

The Unbrako logo is positioned in the top left corner, featuring the brand name in white on an orange rectangular background. The background of the entire page is a light blue gradient with a subtle, embossed map of the world centered behind the logo.

**Unbrako®**

UNBRAKO ENGINEERED INDUSTRIAL FASTENERS

THE WORLD LEADER

# PRECISION SPECIAL FASTENERS

## COMPANY PROFILE

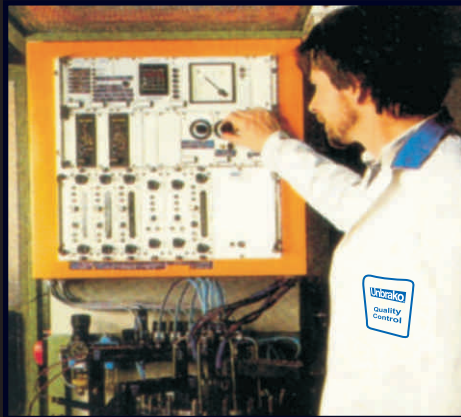
UNBRAKO, renowned for the widest range of Hexagon Socket Screws and allied products, whose quality is beyond reproach.

Such capabilities and expertise encompass more than standard product. The manufacture of precision fasteners, both in small and large batch volumes, is something that UNBRAKO can also reliably offer.

With our Aerospace and Industrial Fastener manufacturing experience, plant and facility resources are available for the supply of numerous special and Precision Fasteners, either forged or machined to suit all types and specifications.

Supported by active Technical and Application Engineering experts, assistance can be given at the design stage. Advice on materials and the ability to offer a diverse range of various drive systems is something our competitors cannot do.

Non-listed or 'made to print' enquiries for Hexagon Socket Screws are always welcome.



So, don't just think of Unbrako for the standard Hexagon Socket Screw and allied product range—remember us for all precision fasteners or component needs when quality and performance are the criteria.

## MANUFACTURING CAPABILITY

Our advanced manufacturing techniques and capabilities provide the market with requirements to suit applications, using materials, either in alloy, stainless or exotic steels (even non-ferrous materials).

### Size range capability:

M1.4 (0.060") to M42 (1 5/8") diameters—even greater in some cases.

### Materials:

- ★ Alloy Steels, to various finished heat treated conditions. (B7, B7M etc.)
- ★ High temperature alloy steel (SPS-M-254)
- ★ Stainless steels in various grades.
- ★ High strength alloy steels in various grades. Exotic materials.

Advice on Material selection and Heat Treatment requirements is also available, on request

### Drive Systems:

- ★ Hexagon Socket.
- ★ Hexagon Head.
- ★ Spline Socket (Internal).
- ★ 12-point with Flange Head.
- ★ 'D'-Heads.
- ★ Special Nuts (various drive methods).
- ★ Tamper Resistant drive methods.

### Manufacturing Methods:

- ★ Hot and Cold Forge Process.
- ★ Machined parts and components from Bar Automatics.
- ★ Thread Rolling.
- ★ Grinding.
- ★ Cross Drilling (Heads and Shanks).
- ★ Heat Treatment.
- ★ Lathe and Capstan work.

### Plating & Finishes:

We are able to undertake plating of a number of finishes, either to international or customer specifications.

### Finishes available:

- ★ Zinc (electro and mechanical) with passivation to requirements.
- ★ Cadmium.
- ★ Dacromet 320.
- ★ Nickel.
- ★ Chrome.
- ★ Phosphate.
- ★ Chemical black etc.

### Specifications to which Unbrako will plate include:

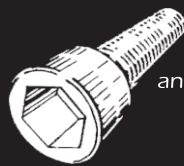
- ★ Bs 3382 Parts 1 & 2.
- ★ DTD 903
- ★ DTD 904 or DEF 03-19

### Prevailing Torque Features:

Various features can be accommodated, including the Unbrako Locwel process as well as wedglok. Details are available on request.

## Hex Socket

Internal hex drive for high torque applications and where fastener spacing is critical.



## Spline

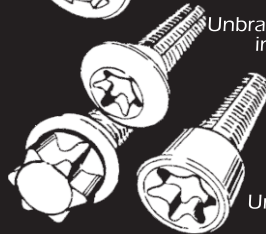
Spline drive advantages include driving efficiency and use of greater wrenching forces without damage or reaming of the socket, especially on smaller diameters.



## Unbrako

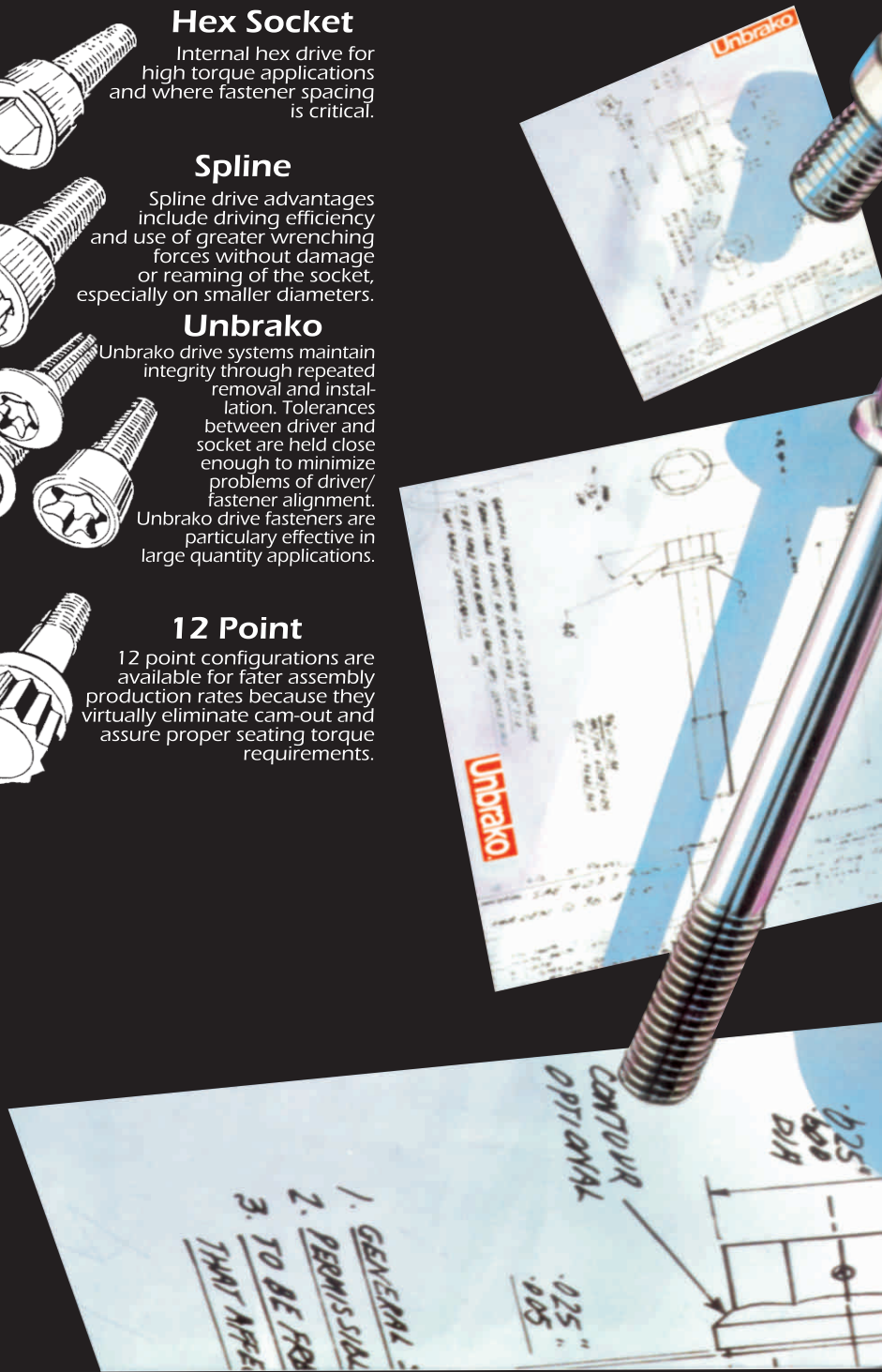
Unbrako drive systems maintain integrity through repeated removal and installation. Tolerances between driver and socket are held close enough to minimize problems of driver/fastener alignment.

Unbrako drive fasteners are particularly effective in large quantity applications.



## 12 Point

12 point configurations are available for faster assembly production rates because they virtually eliminate cam-out and assure proper seating torque requirements.





## MANUFACTURING STANDARDS

The use of international standards that affect the design of product or component is paramount.

Over many years, UNBRAKO have developed their own product standards and conformance which are within the specifications usually demanded by the international standards.

The philosophy and results of pursuing this policy brings benefits to the user through the achievement of higher tensile strengths, high quality criteria and, where necessary, greater fatigue strength in the finished fastener or component.

Metallurgical development have enabled us to use our own steel specification which brings additional design improvements and mechanical properties.

Our objective is to achieve superiority in the true setting of 'high technology equals high quality equals high customer specification and assurance.'

Through our global organization, we have manufacturing resources and facilities which, in many instances, can be utilized to suit the manufacture of any special fasteners and components.

In all manufacturing plants, the UNBRAKO standards of performance are universal

## RESEARCH & DEVELOPMENT

Through our Research & Development Establishments, a truly international wealth of expertise and leadership in the development of high technology products and processes is brought to the market place.

UNBRAKO is the world's largest manufacturer of precision fasteners, which enables the company to be at the forefront of fastener technology.

## TECHNICAL & ENGINEERING SUPPORT

When you have a fastening problem, Unbrako has a complete consulting engineering service to help you solve it. The service covers application, testing and design of special fasteners.

The Application Engineering Service is available to assist you in all phases of fastening and joining, including joint design, product capability, installation techniques and failure analysis.

Technical representatives can work with you in your plant, or in ours. They can frequently effect substantial economics in both the design and production of your product because of their wide experience in the field of Fastener Technology.

Complete laboratory facilities are available for any fastener testing you may need. Capabilities are full range, extending from properties of base materials through to the finished product. Design criteria is uppermost on our list of objectives and UNBRAKO can assist you.







# Advantages built into every detail.

## THE UNBRAKO DIFFERENCE

Your application demands a fastener, which outperforms all others. We build our products for life, to help you build your products for life.

What's holding your product together?

**HIGHER MIN ULT TENSILE**  
10,000 PSI stronger than industry standard

**COMPOUND FILLET RADIUS**  
Doubles fatigue life at critical head-shank juncture

**WIDE RADIUS THREADS**  
Maximizes fatigue resistance where it's needed most

**3R (RADIUSED ROOT RUNOUT) THREAD**  
Increases fatigue life up to 300%

**E CODE "LOT CODE" MARKINGS**  
The ultimate in fastener traceability

**CALL FOR  
MORE  
INFORMATION  
AND EXPERIENCE  
THE UNBRAKO  
DIFFERENCE FOR  
YOURSELF.**

**Unbrako®**  
**BUILT FOR LIFE.**

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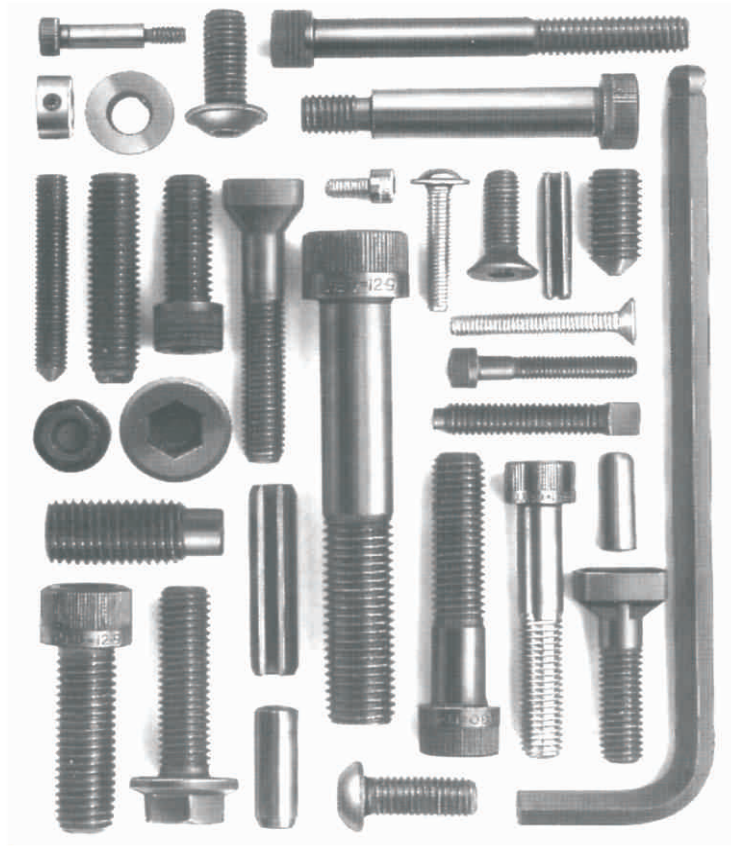
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# WHY USERS DEMAND UNBRAKO

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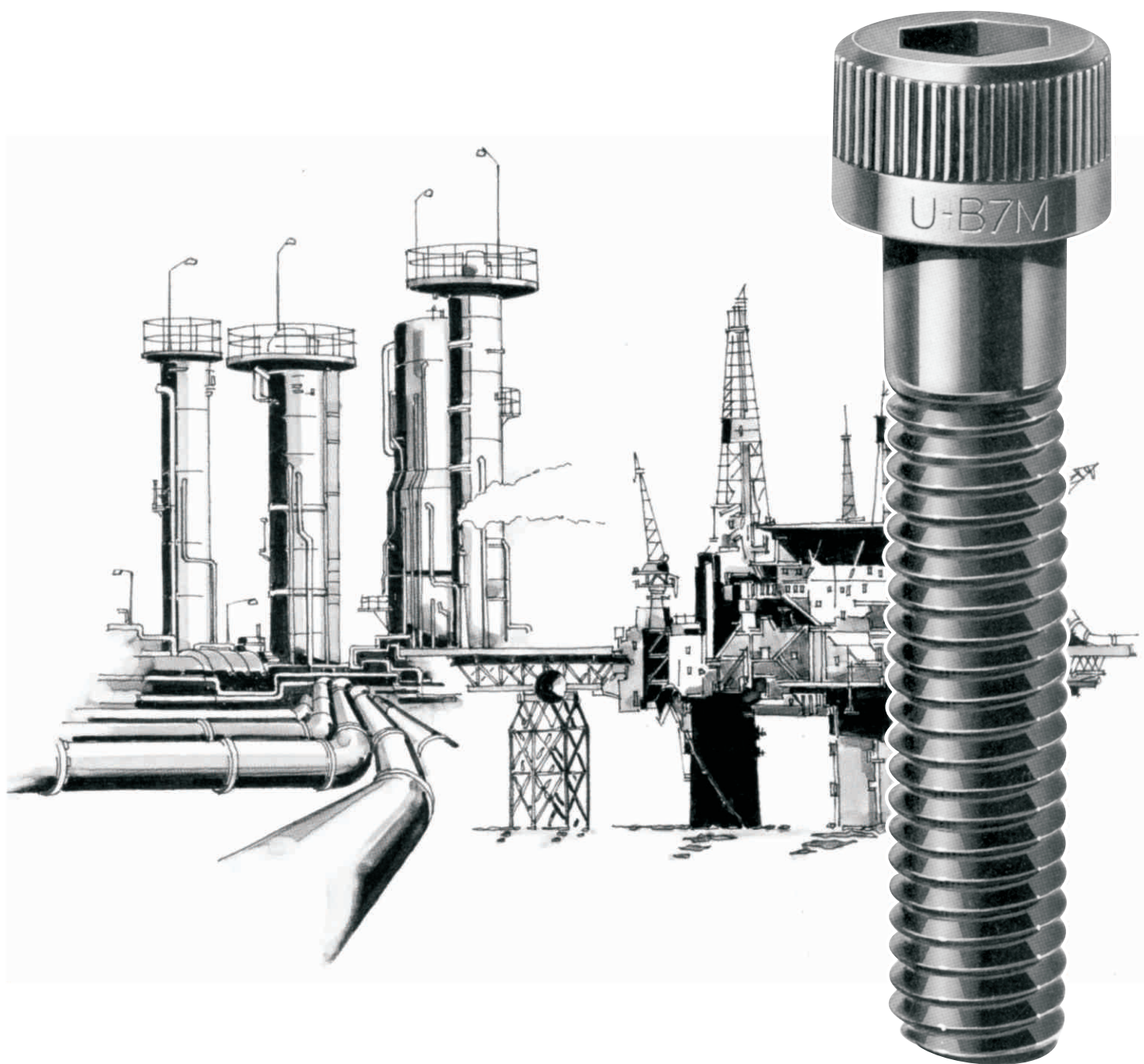


## Unbrako®

### **UNBRAKO SOCKET SCREWS GIVE DISTRIBUTORS AND USERS THESE OUTSTANDING ADVANTAGES OVER OTHER BRANDS.**

- Unique worldwide corporate Specification which ensures product consistency and guaranteed quality.
- Highest level of mechanical properties to give maximum fastening power and lowest in-place cost.
- Distinctive clearly labelled, high strength packaging to provide protection and fast identification - the famous greys.
- Widest range of product types and sizes for design and application flexibility.
- National distribution network to ensure local and immediate product availability.
- Free technical literature and advisory service for expert customer service and distributor support.

**Unbrako®**

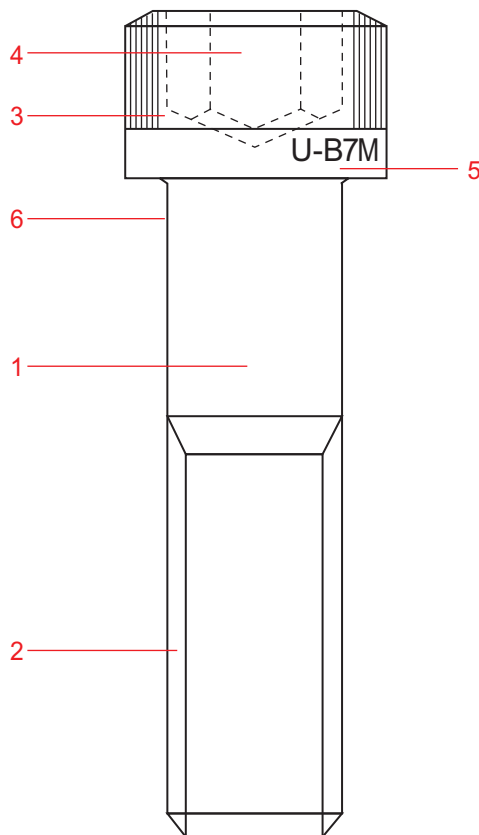


# **B7 & B7M SOCKET SCREWS**



# B7 & B7M SOCKET SCREWS

These Socket Screws are used in the oil, petrol-refining and other related industries for applications which require products to withstand high temperatures and/or hostile environments. The special heat treatment during manufacture complete with detailed specification of the raw material chemical composition aids the product performance in these environments. "M" denotes product for "sour" (hydrogen sulphide) applications minimising sulphide stress cracking (ssc) failures.



## Design Features

1. Alloy Steel: Hardened and tempered to
  - a. B7 125,000 psi min UTS, 105,000 psi min yield strength, 28 HRC min.
  - b. B7M 100,000 psi min UTS, 80,000 psi min yield strength, 22 HRC max.
2. Rolled Threads: With smooth, radiused roots and run-out; Contoured grain flow for extra fatigue strength.
3. Forged Head: With optimum grain flow and a compound radiused underhead fillet for reduced stress concentrations to improve fatigue life.
4. Dimensionally accurate socket for controlled tightening with Unbrako hexagon wrenches.
5. Identification; U-B7 or U-B7M stamped onto head.
6. Plating is available; if required, for corrosion protection.

## Specifications

Unbrako B7 and B7M socket screws comply with ASTM A193 'Alloy Steel and Stainless Steel Bolting material for High Temperature Service' and BS 4882 'Bolting for Flanges and Pressure Containing Vessels. The former is referenced in NACE standard MR-01-75 'Sulphide Stress Cracking Resistant Metallic Material for Oil Field Equipment'.

## RANGE OF STOCK SIZES AVAILABLE

Non Thread Size (UNC/UNF)	Length (Inch)
5/16	1/2 - 1 1/2
3/8	5/8 - 2
7/16	5/8 - 2 1/4
1/2	3/4 - 2 1/4
5/8	3/4 - 2 1/4
3/4	1 1/4 - 2 1/2

Also available in metric diameters and length from M8 to M16. Hexagon head screws and specials available on special order.

You're Safer with

# Unbrako®

Engineered for Engineers



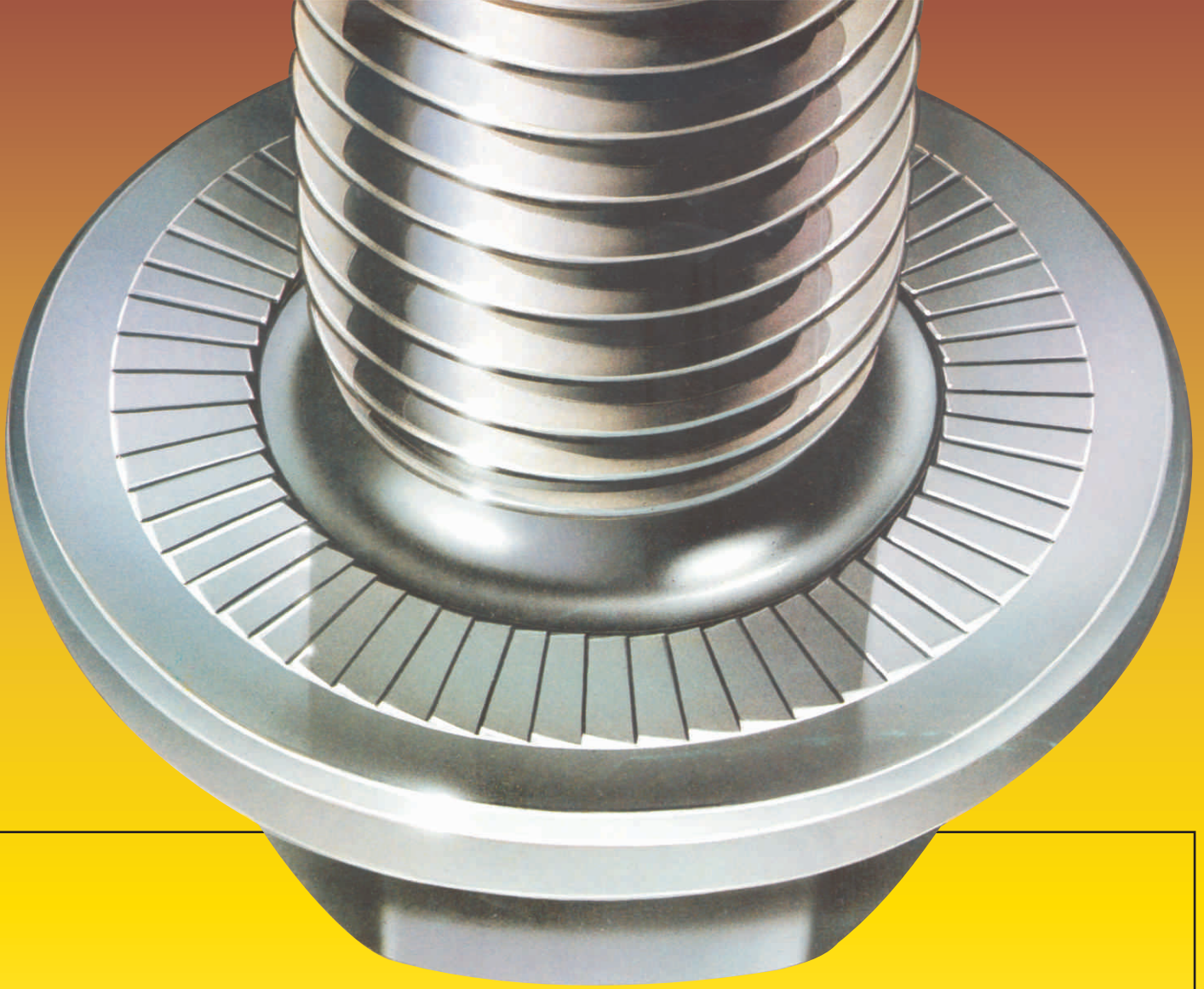
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ISO 9001:2000

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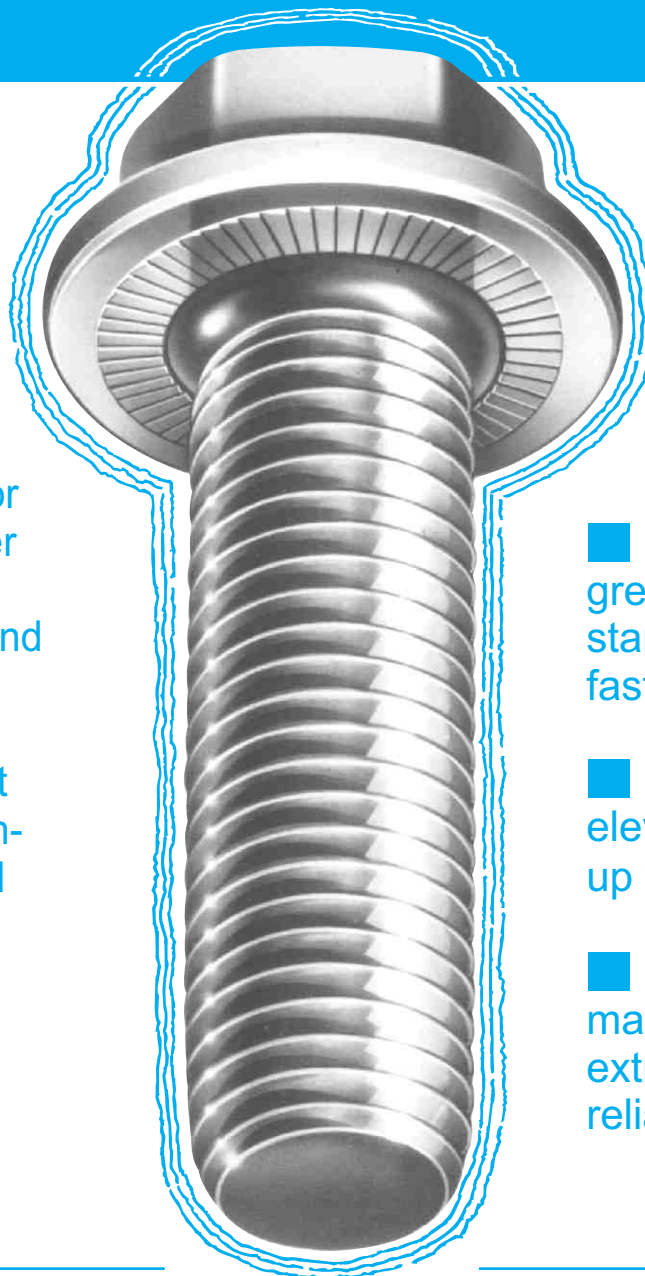
Self-locking  
Fasteners for  
tough applications

**Unbrako®**

**Durlok®**



# The DURLOK self-locking system is the solution to one of the most persistent problems in the field of fastener technology *...VIBRATION.*



■ Will not loosen or unscrew even under the most severe transverse jarring and vibration.

■ Fatigue resistant design in thread run-out and under-head fillet.

■ Free-spinning during installation and removal.

■ Re-usable with locking ability maintained.

■ Embedding is no greater than with standard types of fasteners.

■ Effectiveness at elevated temperatures up to 300°C is ensured.

■ Closely controlled manufacturing for extra safety and reliability.

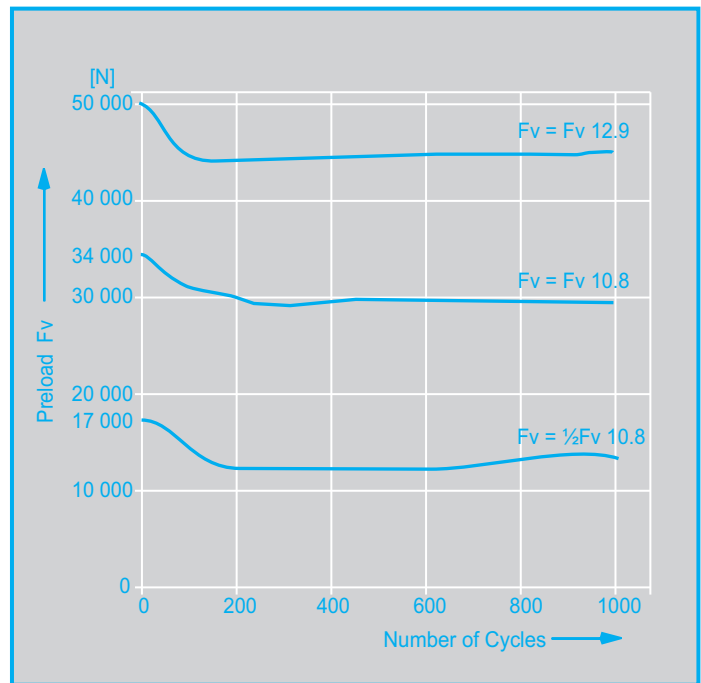
# How can the self-locking ability be evaluated?

The most commonly used method for measuring locking ability has been by the indirect method of measuring and comparing the tightening and untightening torques. However, there is a growing realisation that such a test in no way simulates the self-loosening mechanics of a fastener subjected to vibration. The only way this can be achieved is to apply a vibratory force to the bolted joint and determine whether the fastener rotates loose. This has been attempted but without achieving any real measure of the self-locking ability of the fastener.

There are numerous possibilities of recording test data. However, the clearest presentation of self-locking ability is shown by recording loss of preload versus number of cycles.

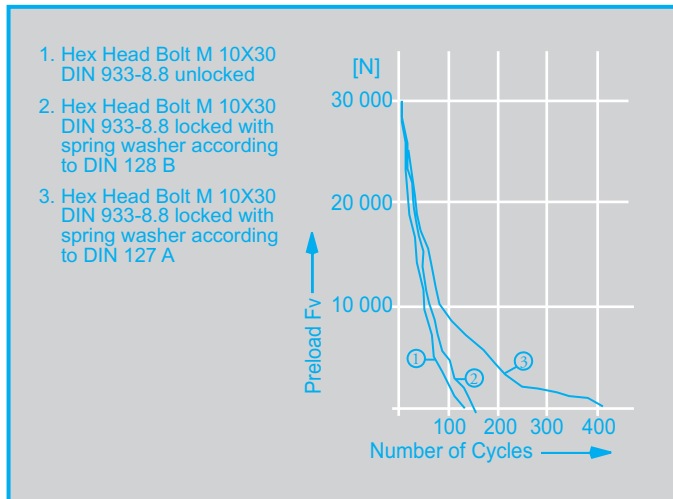
A typical recording for both unlocked bolts and bolts supposedly locked with spring washers shows that the initial bolt preload is completely lost after very few test cycles; conclusive evidence that the bolt has undergone total self-loosening.

These results clearly show that spring washers do not possess any genuine self-locking ability.

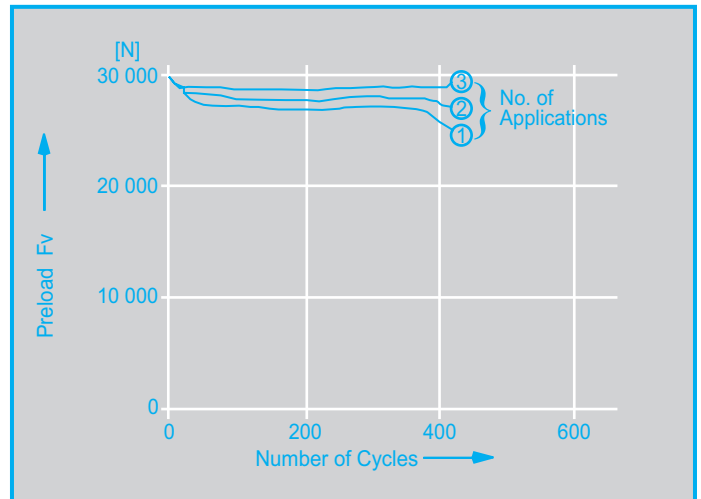


## Other advantages of DURLOK

DURLOK bolts and nuts are suitable for re-use because the serrations cause relatively little damage to the clamped material. This means that the locking ability can be maintained as shown by the original vibration test recorded below.



DURLOK bolts, however do not rotate loose when tested in the same way, even under the heaviest amplitudes. Even when only half of the recommended preload was used, Durlok bolts still did not loosen. This is illustrated by the figure below, which is an original recording of a vibration test on M 10 DURLOK bolts. This shows that there is minimal loss of preload even when the fastener is re-used.



This recording shows that the minimal loss of preload due to embedding even decreases due to cold-working of the surface of the clamped material during retightening of the fastener.

The DURLOK fastener system is effective on a wide variety of engineering materials including steel—both heat-treated and non heat-treated, cast irons including nodular types, non-ferrous metals and sheet materials.



## Metric Sizes - Metric Units

Size	Stress area $A_s$ $\text{mm}^2$	Property class	Proof load (N)	Load at yield point $\alpha 0.2 \times A_s$ (N)	Load at minimum UTS (N)	Induced preload $F_{\max}$ for $\mu$ thread $= 0.125$ (N)	Tightening torques $T_{\max}$ (Nm) for $\mu$ head of		
							0.125	0.16	0.20
M5	14.2	12.9	13750	15600	17300	11300	10.8	12.4	14.2
M6	20.1	12.9	19500	22100	24500	15950	18.2	21.0	24.0
M8	36.6	12.9	35500	40300	44600	29300	44.0	50.0	58.0
M10	58.0	12.9	56300	63800	70800	46600	84.0	96.0	109.0
M12	84.3	12.9	81800	92700	102800	68000	148.0	169.0	194.0
M14	115.0	12.9	111500	126500	140000	93000	233.0	266.0	304.0
M16	157.0	12.9	152000	172500	191500	129000	362.0	413.0	472.0
M20	245.0	12.9	238000	270000	299000	201000	695.0	797.0	913.0

Metric sizes: All dimensions in millimetres.

The presence of oil or other lubricants, organic or inorganic coatings should not adversely affect the locking ability.

DURLOK fasteners can be used at elevated temperatures up to 300°C and, in addition, can be manufactures in special materials to perform at even higher temperatures.

The value of the friction coefficient in the bearing area,  $\mu_H$ , has a different value to that of the friction coefficient in the threads,  $\mu_T$ , due to the serrations. As for all bolts, the friction coefficient under the head is a function of the material, surface finish and lubrication condition of the contacting materials. To account for this, the lightening torques are listed for various values of  $\mu_H$ .

For guidance, the following chart is designed to indicate the appropriate value of friction coefficient to be applied for various engineering materials and finishes. The values of  $\mu_H$  are based on the results of comprehensive tests.

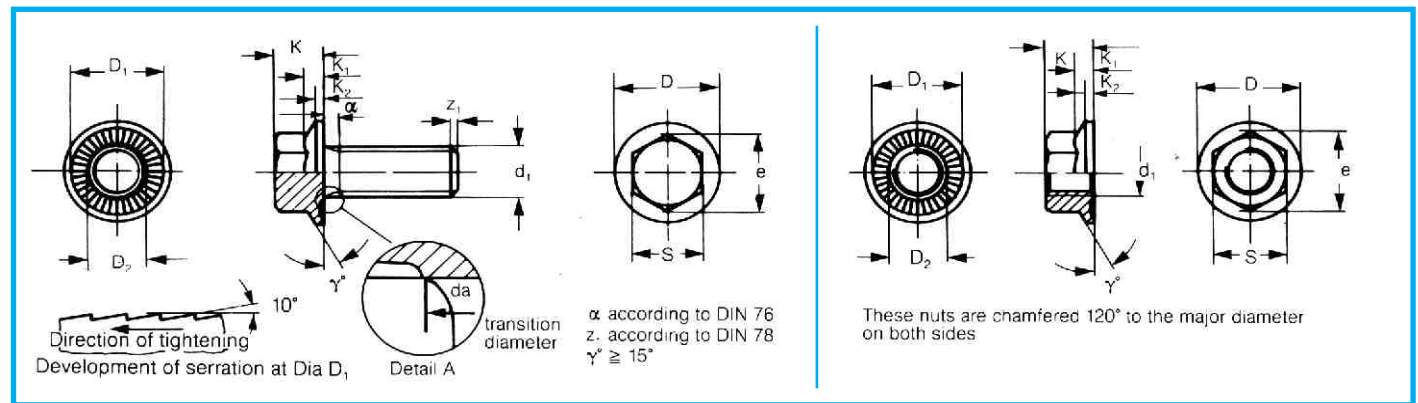
Coated Surface	Bare Bolt Surface	Method of Producing Bearing Surface		
		Fine Turning Grinding	Tuning, boring, Milling	Rough Turning Rough Milling
STEEL Hardness 250 - 350 HV		0.125 / 0.16	0.125 / 0.16	0.125 / 0.125
STEEL Hardness 150 - 250 HV		0.16 / 0.20	0.16 / 0.16	0.16 / 0.16
Grey Cast Iron Nodular Cast Iron		— / 0.20	— / 0.16	— / 0.125

Coatings are: Thermal oxide, phosphate, zinc plating, cadmium plating.

### Notes:

For malleable cast iron bearing material, tightening torques should be obtained for grey case iron and then increased by 10%.

# Dimensions



Metric Sizes: All dimensions in millimetres.

d	M5	M6	M8	M10	M12	M14	M16	M20
D(h 15)	12	14	18	21	25	28	32	39
D1 min	10.0	11.8	15.2	17.2	20.6	22.8	25.7	31.2
D2*	5.5 (6.2)	6.6 (7.4)	9.0 (9.5)	11 (12.5)	14 (15)	16 (17)	18 (19)	22.0 (22.3)
e min*	8.84	11.10	14.49	16.64	19.01 (21.1)	21.23 (24.5)	24.62 (26.8)	30.14 (34.0)
K(js 15)	4.5	5.2	7.2	9.0	11.0	12.5	16.0 (14.5)	18.0 (18.0)
K1 max	2.17	2.27	2.70	3.24	4.00	4.50	6.38 (3.9)	6.49 (4.0)
K2	1.0	1.1	1.3	1.6	1.9	2.2	3.8 (2.4)	3.1 (2.4)
da max	5.10	6.20	8.50	10.40	13.30	15.20	17.20	21.00
S*	8	10	13	15	17 (19)	19 (22)	22 (24)	27 (30)

\* Dimensions in brackets are for nuts.

Strength grades: 12.9 for bolts and class 12 for nuts.

Material: Special alloy steel according to DIN 267

Sheet 3 for 12.9 bolts and special steels for class 12 nuts.

Thread: According to DIN 13 medium fit (6 g) for the bolts and 6 H for the nuts.

This data also applies to DURLOK nuts when used with 12.9 strength grade DURLOK bolts.

Where other design criteria exist, consult the supplier for technical advice.

## Technical Data

The induced assembly preload,  $F_{max}$ , and the corresponding tightening torques,  $T_{max}$ , are based on a 90% utilisation of the minimum yield strength by combined tension and torsional stresses. For cases where the yield strength must never be exceeded during tightening, the tightening torque must be reduced by a value equivalent to the scatter. Comprehensive investigation has shown that the scatter, due to variations in friction coefficient and torque scatter when tightening by torque wrench, must be accounted for by using a reduced torque  $T$  which is 90% of the tabulated value  $T_{max}$ .  $T = 0.9 \times T_{max}$ .

Accordingly, the induced preload  $F_{max}$  will be reduced to the new preload  $F_F = 0.9 \times F_{max}$ .

It should be noted that preload and tightening torque are a function of the joint stiffness. The tabulated values are valid for a joint stiffness which occurs under snug conditions with a clamping length of 2.5- 4d. In addition, the values are based on an average friction coefficient for the threads of  $\mu = 0.125$ .

## Mechanical properties of DURLOK fasteners

DURLOK bolts:

Mechanical Property	DURLOK 12.9
Tensile Strength, $R_m$ (N/mm <sup>2</sup> ) min	1220
0.2% Proof Stress (N/mm <sup>2</sup> ) min	1100
Stress under Proof Load $S_p$ (N/mm <sup>2</sup> )	970
% Elongation 5D min	9
Core Hardness HV <sub>0.05</sub> max	420

DURLOK nuts:

DURLOK nuts are manufactured to meet the mechanical properties of ISO class 12 and are suitable for use with DURLOK bolts.



# Durlok<sup>®</sup>



## Unbrako<sup>®</sup>

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High Tensile  
Structural Steel Fasteners  
in Friction Grip Joints



## Unbrako High Strength Structural Fasteners

These are large series hexagon bolts, nuts and washers available in the range shown in Table 1. The bolts are having short thread lengths, suitable for use in both friction type and bearing type structural steel joints.

**Table 1: Unbrako range of High Strength Structural Fasteners**

Product	Specification	Size	Threads	Mechanical Properties*
High Strength Structural Bolts	ISO: 7412 IS: 3757	M16 to M36	Metric Coarse, 6g ISO: 261, ISO: 965 IS: 4218	Property Class 8.8 or 10.9 ISO: 898/1 IS: 1367, Part 3
High Strength Structural Nuts	ISO: 4775 IS: 6623	M16 to M36	Metric Coarse, 6H ISO: 261, ISO: 965 IS: 4218	Property Class 8 or 10 ISO: 898/2 IS: 1367, Part 6
Hardened and Tempered Washers	ISO: 7415 IS: 6649	M 16 to M36 (Plain Hole, Circular)		Hardness HRC 35-45

\*For details, refer Table: 6 and 7

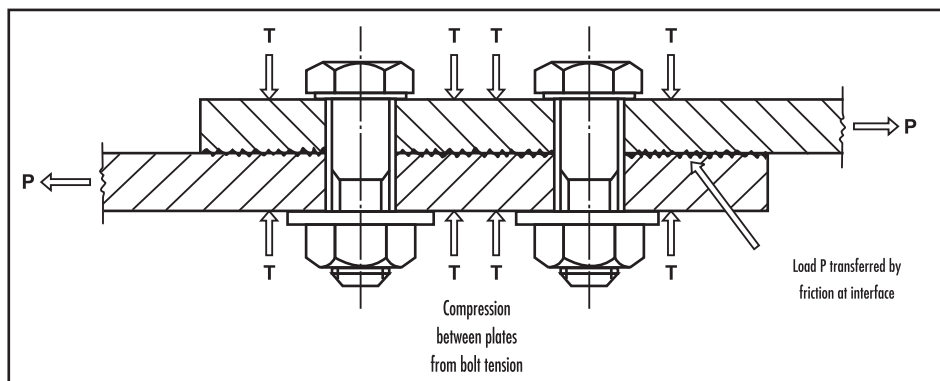
## Unbrako High Strength Structural Bolts, Nuts and Washers in Friction Grip Joints

The use of high strength structural fasteners in friction grip joints has been one of the most important developments in structural engineering over the last about four decades.

It provides a simple method of transmitting loads through a structural joint by the friction on the contact face developed through the high clamping force from correctly tightened high strength bolts and nuts. (See Fig. 1)

The bolts are fitted in clearance holes and since the joint is designed to resist slip, they are not subject to bearing or shear forces and thus remain in virtually static tension throughout their working life, with fluctuating loads having very little, if any, effect on bolt stress.

**Fig. 1: Principle of Friction Type Joint using H.S.S. Bolts and Nuts**



The head dimensions (across flat sizes) of H.S.S. Bolts are one step higher than those of the normal hexagon bolts and nuts of the same diameter. The bearing pressure under the head of H.S.S. Bolts will

thus be necessarily lower than that of the convention hexagon head bolts. Indentation of the hard bolt head into the softer structural steel is therefore prevented.

Unbrako high strength structural fasteners in friction grip joints are ideal for use on time-bound projects. Over the conventional methods of rivetting or welding, they offer the following advantages:

### RELIABILITY:

Once tightened, the bolts will remain tight and maintain the permanent strength of the joint. Absence of heavy stress concentration due to absence of bearing between bolts and plates. As bolts are in tension, it does not permit loosening, thus making it most ideal where vibrations are involved.

### ECONOMY:

Fewer high strength bolts are required than M.S. bolts and rivets. Drilling of close tolerance holes is not required. Overall weight of the structure will be very

light.

### SIMPLICITY:

A minimum skill is required in tightening and the operators need only to follow a few simple rules.

### CONVENIENCE:

Whether in the workshop or at site, H.S.S. Bolts enable joints to be made easily. Welding of site splices can be eliminated, avoiding the difficulties of welding in adverse weather conditions. Absence of pneumatic hammers used in rivetted joints reduce noise level considerably.

## REFERENCE STANDARDS

### BS: 4395

Specification for HSFG Bolts/Nuts/Washers

### BS: 4604

The use of  
HSFG Bolts/Nuts/Washers  
in Structural Steel Works

### IS: 4000

Code of practice for  
use of HSFG Fasteners

### IS: SP6 (4)

Handbook for  
Structural Engineers

### ASTM A325/A563/F436

Specifications for High Strength  
Bolts/Nuts/Washers



**Table 2: Unbrako High Strength Structural Bolts - Dimensions**

Thread Size		M16	M20	(M22)	M24	(M27)	M30	M36
Pitch		2.0	2.50	2.50	3.00	3.00	3.50	4.00
B	Max.	16.70	20.84	22.84	24.84	27.84	30.84	37.00
	Min.	15.30	19.16	21.16	23.16	26.16	29.16	35.00
da	Max.	18.70	23.24	25.24	27.64	30.40	33.40	39.40
	Max.	27.00	34.00	36.00	41.00	46.00	50.00	60.00
W	Min.	26.16	33.00	35.00	40.00	45.00	49.00	58.80
	Min.	29.56	37.29	39.55	45.20	50.85	55.37	66.44
C	Max.	10.75	13.40	14.90	15.90	17.90	19.75	23.55
H	Min.	9.25	11.60	13.10	14.10	16.10	17.65	21.45
R	Min.	0.60	0.80	0.80	1.00	1.20	1.20	1.50
T <sub>1</sub> Ref.		31	36	38	41	44	49	56
T <sub>2</sub> Ref.		38	43	45	48	51	56	63

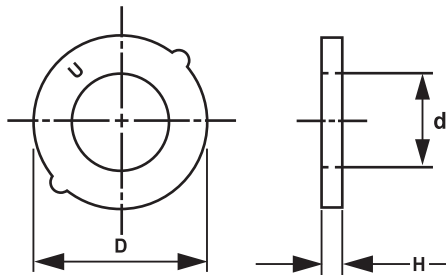
**Table 3: Unbrako High Strength Structural Nuts - Dimensions**

Thread Size		M16	M20	(M22)	M24	(M27)	M30	M36
Pitch		2.0	2.50	2.50	3.00	3.00	3.50	4.00
W	Max.	27.00	34.00	36.00	41.00	46.00	50.00	60.00
	Min.	26.16	33.00	35.00	40.00	45.00	49.00	58.80
C	Min.	29.56	37.29	39.55	45.20	50.85	55.37	66.44
	Max.	17.10	20.70	23.60	24.20	27.60	30.70	36.60
H	Min.	16.40	19.40	22.30	22.90	26.30	29.10	35.00
Weight Kg./1000pcs.		60.4	115.3	142.8	197.7	282.3	3650	281.8

**Table 4: Grip Lengths and Weight of Bolts (Kgs per 1000pcs.)**

Dia L	M16		M20		(M22)		M24		(M27)		M30		M36	
	Gt.	Wt.	Gt.	Wt.	Gt.	Wt.	Gt.	Wt.	Gt.	Wt.	Gt.	Wt.	Gt.	Wt.
40	10 to 14	102.8												
45	15 to 19	110.7	11 to 15	180.3										
50	20 to 24	118.6	16 to 20	192.6	12 to 16	252.0								
55	25 to 29	126.5	21 to 25	205.0	17 to 21	266.9	15 to 19	337.4						
60	30 to 34	134.4	26 to 30	217.3	22 to 26	281.8	20 to 24	355.2	17 to 21	480.9				
65	35 to 39	142.3	31 to 35	229.6	27 to 31	296.7	25 to 29	372.9	22 to 26	503.4				
70	40 to 44	150.2	36 to 40	241.9	32 to 36	311.6	30 to 34	390.7	27 to 31	525.8	24 to 28	672.5		
75	45 to 49	158.1	41 to 45	254.3	37 to 41	326.6	35 to 39	408.4	32 to 36	548.3	29 to 33	700.3	23 to 27	1089.1
80	50 to 54	166.0	46 to 50	266.6	42 to 46	341.5	40 to 44	426.2	37 to 41	570.8	34 to 38	728.0	28 to 32	1129.0
85	55 to 59	173.9	51 to 55	278.9	47 to 51	356.4	45 to 49	443.9	42 to 46	593.2	39 to 43	755.7	33 to 37	1169.0
90	60 to 64	181.7	56 to 60	291.3	52 to 56	371.3	50 to 54	461.8	47 to 51	615.7	44 to 48	783.5	38 to 42	1209.0
95	65 to 69	189.6	61 to 65	303.6	57 to 61	386.2	55 to 59	479.4	52 to 56	638.2	49 to 53	811.2	43 to 47	1248.9
100	70 to 74	197.5	66 to 70	315.9	62 to 66	401.2	60 to 64	497.2	57 to 61	660.7	54 to 58	839.0	48 to 52	1288.9
110	75 to 84	211.4	71 to 80	337.7	67 to 76	427.8	65 to 74	528.5	62 to 71	685.6	59 to 68	888.4	53 to 62	1362.0
120	80 to 94	227.2	81 to 90	362.4	77 to 86	457.7	75 to 84	564.1	72 to 81	730.6	69 to 78	949.9	63 to 72	1441.9
130	85 to 104	243.0	91 to 100	387.0	87 to 96	487.5	85 to 94	599.6	82 to 91	775.5	79 to 88	999.4	73 to 82	1521.8
140	95 to 114	258.8	101 to 110	411.7	97 to 106	517.3	95 to 104	635.1	92 to 101	820.5	89 to 98	1054.9	83 to 92	1601.7
150	105 to 124	274.6	111 to 120	436.3	107 to 116	547.2	105 to 114	670.6	102 to 111	865.4	99 to 108	1110.4	93 to 102	1681.6
160	115 to 134	290.3	121 to 130	461.0	117 to 126	577.0	115 to 124	706.1	112 to 121	910.4	109 to 118	1165.8	103 to 112	1761.5
170	125 to 144	306.1	131 to 140	485.7	127 to 136	606.9	125 to 134	741.6	122 to 131	955.3	119 to 128	1221.3	113 to 122	1841.4
180	135 to 154	321.9	141 to 150	510.3	137 to 146	636.7	135 to 144	777.1	132 to 141	1000.2	129 to 138	1276.8	123 to 132	1921.3
190	145 to 164	337.7	151 to 160	535.0	147 to 156	666.7	145 to 154	812.6	142 to 151	1045.2	139 to 148	1332.3	133 to 142	2001.2
200	155 to 174	353.5	161 to 170	559.6	157 to 166	694.4	155 to 164	848.2	152 to 161	1090.2	149 to 158	1387.8	143 to 152	2081.1
210									162 to 171	1135.2	159 to 168	1443.3	153 to 162	2161.0
220									172 to 181	1180.1	169 to 178	1498.8	163 to 172	2240.9
230									182 to 191	1225.0	179 to 188	1554.3	173 to 182	2320.8
240									192 to 201	1270.0	189 to 198	1609.8	183 to 192	2400.7
250									202 to 211	1314.0	199 to 208	1665.3	193 to 202	2480.6
260									212 to 221	1359.9	209 to 218	1720.7	203 to 212	2560.5
270									222 to 231	1404.9	219 to 228	1776.2	213 to 222	2640.4
280									232 to 241	1449.8	229 to 238	1831.5	223 to 232	2720.3
290									242 to 251	1493.9	239 to 248	1887.2	223 to 242	2800.2
300									252 to 261	1538.9	249 to 258	1942.7	243 to 252	2880.1

Sizes in brackets are at second preference  
 \* T1 Ref. - For lengths ≤ 100mm  
 T2 Ref. - For lengths > 100mm



**Table 5: Unbrako High Strength Structural Washers - Dimensions**

Bolt Size		M16	M20	(M22)	M24	(M27)	M30	M36
d	Min.	18.00	22.00	24.00	26.00	30.00	33.00	39.00
	Max.	18.43	22.52	24.52	26.52	30.52	33.62	39.62
D	Max.	34.00	42.00	44.00	50.00	56.00	60.00	72.00
	Min.	32.40	40.40	42.40	48.40	54.10	58.10	70.10
H	Max.	4.60	4.60	4.60	4.60	4.60	4.60	4.60
	Min.	3.10	3.10	3.40	3.40	3.40	3.40	3.40
Weight Kg/1000pcs		20.3	31.3	33.2	44.7	54.8	61.4	89.7

**Table 6: Mechanical Properties of H.S.S. Bolts**

Thread Size	Stress Area mm <sup>2</sup>	Property Class 8.8			Property Class 10.9		
		Ultimate Load (Min)	Proof Load (Min)	Hardness	Ultimate Load (Min)	Proof Load (Min)	Hardness
		Newtons	Newtons	HRC	Newtons	Newtons	HRC
M16	157	125600	91060	22 - 32  23 - 34	163280	130310	32 - 39
M20	245	203350	147000		254800	203350	
(M22)	303	251490	181800		315120	251490	
M24	353	292990	211800		367120	292990	
(M27)	459	380970	275400		477360	380970	
M30	561	465630	336600		583440	465630	
M36	817	678110	490200		849680	678110	

**Table 7: Mechanical Properties of H.S.S. Nuts**

Thread Size	Property Class 8		Property Class 10	
	Proof Load	Hardness	Proof Load	Hardness
	Newtons		Newtons	
M16	168900	HRB 89 to HRC 38	195500	HRC 26 to HRC 38
M20	263400		305000	
(M22)	325700		377200	
M24	379500		439500	
(M27)	493400		571500	
M30	603100		698400	
M36	878300		1017200	

## Assembly

### Calculation of Bolt length :

The length of bolt required to be used in the assembly will depend on the Grip Length (Clamping Length). Table 4 gives range of Grip Lengths for individual Bolt Lengths. In deciding the ranges, allowances have been made for the thickness of nut, one flat round washer and sufficient thread protrusion beyond nut, adequate allowances should be made for additional washers or taper washers, if used.

### Holes in Members:

All holes should preferably be drilled, burrs should be removed. Nominal hole diameters are given in table 8.

### Operation:

All contact surfaces should be free of all, dirt, loose

scales, rust, burrs, paint or any other foreign material or any defect. A clean, as rolled surface with light mill scale is acceptable.

All bolts, nuts and washers should be identified as being the correct type H.S.S. Fasteners while drawing from stores. The holes will be lined up with sufficient drift pins to maintain the dimensions and plumbness of the structure until bolts in the remaining holes have been fully tightened - well aligned holes will

permit bolts to be freely placed in position.

Driving of bolts should not be permitted as it will damage the threads.

Each bolt and nut should be assembled with flat washer under the nut or bolt head, whichever is to be rotated during tightening, preferably tightening will be done by nut rotation. Taper washers are used under nuts or bolts heads where angular seatings are necessary.

**Table 8: Hole Dimensions for H.S.S. Bolts**

Number of plies in the joint	Hole Diameter For Bolt Diameter (D)	
	M16 to M24	M27 to M36
<3	D + 2 mm	D + 3 mm
≥3		
a, Two outer plies	D + 2 mm	D + 3 mm
b, Inner Plies	D + 3 mm	D + 3 mm

## Determining the Slip Factor:

The friction grip joint depends for its performance on tightening of bolts to high preload so that the adjoining members are brought into contact and the shear load transmitted by friction between them.

The resistance to Slip (P) is expressed by  $P = \mu \times T$

where  $\mu$  is the experimentally determined Slip Factor and T is the initial Bolt Preload. (Ref. Flg. 1).

It is desirable that before designing a structural joint, a series of slip factor tests are carried out to determine the actual slip factor, creating contact surface conditions similar to be used at site.

Table 9 gives slip Factor values for various contact surfaces.

**Table 9: Slip Factor Values for various Contact Surfaces**

Surface Condition	Average Slip Factor
Untreated tight mill scale	0.45
Grit Blast Surface	0.50 - 0.55
Hot Dip Galvanised	0.21 - 0.35
Hot Dip Galvanised + Wire Brush	0.35
Hot Dip Galvanised + Sand Blast	0.40 - 0.45

## Tightening:

### a. Torque Control Method

Part of the torque effort in tightening is absorbed in overcoming friction between threads and nut bearing surface. The friction varies considerably depending upon the thread condition, oil coating on bolt and nut etc., and consequently, shank tensions induced by a particular torque differ widely. Even under the best conditions, a variation of 30% can be expected recommend torque values that can relate reliably to shank tensions. It is therefore, of utmost importance to control initial calibration of tools under site conditions, and also frequent checking.

The torque wrench should be calibrated at least once each shift by tightening a bolt in a load cell above the required minimum, nothing the torque at which this tension is reached. A change in the bolt diameter or length requires re-calibration of the tool.

### b. Part Turn Method

This method is more practical, economical and reliable. Installed bolts are tightened to bring the surfaces in close contact (snug fit). a matching marks is then made on each nut and bolt shank end and tightening completed by turning the nut a half or three-quarter turn depending on bolt length. (See Table 10 and Fig. 2).

with the amount of nuts rotation specified in the table, a bolt tension at least equal to the Proof Load will be attained. Since the part turn method will often give rise to tensions above the yield point, It is not recommended for BS Higher Grade (10.9) reduced ductility and fracture could result from excess tension.

### c. Other Method

Load indicating Devices:

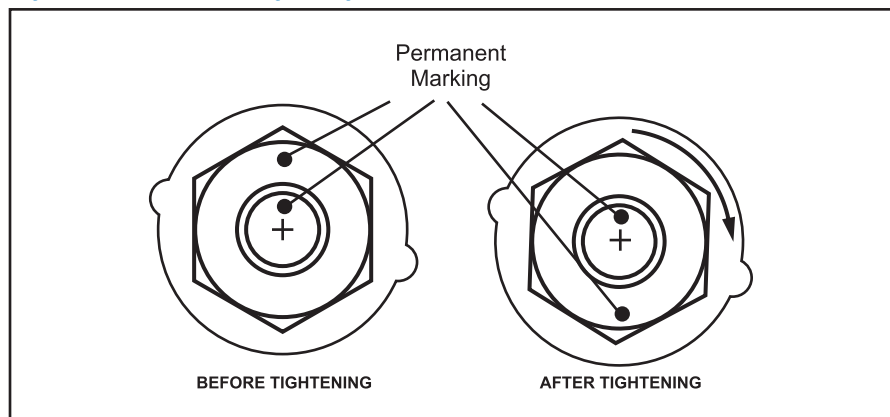
These methods are designed to give a direct

indication of the load induced along the axis of the bolt with the help of Load Indicating Devices incorporated in the bolt, nut or washer assembly.

**Table 10: Part Turn Method - Amount of Nut Rotation**

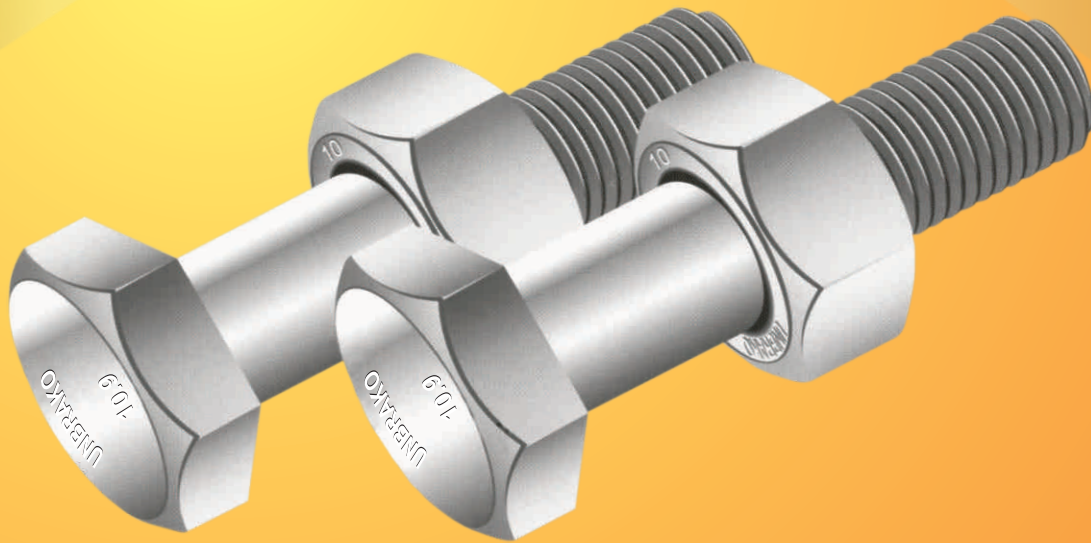
Bolt dia	Bolt Grip Length/Rotation of Nut Relative to Shank	
	Not Less than 1/2	Not Less than 3/4
M16	upto 115 mm	over 115 mm
M20	upto 115 mm	over 115 mm
M22	upto 115 mm	over 115 mm
M24	upto 160 mm	over 160 mm
M27	upto 160 mm	over 160 mm
M30	upto 160 mm	over 160 mm
M36	upto 160 mm	over 160 mm

**Fig. 2: Part Turn Method-Tightening Procedure**





# 10.9 METRIC HIGH TENSILE



## *The 10.9 Advantage...*

With 10.9 giving you 30% more strength over 8.8, it is not hard to understand why more and more end users are asking for 10.9 product...

### UNBRAKO 10.9 HIGH TENSILE BOLTS

Material	: High Grade Steel	Tensile Strength	: 1040 MPa
Hardness	: Rc 32-39	Yield Strength	: 940 MPa
Thread Class	: Bolts and Screws-6g Nuts-6h	Branded	: Bolts - Unbrako 10.9 Nuts Unbrako-10

# High Tensile Track Shoe Bolts & Nuts for Earth Moving Equipments



You're Safer with  
**Unbrako**  
Engineered for Engineers

## **UNBRAKO (EUROPE)**

Deepak Fasteners (Shannon) Ltd.  
Bays 25-30, Shannon Industrial Estate,  
County Clare, IRELAND  
Ph: +353-61-716-500  
Fax: 353-61-716-584

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## **UNBRAKO (USA)**

Interfast USA (Deepak Fasteners)  
4444 Lee Road, Cleveland,  
Ohio 44128-2902  
Ph: 216-581-3000  
Fax: 800-225-5777



Earth moving equipments are the means to exploit the nation's natural resources. They are the moving symbols of the economic progress of any country. They work to strict time bound schedules in rough and remote terrains. In such critical situation, any breakdown, and any delay means heavy losses.

Yet the best of earthmoving equipment could breakdown and throw production schedules out of gear-just because someone, somewhere, compromised on quality of fasteners, holding the equipment together. And the fasteners cost a mere 1% of the total cost of the equipment.

A High degree of commitment to precision and excellence has enabled UNBRAKO to match its fasteners with those of any international maker in design, quality, strength and reliability.

"UNBRAKO" Track Shoe Bolts and Nuts and other High Tensile Fasteners come to you from the most modern fasteners manufacturing plant in India. Made out of High Grade Alloy Steels, the fasteners are cold formed and cold rolled and heat treated in atmosphere controlled furnaces, to give you the highest strength and reliability.

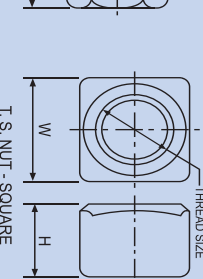
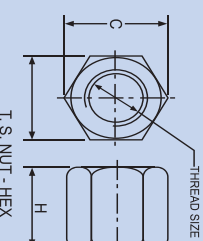
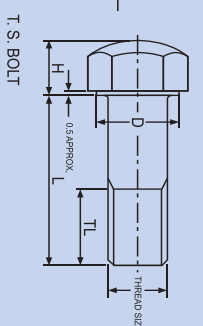
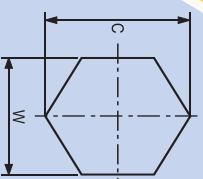


Table No. 1 : Dimensions

BOLT SIZE	T.S. BOLTS						T.S. NUTS-HEX			T.S. NUTS-SQ			FOR USE ON	
	W	C	H	D	TL	L	W	C	H	W	H			
M16 x 1.5	23.0	26.6	16.00	21.60	28.0	57.0	23	26.6	22				BEML-KOMATSU D50, D50 A15	
M18 x 1.5	27.0	31.2	16.50	26.00	30.0	58.0	27	31.2	24				L&T POCAM 100K	
M19 x 1.5	29.0	33.5	19.00	28.00	35.0	62.0	29	33.5	26				BEML-KOMATSU D80, D80 A12	
M19 x 1.5	29.0	33.5	19.00	28.00	35.0	65.0	29	33.5	26				BEML-KOMATSU R300, D80 A12	
M20 x 1.5	30.0	34.6	19.00	29.00	32.0	63.0	30	34.6	26				BEML-KOMATSU R300K	
M24 x 1.5	36.0	41.6	22.00	35.00	36.0	78.5				35.0	24.00		BEML-KOMATSU D155 A1	
M27 x 1.5	41.0	47.3	24.00	40.00	38.0	82.5				41.0	27.00		BEML-KOMATSU PD355 A3, P6550	
5/8-18 UNF	23.8	26.9	16.66	23.00	28.6	51.0				24.6	18.24		CATERPILLAR D4, D5	
5/8-18 UNF	23.8	26.9	16.66	23.00	30.6	56.0				24.6	18.24		CATERPILLAR D4, D5	
3/4-16 UNF	28.6	32.3	19.05	27.56	27.0	60.3				28.3	19.05		CATERPILLAR D6, D7	
3/4-16 UNF	28.6	32.3	19.50	27.56	30.0	70.0				28.6	19.00		HM-TEREX/HM-DEMAG H36	
7/8-14 UNF	33.3	37.0	20.60	32.15	31.8	67.6				33.1	23.00		CATERPILLAR D8 L&T POCAM 3000K	
7/8-14 UNF	33.3	37.0	19.90	32.15	35.0	84.0				33.3	23.00		HM-TEREX/HM-DEMAG H51	
1-14 UNS	38.1	43.0	22.86	37.20	31.5	74.7				38.1	25.40		CATERPILLAR D9	

Table No. 2 : Technical Data

BOLT SIZE	HARDNESS	HRC	CROWN HARDNESS	TO DEPTH mm	TENSILE STRENGTH (MIN.)	N/Sq. mm
M16 x 1.5 x 57.0	34-40	52-60		4-7	1040	
M18 x 1.5 x 58.0	38-43	52-60		4-7	1220	
M19 x 1.5 x 62.0	38-43	52-60		4-7	1220	
M19 x 1.5 x 65.0	34-40	52-60		4-7	1040	
M20 x 1.5 x 78.5	38-43	52-60		4-7	1220	
M24 x 1.5 x 78.5	34-40	52-60		4-7	1040	
M27 x 1.5 x 82.5	34-40	52-60		4-7	1040	
5/8-18 UNF x 2.008"	38-43	52min-60		4-7	1220	
5/8-18 UNF x 2.66"	37-42	52min-60		4-7	1220	
3/4-16 UNF x 2.3/8"	38-43	52min-60		4-7	1220	
3/4-14 UNF x 2.66"	38-43	52min-60		4-7	1220	
7/8-14 UNF x 2.66"	38-43	52min-60		4-7	1220	
7/8-14 UNF x 84.6	38-43	52min-60		4-7	1220	
1-14 UNS x 2.94	34-40	52min-60		4-7	1040	

Table No. 3 : Tightening Torque Recommendation

BOLT DIA		INITIAL TIGHTENING TORQUE		FULL TIGHTENING TORQUE*	
Inch	mm	Lb. Ft.	Nm.		Nm.
	M16				340-420*
	M18				530-660*
	M19				600-740
	M20		360-440		
	M24				100-1200*
	M27				1650-1950*
5/8"		120-150		170-210	
3/4"		220-260		300-350	
7/8"		250-300		340-410	
1"		400-450		550-620	

### Tightening Procedure

To ensure that Track Shoe Bolts and Nuts are properly tightened, follow the procedure outlined below:

1. Remove paint from Track link and Shoe mating surfaces.
2. Lubricate the Bolt threads and bolt washer face.
3. Tighten the Bolts to specified Torque (refer Table no. 3 for initial torque value for each size).
4. Give each Bolt additional 'One Third' turn, i.e. additional '120 degree' turn. Initial torque draws the parts together tightly.
5. Additional 'One Third' or '120 degree' turn gives the Bolt proper stretch for good retention. Stretching stresses the Bolt till permanent deformation takes place, which ensures that the Bolt's maximum clamping force is used.
5. For Bolts, marked thus "\*", full tightening should be done with specified torque. Additional 'One Third' turn is not necessary and should not be given in such cases.

In case of M18 Track Shoe Bolts, values for both the methods of tightening are specified. Either method can be used for tightening.



# Engineered Fastener Solutions

## CHALLENGE



Major outdoor recreational vehicle manufacturer experiencing fatigue failure with their snowmobile engine studs. The engine stud, being supplied by other companies, is used to hold the upper and lower castings of the engine

together. This is a high vibration corrosive environment.

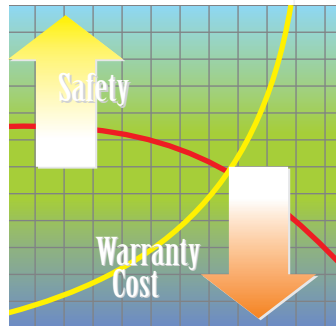
## SOLUTION

Customer contacted Unbrako based on experience with fatigue applications as well as the facilities to test the product to ensure fatigue performance. Unbrako offered our proprietary WR threadform, fatigue-resistant ground fillet designs and corrosion-resistant coating.



## BENEFIT

The Unbrako product improved the fatigue properties by more than doubling the performance criteria specified, thereby increasing safety and reducing warranty costs in excess of \$8 million. Unbrako engineers address ongoing fastener issues for this company for other recreational products including motorcycles, personal water craft and all terrain vehicles.



*Unbrako Engineered Fasteners specializes in developing custom fastening systems for one-of-a-kind, high volume applications. Services include engineering, manufacturing, accredited quality control and post-delivery liability insurance supporting protection of the manufacturer.*

**Unbrako**



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The UNBRAKO Global service network include facilities in IRELAND, INDIA, U.K, AUSTRALIA & USA.



ISO 9001:2000

PRODUCTIVITY



# Engineered Fastener Solutions

## CHALLENGE



Paper mill equipment manufacturer required a fastener for their replaceable plates on log crushing rolls. Fasteners hold external replaceable crushing plates to a 4' diameter x 15' long roll. There are extreme alternating loads between compression and tension as well as a corrosive environment.

Short grip length and low head profile plus high torque requirements presented additional challenges.

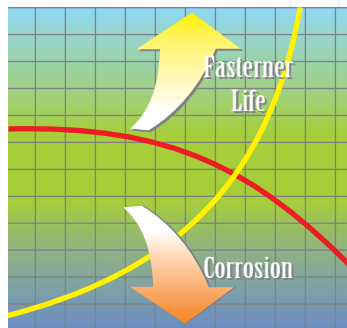
## SOLUTION

Unbrako engineers determined the proper alloy steel to be utilized, as well as rolling threads after heat treatment to enhance the fatigue resistance. The design included the use of our proprietary WR thread manufacturing technique. Unbrako optimized the head and socket size for no embedment and high torque simultaneously.



## BENEFIT

The life of the fastener exceeds the lift of the plate thus preventing premature failure that would cause damage to the plates and processing downtime.



*Unbrako Engineered Fasteners specializes in developing custom fastening systems for one-of-a-kind, high volume applications. Services include engineering, manufacturing, accredited quality control and post-delivery liability insurance supporting protection of the manufacturer.*

**Unbrako**



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QUALITY

# Engineered Fastener Solutions

## CHALLENGE



A major amusement and entertainment park required a fastener for the car body lift arm on their popular earthquake ride. It must meet strict vibration criteria and have a plating that will resist corrosion caused by the cleaning agent. Performance has to be met on a constant basis. The car body lift arm is on the underside of the ride and fastens the arm of the trolley wheels to the car.

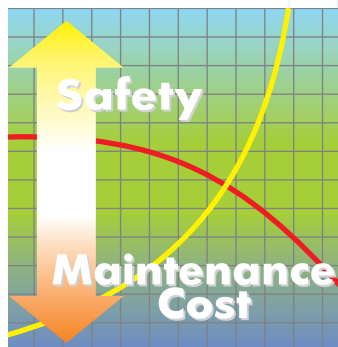
## SOLUTION

Unbrako engineers, interacting with the customer and ride design company, developed and manufactured a high strength 3/4" – 10 x 15" cadmium plated life safety socket head cap screw specifies for this application. Our proprietary fillet radius and run out root radius give the fastener its high fatigue endurance. Cadmium plating met the corrosion resistance criteria for Frankling Chemical 717 and brine solution.



## BENEFIT

Improved passenger safety and maintenance cost reduction. Unbrako supplies replacement and MRO parts for this ride. Customer engineers contact Unbrako engineers for ongoing technical advice on new applications.



*Unbrako Engineered Fasteners specializes in developing custom fastening systems for one-of-a-kind, high volume applications. Services include engineering, manufacturing, accredited quality control and post-delivery liability insurance supporting protection of the manufacturer.*

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The UNBRAKO Global service network include facilities in IRELAND, INDIA, U.K, AUSTRALIA & USA.



ISO 9001:2000

**SAFETY**



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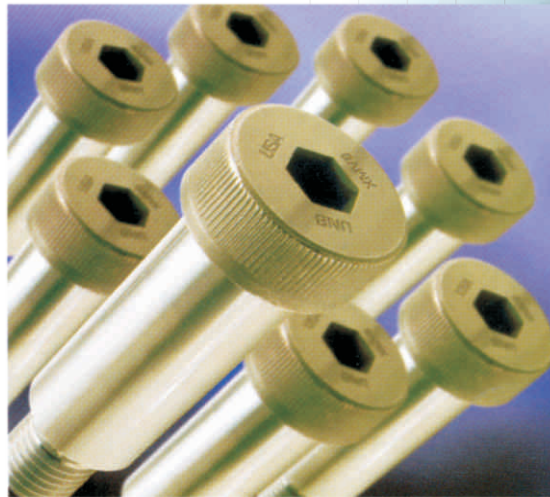
## CHALLENGE



Well-known manufacturer of hydraulic controlled service and passenger elevators experiencing problems with fasteners on a new back-up mechanical brake system. The two section 360°, mechanical brake clamps on the cylinder lift arm and activates should there be a loss in hydraulic pressure.

## SOLUTION

Unbrako engineers developed a special 1-1/4" diameter forged and machined shoulder bolt from high-grade alloy steel to secure the two sections of the brake.



## BENEFIT

This patented brake system, incorporating the new design shoulder bolt from Unbrako, performs to the stated criteria for endurance, safety and liability coverage. In addition to their own original equipment applications, the brake system is being offered for installation on all hydraulic elevators currently in service.



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## A COMMITMENT TO QUALITY

- ISO 9001 Approved Since June 15, 2004
- ISO 9001 Certification Number: 01182-2004-AQ-BOM-NABCB
- CE Certification
- TS Certification



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You're Safer with

# Unbrako®

Engineered for Engineers

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