG2286MS

The calibration was maintained at a constant ambient temperature of 20 °C ± 2 °C and a relative humidity of 55% r.h. ± 10% r.h.
The laboratory environmental conditions recorded on a Hygro-Thermograph, Serial # 4482.

The intrinsic corrections took into account the following data :
- A local gravity of 9.78067 m/s^2.
- Stainless steel mass set, using a density of 8000 kg/m^3 in the surrounding air of density 1.2 kg/m^3 for standard buoyancy correction.
- The pressure input of the instrument was set at the same height as the pressure balance.
- Pressurisation medium was ISO VG15 mineral oil.
- The equipment was calibrated against a dead weight tester with an accuracy of 0.015% of indicated reading.

Calibration method in accordance with ISO/IEC GUIDE 17025 QUALITY PRESSURE PROCEDURE SECTION 2.1.0.

Note : This cover page does not form part of the calibration results, part or whole of the work maybe subcontracted under International Standard ISO/IEC 17025 Section 4.5.1.

ACCREDITED LABORATORY SAC - SINGLAS

METROLOGY AND CALIBRATION PROGRAM US - DEPARTMENT OF THE NAVY

BRITISH CHAMBER OF COMMERCE SINGAPORE

CERTIFICATE OF CALIBRATION

CERTIFICATE NO : 37497-S-P

SERIAL NO : 00/1956

INSTRUMENT : PRESSURE GAUGE

INCREMENT : 1 bar

The instrument was allowed to settle before each reading was taken.

ACTUAL VALUE bar	DEVICE READING					
	RUN 1		RUN 2		RUN 3	
	RISING	FALLING	RISING	FALLING	RISING	FALLING
0.0	0	0	0	0	0	0
171.9	175	175	175	175	175	175
343.8	345	345	345	345	345	345
522.6	525	525	525	525	525	525
694.5	700	700	700	700	700	700

RISING MEAN bar	FALLING MEAN bar	MAXIMUM Correction (% f.s.)	MAXIMUM Hysteresis (% f.s.)	Uncertainty bar
0	0	0.0000	0.0000	(±) 2.8290
175	175	-0.4429	0.0000	(±) 2.8291
345	345	-0.1714	0.0000	(±) 2.8292
525	525	-0.3429	0.0000	(±) 2.8295
700	700	-0.7857	0.0000	(±) 2.8299

Piston & Ambient Temperature : 20.0 °C [± 2 °C]
Based on the above results, the instrument is within ± 0.8 % of full scale value.
The accuracy of this instrument conforms to Accuracy Class 1.0 as per BS EN 837 - 1 : 1998 / EA - 10/17.
The above instrument has been tested in general accordance with the manufacturer's published specification model.
The test results have been verified to be generally within specifications UNLESS indicated otherwise.
No adjustment was done unless Before Adjustment and After Adjustment readings are shown.

Calibrated by : Technician — R. Ayyappan, Dip. E.com. Eng.

Approved by : Authorised Signatory — M. Wheeler, M.Sc. Eng. Tech.

HOUSING & DEVELOPMENT BOARD

My Business >

HDB's Materials List

- About Us >
- Suppliers >
- Product Performance Requirement >
- Materials List Application >

Suppliers

Brand	MASON Wedge Anchor M10 x 90mm (MW 10 x 90)
Model	
Listed Date	2016-08-17
Expiry Date	2019-08-31
Company	FASTEN ENTERPRISES (PTE) LTD
Telephone No.	67412998
Email	office@fasten.com.sg
Website	www.fasten.com.sg

Back

HOUSING & DEVELOPMENT BOARD

My Business >

HDB's Materials List

- About Us >
- Suppliers >
- Product Performance Requirement >
- Materials List Application >

Suppliers

Brand	MASON Wedge Anchor M12 x 120mm (MW 12 x 120)
Model	
ML Image	
Listed Date	2016-06-01
Expiry Date	2019-05-31
Company	FASTEN ENTERPRISES (PTE) LTD
Telephone No.	67412998
Email	office@fasten.com.sg
Website	www.fasten.com.sg

Back

SETSCO

SETSCO SERVICES PTE LTD

18 Teban Gardens Crescent
Singapore 608925
Tel : (65) 6566 7777
Fax: (65) 6566 7718
Website: www.setsco.com
Business Reg. No. 196900269D

Date : 29/04/2014

TEST REPORT

(This Report is issued subject to the terms & conditions set out below)

Your Ref. : Endorsed Sales Quotation No. 34537-CQ **Our Ref :** ST - 14288/1

Subject	:	Tensile Proof Load Testing on Mason Drop-In Anchors 3/8"x40mm & ½"x50mm installed onto concrete block (Grade 30)* as requested by Fasten Enterprises (Pte) Ltd.
Tested For	:	**FASTEN ENTERPRISES (PTE) LTD** Block 171 Kallang Way #01-04 Kolam Ayer Industrial Estate Singapore 349250 **Attn :** Mr. Thein Htike
Test Location	:	Block 171 Kallang Way
Date of Test	:	28th April 2014
Sample Description	:	A total of Two (02) nos. each of Mason Drop-In Anchors 3/8"x40mm & ½"x50mm installed were tested. The installation of the Mason Drop-In Anchors was undertaken by the client on site.
Method of Test	:	**Adopted from BS 5080: Part 1: 1993** Load was applied axially to the various sizes of Mason Drop-In Anchors by a centre-pull hydraulic jack system to the ultimate load as advised by the client. The maximum load applied shall then be recorded and the mode of failure noted.

Note '' information provided by the client.*

Refer to the table on page 2 for test results and Appendix 1 - 2 for photographs.

Results : **Tensile Proof Load Test On 3/8" x 40mm & ½" x 50mm Mason Drop-In Anchor**

Sample Ref.	Test Member	Fixing Type	Nominal Dia. of Hole++ (mm)	Depth of Hole++ (mm)	Req'd Ultimate Load (kN)	Applied Tensile Load (kN)	Observation After Test
B01	Mock-up Concrete Block ++ (Grade 30)	Mason Drop-In Anchor 3/8" x 40mm	12	40	17.0	22.2	Concrete Failure
B02						26.6	
B03		Mason Drop-In Anchor ½" x 50mm	16	50	27.0	28.8	Concrete Failure
B04						28.8	

Note:- '++' - information provided by the client.

Witness(es) :

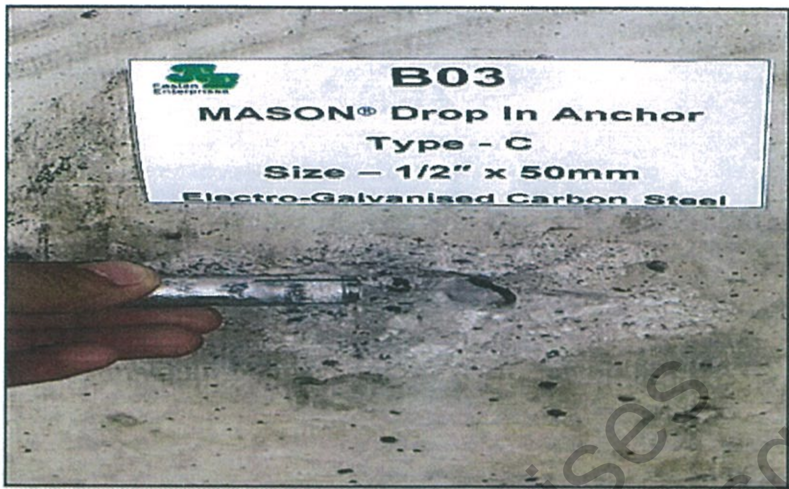
Thein Htike (Fasten Enterprises (Pte) Ltd)

Test Conducted By: Kon Chan Loong

HOW YONG MENG
Assistant Manager
Structural & Integrity Testing Dept.
Construction Technology Division

B01 - Drop-In Anchor 3/8" x 40mm

B02 - Drop-In Anchor 3/8" x 40mm



B03 - Drop-In Anchor ½" x 50mm

B04 - Drop-In Anchor ½" x 50mm

SETSCO SERVICES PTE LTD
18 Teban Gardens Crescent
Singapore 608925
Tel : (65) 6566 7777
Fax: (65) 6566 7718
Website: www.setsco.com
Business Reg. No. 196900269D

Date : 29/04/2014

TEST REPORT

(This Report is issued subject to the terms & conditions set out below)

Your Ref. : Endorsed Sales Quotation No. 34537-CQ

Our Ref : ST - 14288/2

Subject : Tensile Proof Load Testing on Mason Drop-In Anchors M16 x 65mm installed onto concrete block (Grade 30)* as requested by Fasten Enterprises (Pte) Ltd.

Tested For : **FASTEN ENTERPRISES (PTE) LTD**
Block 171 Kallang Way #01-04
Kolam Ayer Industrial Estate
Singapore 349250
Attn : Mr. Thein Htike

Test Location : Block 171 Kallang Way

Date of Test : 28th April 2014

Sample Description : A total of Two (02) nos. of Mason Drop-In Anchors M16 x 65mm installed were tested. The installation of the Mason Drop-In Anchors was undertaken by the client on site.

Method of Test : **Adopted from BS 5080: Part 1: 1993**
Load was applied axially to the Mason Drop-In Anchors M16 x 65mm by a centre-pull hydraulic jack system to the ultimate load as advised by the client. The maximum load applied shall then be recorded and the mode of failure noted.

Note '' information provided by the client.*
Refer to the table on page 2 for test results and Appendix 1 - 2 for photographs.

ST-14288/2 2-Bolts) Fasten/linda

Results : **Tensile Proof Load Test For M16 x 65mm Mason Drop-In Anchor**

Sample Ref.	Test Member	Fixing Type	Nominal Dia. of Hole++ (mm)	Depth of Hole++ (mm)	Req'd Ultimate Load (kN)	Applied Tensile Load (kN)	Observation After Test
B05**	Mock-up Concrete Block ++ (Grade 30)	Mason Drop-In Anchor M16 x 65mm	20	65	45.9	70.7	Anchor Fracture
B06***						50.8	Anchor Slippage

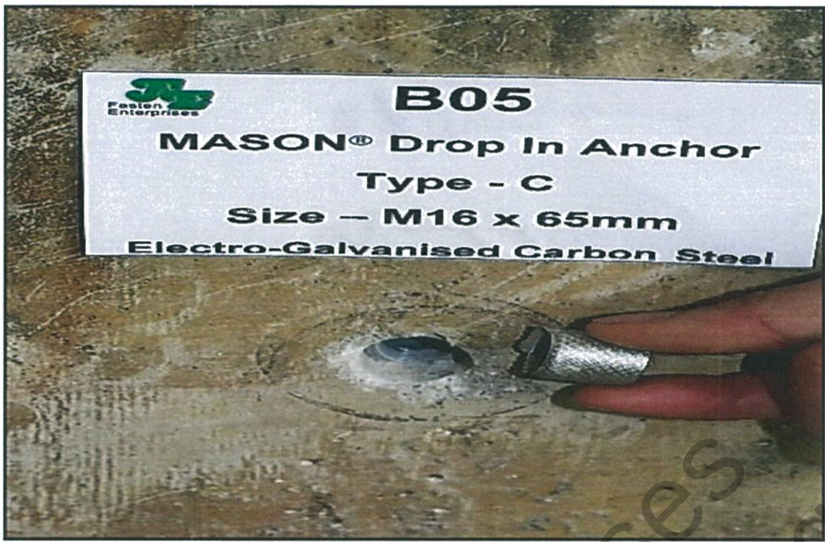
Note:- '++' - information provided by the client.
***B05 - during installation, anchor is fully expanded into the concrete.*
****B06 - during installation, anchor is only 70% expanded into the concrete due to internal rebar.*

Witness(es) :

Thein Htike (Fasten Enterprises (Pte) Ltd)

Test Conducted By: Kon Chan Loong

HOW YONG MENG
Assistant Manager
Structural & Integrity Testing Dept.
Construction Technology Division



B05 - Anchor M16 x 65mm

B06 - Anchor M16 x 65mm

SETSCO SERVICES PTE LTD

SETSCO

18 Teban Gardens Crescent
Singapore 608925
Tel : (65) 6566 7777
Fax: (65) 6566 7718
Website: www.setsco.com
Business Reg. No. 196900269D

Date: 02 /09/ 2008

TEST REPORT

(This Report is issued subject to the terms & conditions set out below)

Our Ref: ST - 4573

Subject : Third Party Witnessing of Tensile (Pull out) testing on M12 x 100 set anchors and 3/8" x 30 Drop-In anchors installed into the grade 30* unreinforced concrete block conducted by M/s Fasten Enterprises (Pte) Ltd personnel.

Witnessed For : **FASTEN ENTERPRISES (PTE) LTD**
Blk 171, Kallang Way, #01-04
Kolam Ayer Industrial Estate
Singapore 349250
Attn : Mr. Tan Kwok Cheng

Date of Witnessing : 2nd September 2008

Test Location : Blk 171, Kallang Way

Sample Description : Three (3) pieces each of M12 x 100 set anchors and 3/8" x 30 Drop-In anchors installed into the concrete block were tested. The installation of the above anchors into the concrete block were undertaken by the client.

Method of Test : **Adopted from BS 5080 : Part 1 : 1993**
Load was applied axially to installed M12 x100 set anchors and 3/8" x 30 Drop-In anchors by a hydraulic jack system to the required test load and held for a minute before proceeding to the ultimate.
The maximum load applied shall be recorded and the observation after test of each individual sample was noted.

Results : The detailed result of the test conducted are as presented in the table 1 & 2 in the next page.

Images of the mode of failure for the tested samples are presented in the ~~Annex~~ while the calibration certificate of the test equipment used for conducting the test are as presented in the Appendix.

Results:-

Table 1 :- Tensile (Pull-Out) Test on M12 x 100 Set Anchors Installed Into Grade 30 Concrete Block*

Test Ref.	Fixing Type	Hole Diameter (mm)*	Depth of Hole (mm)*	Edge Distance (mm)	Anchors Centre to Centre (mm)	Applied Required Tensile Load (kN)*	Ultimate Load Applied (kN)	Observation after test
S1	M12 x 100 Set Anchor	18	100	220	180	34.0	58.9	anchor fracture
S2		18	100	220	180	34.0	54.0	Slippage of anchor
S3		18	100	220	180	34.0	58.9	anchor fracture

Table 2 :- Tensile (Pull-Out) Test on 3/8" x 30 Drop-In Anchors Installed Into Grade 30 Concrete Block*

Test Ref.	Fixing Type	Hole Diameter (mm)*	Depth of Hole (mm)*	Edge Distance (mm)	Anchors Centre to Centre (mm)	Applied Required Tensile Load (kN)*	Ultimate Load Applied (kN)	Observation after test
S4	3/8" x 30 Drop-In Anchor	12	30	150	120	11.0	24.5	concrete failure
S5		12	30	150	120	11.0	24.5	concrete failure
S6		12	30	150	120	11.0	19.6	concrete failure

note:- '*' - info provided by the client

HOW YONG MENG (Witnessing Officer)
Principal Engineer
Structural Engineering Dept.
Construction Technology Division

APPENDIX A

Calibration Reports

MW Group Pte. Ltd.
196 Pandan Loop • #02-21 Pantech Industrial Complex Singapore 128384
Tel: 65 - 6872 - 0811 • Fax: 65 - 6872 - 1811
E-mail: sales@mwgroup.com.sg
Website: www.mwgroup.com.sg

CERTIFICATE OF CALIBRATION

CLIENT	FASTEN ENTERPRISES PTE LTD BLK 171, KALLANG WAY, #01-04 KOLAM AYER INDUSTRIAL ESTATE SINGAPORE 349250	**DATE OF ISSUE**	: 26/OCT/2007
		PAGE	: 1 OF 2
		CERTIFICATE NO	: 43900-S-P
INSTRUMENT	PRESSURE GAUGE C/W HAND PUMP	**MANUFACTURER**	: ENERAPAC
SERIAL NO	: 12387	**DATE CALIBRATED**	: 26/OCT/2007
RANGE	: 0 to 10000 psi	**MANUFACTURER RECOMMENDED**	
DATE RECEIPT	: 25/OCT/2007	**DUE DATE**	: 26/OCT/2008

The instrument was calibrated against a pressure balance Deadweight tester,
Budenberg 380HX
Base Serial Number : 22787
Piston/Cylinder Number : 061D
Traceability Referance : SPRING - MM 007925

Calibration of this instrument has been accomplished using standards maintained by MW Group Pte Ltd.
The standards used are traceable to the standards maintained by SPRING Singapore.

CALIBRATION TRACEABLE TO NATIONAL STANDARDS

The procedures and methods are also acceptable by the surveyors of the following societies :
- Det norske Veritas (Aberdeen) reference SSJ/BJM
- Lloyds Register (Aberdeen) reference GL/KC
- American Bureau of Shipping (Singapore) reference SG2286MS

The calibration was maintained at a constant ambient temperature of 20 °C ± 2 °C and a relative humidity of 55% r.h. ± 10% r.h.
The laboratory environmental conditions recorded on a Hygro-Thermograph, Serial # 4482.

The intrinsic corrections took into account the following data :
- A local gravity of 9.78067 m/s².
- Stainless steel mass set, using a density of 8000 kg/m³ in the surrounding air of density 1.2 kg/m³ for standard buoyancy correction.
- The pressure input of the instrument was set at the same height as the pressure balance.
- Pressurisation medium was ISO VG15 mineral oil.
- The equipment was calibrated against a dead weight tester with an accuracy of 0.011% and 0.025% of indicated reading.

Calibration method in accordance with ISO/IEC GUIDE 17025 QUALITY PRESSURE PROCEDURE SECTION 2 1.0.

Note : This cover page does not form part of the calibration results, part or whole of the work maybe subcontracted under International Standard ISO/IEC 17025 Section 4.5.1

CERTIFICATE OF CALIBRATION

CERTIFICATE NO : 43900-S-P SERIAL NO. : 12387

INSTRUMENT : PRESSURE GAUGE C/W HAND PUMP INCREMENT : 100 psi

The instrument was allowed to settle before each reading was taken.

ACTUAL VALUE psi	DEVICE READING RUN 1 RISING	RUN 1 FALLING	RUN 2 RISING	RUN 2 FALLING	RUN 3 RISING	RUN 3 FALLING
0.0	0	0	0	0	0	0
2494.0	2500	2500	2500	2500	2500	2500
4988.0	5000	5000	5000	5000	5000	5000
7481.9	7500	7500	7500	7500	7500	7500
9975.9	9950	9950	9950	9950	9950	9950

RISING MEAN psi	FALLING MEAN psi	MAXIMUM Correction (% f.s.)	MAXIMUM Hysteresis (% f.s.)	Uncertainty psi
0	0	0.0000	0.0000	(±) 28.3
2500	2500	-0.0600	0.0000	(±) 28.3
5000	5000	-0.1200	0.0000	(±) 28.3
7500	7500	-0.1810	0.0000	(±) 28.3
9950	9950	0.2590	0.0000	(±) 28.3

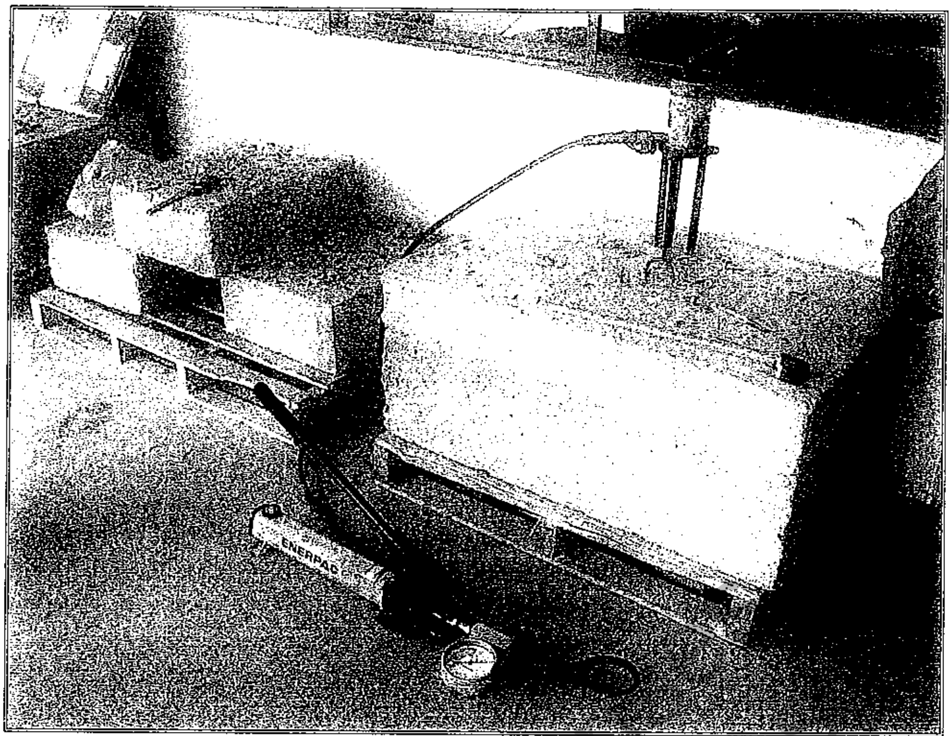
Piston & Ambient Temperature : 20.0 °C [± 2 °C]
Based on the above results, the instrument is within ± 0.3 % of full scale value.
The accuracy of this instrument conforms to Manufacturer's Recommended Accuracy.
The above instrument has been tested in general accordance with the manufacturer's published specification model
The test results have been verified to be generally within specifications UNLESS indicated otherwise.
No adjustment was done unless Before Adjustment and After Adjustment readings are shown.

Calibrated by : Technician — S. Karuppiah, Dip. Mech. Eng.

Approved by : Authorised Signatory — M. Wheeler, MSc. Eng. Tech.

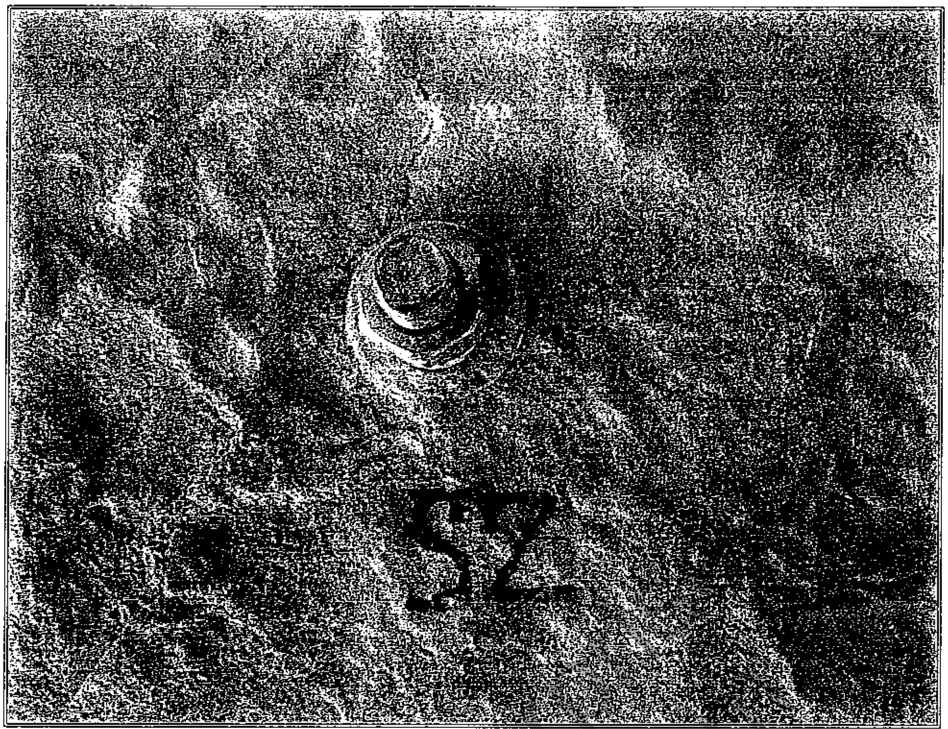
ANNEX

Images Of Failures Of Test Specimens After Test

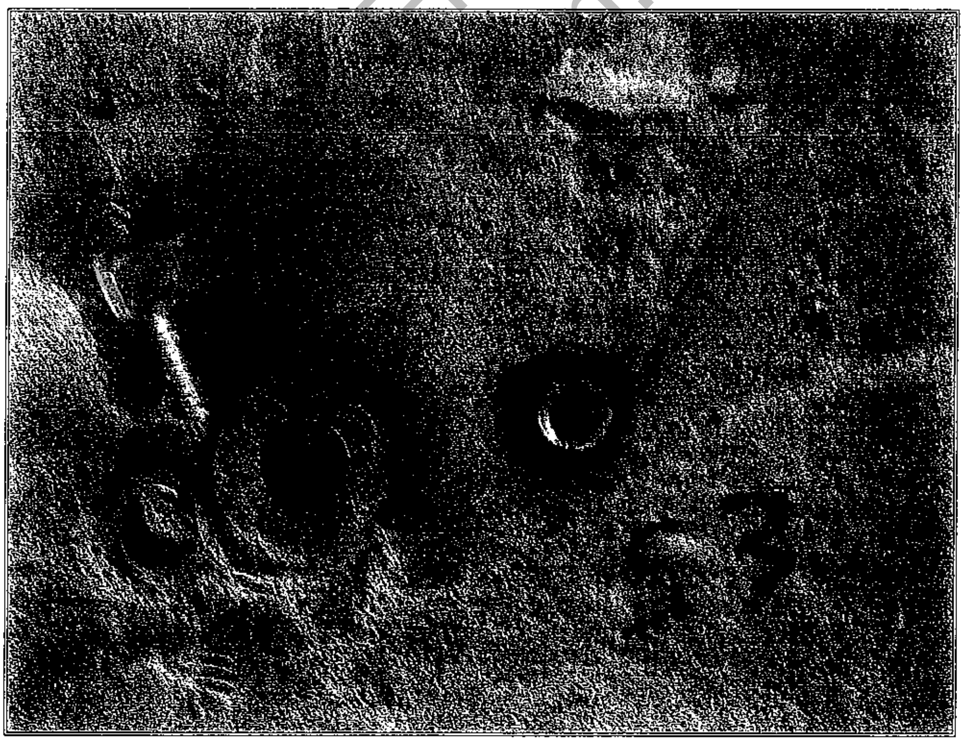


Typical Test Set-Up

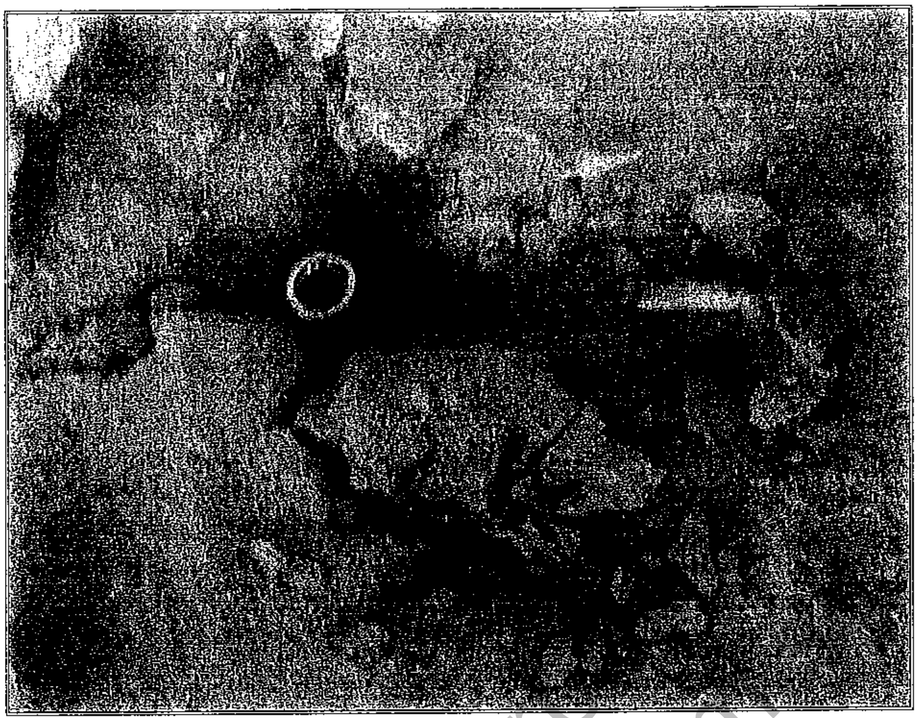
Sample S1 (specimen after test)



Sample S2 (specimen after test)



Sample S3 (specimen after test)



Sample S4 (specimen after test)

Sample S6 (specimen after test)

TEST REPORT

(This Report is issued subject to the terms & conditions set out below)

SETSCO

Setsco Services Pte Ltd
18 Teban Gardens Crescent
Singapore 608925
Tel : (65) 6566 7777
Fax: (65) 6566 7718
www.setsco.com
Business Reg. No. 196900269D

Date : 26/10/2018

Our Ref : ST-8500028498

Subject	:	Ultimate Tensile Load Testing on Mason Sleeve Anchors Ø10 x 40mm, Ø12 x 60mm & Ø16 x 111mm installed onto concrete block (Grade 25)* as requested by Fasten Enterprises (Pte) Ltd.
Tested For	:	**FASTEN ENTERPRISES (PTE) LTD** 3, Ang Mo Kio Street 62 Link @ AMK #01-50/51 Singapore 56989 **Attn :** Mr. Thein Htike
Test Location	:	Block 1014 Eunos Avenue 5 #01-26, S409740
Date of Test	:	25th October 2018
Sample Description	:	One (01) no. each of Mason Sleeve Anchors Ø10 x 40mm, Ø12 x 60mm & Ø16 x 111mm installed were tested. The installation of the Mason Sleeve Anchors was undertaken by the client on site.
Method of Test	:	**Adopted from BS 5080: Part 1: 1993** Load was applied axially to the various sizes of Mason Sleeve Anchors by a centre-pull hydraulic jack system to the ultimate load as advised by the client. The maximum load applied shall then be recorded and the mode of failure noted.

Refer to the table on page 2 for test results and Appendix 1 for photographs.

Results : **Tensile Ultimate Load Test On Mason Sleeve Anchor**

Sample Ref.	Test Member	Fixing Type	Nominal Dia. of Hole++ (mm)	Depth of Hole++ (mm)	Req'd Ultimate Load (kN)	Achieved Tensile Load (kN)	Observation After Test
B01	Mock-up Concrete Block ++ (Grade 25)	Mason Sleeve Anchor Ø10 x 40mm	10	40	9.5	9.6	Concrete Failure
B02		Mason Sleeve Anchor Ø12 x 60mm	12	50	13	27.6	
B03		Mason Sleeve Anchor Ø16 x111mm	16	100	16	46.0	Bolt Fracture

Note:- '++' - information provided by the client.

Witness(es) :

Thein Htike (Fasten Enterprises (Pte) Ltd)

Test Conducted By: Kon Chan Loong

HOW YONG MENG
Assistant Manager
Structural & Integrity Testing Dept.
Construction Technology Division

Sleeve Anchor Ø10 x 40 mm

Sleeve Anchor Ø16 x 111 mm

Sleeve Anchor Ø12 x 60 mm

Sleeve Anchor Ø10 x 40 mm

Sleeve Anchor Ø16 x 111 mm

Sleeve Anchor Ø12 x 60 mm

European Technical Assessment

ETA-14/0234 of 31 July 2014

General Part

Technical Assessment Body issuing the European Technical Assessment:	Deutsches Institut für Bautechnik
Trade name of the construction product	MASON Wedge Anchor MWA
Product family to which the construction product belongs	Torque-controlled expansion anchor of sizes M8, M10, M12 and M16 for use in non-cracked concrete
Manufacturer	Fasten Enterprises (PTE) Ltd. Blk 171 Kallang Way #01-04 SINGAPORE 349250 SINGAPUR
Manufacturing plant	Fasten Enterprises (PTE) Ltd. plant 1
This European Technical Assessment contains	13 pages including 3 annexes which form an integral part of this assessment
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of	Guideline for European technical approval of "Metal anchors for use in concrete", ETAG 001 Part 2: "Torque controlled expansion anchors", Edition April 2013, used as European Assessment Document (EAD) according to Article 66 Paragraph 3 of Regulation (EU) No 305/2011.

FASTEN ENTERPRISES

MASON

MASON MECHANICAL ANCHOR PARTICIPATION IN MAJOR PROJECTS

INDUSTRIAL / COMMERICAL PROJECTS

10 Sty Light Industrial Building @ No.34 Genting Lane
MSD Engineering A&A
Orchard Centre
Changi Cargo No.61
7 Sty Industrial Building @ MK 23 Ubi Ave 1
8 Sty Factory @ New Industrial Rd
Singapore Press Holding (Media Works) @ Kallang Way
Ubi Tech Park @ Ubi Road
JTC Factory Kallang Place Blk 26
Park Regis Hotel
Garden By the Bay
Marina Bay Sands IR Hotel Tower
TTSH Project
A&A @ PIL Building
MBS IR North Podium P2240
Faculty of Dentistry (NUS)
Mandarin Hotel Orchard
11 Sty Hotel @ 50 Telok Blangah Rd
4 Sty Factory @ 156A Gul Circle
OFFICES @ Science Park Drive
Changi Business Park Crescent
WAREHOUSE @ Tuas South Street 11
Raffles Hospital Extension
Jurong Christian Church at 2 Tah Ching Rd
Centre for Oral Health (COH) at NUH
Northpoint City
Global Indian International School
Child Care Centre @ Segar Gardens
Choa Chu Kang Town Council
2 Tuas South Street 15
60 West Coast Ferry Road

CIVIL & INFRASTRUCTURE PROJECTS

C158 - Design and Construction of Canberra Station
T218 - Construction of Orchard Boulevard Station for Thomson Line
T220 - Construction of Great World Station and Tunnels for Thomson Line
DTSS - T01 Changi Tunnel
Changi Airport Terminal 4
Project C3D - CWRP
C831 Circle Line Stage 1
C824 Circle Line Stage 1
Jurong Sewage Treatment Works Phase III (PUB Job)
KPE C423
KPE C424
C902 Downtown Line Stage 1
Promenade Station & Associated Tunnels
Marina Reservoir Republic Ave
Marina Bayfront Bridges @ Marina Bay
Changi Water Reclaimation

RESIDENTIAL (HDB) PROJECTS

HDB WOODLANDS NEIGHBOURHOOD 6C22
HDB PUNGGOL WEST CONTRACT 33 & 34
HDB HOUGANG TOWN
HDB TOA PAYOH ALKAFF OASIS
HDB Tampines Neighbourhood 6 Contract 2A
HDB SERANGOON NORTH CONTRACT 18
HDB Jalan Bukit Merah
HDB Bukit Merah RC45
HDB Woodland N6 C18 /19
HDB Choa Chu Kang N6C15
HDB Bukit Batok N1C13
HDB Bukit Batok N2C13
HDB Jurong West Central 2/3 N6C31
HDB Yishun N5C2
HDB Hougang N4C17
HDB Bukit Panjang N4C15
HDB Woodlands N1C26/27
HDB COMPASSVALE CAPE
HDB Bukit Batok N4C18
HDB Sembawang N1C1
HDB Tampines North Drive 1HDB
HDB Jalan Bahagia
HDB Geylang RC26
HDB @ Taban Gardens
HDB Sengkang N4C14
HDB Bukit Merah RC36
HDB Sengkang SKN2C36
HDB @ Buangkok Crescent N9C15

RESIDENTIAL PROJECTS

BELLEWOODS @ Woodlands Avenue 5
WATERFRONT @ FABER
OXLEY EDGE @ 308 River Valley Road
HERON BAY 55 Upper Serangoon View
LUSH ACRES @ Sengkang West Way
THE FLOW @ 66 East Coast Road
HE CRITERION @ Yishun Street 51
RIVERTREES RESIDENCES @ 37 Fernvale
THE VISIONAIRE @ Sembawang Road
RIVERBANK @ FERNVALE
OLEANDER BREEZE AT YISHUN AVE 1
TERRACE HOUSE @ 112 Jalan Leban
#1 LOFT @ 1 Lorong 24 Geylang
ESPA @ Cashew Rd
A&A to semi-detached house @ 8a, Mariam Close
Yishun Sapphine Condominium
Spring Leaf Tower @ Anson Road