

# **Tension Structures European Technical Approval**

## **Tension Rods**

**Macalloy 460, S460, 520, S520**

## **Stainless Cables**

**Macalloy SC460**

## **Compression Struts**

**Adjustable and Fixed End**

## **Connection Solutions**



**Materialprüfungsamt für das Bauwesen  
der Technischen Universität München**

**Theresienstraße 90  
80333 München**

**MPA  
BAU**

## **EC Certificate of Factory Production Control**

**1211-CPD-1725-2012**

In compliance with Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products (Construction Products Directive - CPD), as later amended, it has been stated that the construction product:

**Tension Rod System MACALLOY 460, S460 and 520**

placed on the market by

**Macalloy Limited**

**Caxton Way, Dinnington, Sheffield, S25 3QE, Großbritannien**

and produced in the factory

**Macalloy Limited**

**Caxton Way, Dinnington, Sheffield, S25 3QE, Großbritannien**

is submitted by the manufacturer to the initial type-testing of the product, a factory production control and to the further testing of samples taken at the factory in accordance with a prescribed test plan and that the notified body No. 1211 – Materialprüfungsamt für das Bauwesen der Technischen Universität München - has performed the initial inspection of the factory and of the factory production control and performs the continuous surveillance, assessment and approval of the factory production control.

This certificate attests that all provisions concerning the attestation of factory production control described in the European technical approval

**ETA-07/0215 valid from 25. October 2012**

were applied.

This certificate was first issued on 25.10.2012 and remains valid as long as the conditions laid down in the European technical approval in reference or the manufacturing conditions in the factory or the FPC itself are not modified significantly.

This certificate is valid until 25.10.2017.

München, 25.10.2012



.....  
Dr. rer. nat. G. Winklmeier  
(Head of Certification Body)



## European Technical Approval ETA-07/0215

English translation prepared by DIBt - Original version in German language

**Handelsbezeichnung**  
*Trade name*

Zugstabsysteme MACALLOY 355, 460, S460, 520 und S520  
*Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520*

**Zulassungsinhaber**  
*Holder of approval*

Macalloy Limited  
Caxton Way  
DINNINGTON S25 3QE  
GROSSBRITANNIEN

**Zulassungsgegenstand  
und Verwendungszweck**

*Generic type and use  
of construction product*

Vorgefertigtes Zugstabsystem

*Prefabricated tension rod system*

**Geltungsdauer:** vom

*Validity:*

from  
bis  
to

25 April 2013

26 October 2017

**Herstellwerk**  
*Manufacturing plant*

Macalloy Limited  
Caxton Way  
DINNINGTON S25 3QE  
GROSSBRITANNIEN

**Diese Zulassung umfasst**  
*This Approval contains*

29 Seiten einschließlich 21 Anhänge  
*29 pages including 21 annexes*

**Diese Zulassung ersetzt**  
*This Approval replaces*

ETA-07/0215 mit Geltungsdauer vom 26.10.2012 bis 26.10.2017  
*ETA-07/0215 with validity from 26.10.2012 to 26.10.2017*

## I LEGAL BASES AND GENERAL CONDITIONS

- 1 This European technical approval is issued by Deutsches Institut für Bautechnik in accordance with:
  - Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products<sup>1</sup>, modified by Council Directive 93/68/EEC<sup>2</sup> and Regulation (EC) N° 1882/2003 of the European Parliament and of the Council<sup>3</sup>;
  - *Gesetz über das In-Verkehr-Bringen von und den freien Warenverkehr mit Bauprodukten zur Umsetzung der Richtlinie 89/106/EWG des Rates vom 21. Dezember 1988 zur Angleichung der Rechts- und Verwaltungsvorschriften der Mitgliedstaaten über Bauprodukte und anderer Rechtsakte der Europäischen Gemeinschaften (Bauproduktengesetz - BauPG) vom 28. April 1998<sup>4</sup>, as amended by Article 2 of the law of 8 November 2011<sup>5</sup>;*
  - Common Procedural Rules for Requesting, Preparing and the Granting of European technical approvals set out in the Annex to Commission Decision 94/23/EC<sup>6</sup>.
- 2 Deutsches Institut für Bautechnik is authorized to check whether the provisions of this European technical approval are met. Checking may take place in the manufacturing plant. Nevertheless, the responsibility for the conformity of the products to the European technical approval and for their fitness for the intended use remains with the holder of the European technical approval.
- 3 This European technical approval is not to be transferred to manufacturers or agents of manufacturers other than those indicated on page 1, or manufacturing plants other than those indicated on page 1 of this European technical approval.
- 4 This European technical approval may be withdrawn by Deutsches Institut für Bautechnik, in particular pursuant to information by the Commission according to Article 5(1) of Council Directive 89/106/EEC.
- 5 Reproduction of this European technical approval including transmission by electronic means shall be in full. However, partial reproduction can be made with the written consent of Deutsches Institut für Bautechnik. In this case partial reproduction has to be designated as such. Texts and drawings of advertising brochures shall not contradict or misuse the European technical approval.
- 6 The European technical approval is issued by the approval body in its official language. This version corresponds fully to the version circulated within EOTA. Translations into other languages have to be designated as such.

<sup>1</sup> Official Journal of the European Communities L 40, 11 February 1989, p. 12

<sup>2</sup> Official Journal of the European Communities L 220, 30 August 1993, p. 1

<sup>3</sup> Official Journal of the European Union L 284, 31 October 2003, p. 25

<sup>4</sup> *Bundesgesetzblatt Teil I* 1998, p. 812

<sup>5</sup> *Bundesgesetzblatt Teil I* 2011, p. 2178

<sup>6</sup> Official Journal of the European Communities L 17, 20 January 1994, p. 34

## **II SPECIFIC CONDITIONS OF THE EUROPEAN TECHNICAL APPROVAL**

### **1 Definition of product/ products and intended use**

#### **1.1 Definition of the construction product**

The construction products are prefabricated tension rod systems of different sizes (system sizes) used as kits. The tension rod systems comprise metric ISO threads with thread sizes from M10 to M100 (systems 355, 460 and 520: M10 to M100, systems S460 and S520: M10 to M76). The tension rods are made of steel grade S355 (system 355), S460 (systems 460 and S460) or steel grade S520 (systems 520 and S520). The tension rod systems consist of tension rods made of steel (systems 355, 460 and 520) or stainless steel (system S460 and S520) with external threads, which are connected to each other and to the corresponding structure by special connecting devices. The tension rods are connected to the corresponding structure by steel or steel cast fork end connectors (systems 355, 460 and 520) or stainless steel cast fork end connectors (systems S460 and S520) with two eye loops and internal thread. The fork end connectors are connected by double shear pin connections to corresponding steel gusset plates (systems 355, 460 and 520) or stainless steel gusset plates (systems S460 and S520). The tension rods are connected to each other by steel (systems 355, 460 and 520) or stainless steel (systems S460 and S520) threaded sleeves (couplers or turnbuckles).

Drawings of the tension rod systems and the components as well as the essential dimensions of the components are given in the Annexes to this European technical approval.

#### **1.2 Intended use**

The tension rod systems are intended for the use in structures with predominantly static loads. Furthermore the installed tension rod systems shall be accessible (in order) to facilitate replacement of individual components at any time.

The intended use comprises for instance the suspension of roof structures or vertical glazing as well as bracing and truss structures.

The provisions made in this European technical approval are based on an assumed working life of the tension rod systems of 25 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

### **2 Characteristics of products and methods of verification**

#### **2.1 Characteristics of products**

##### **2.1.1 Dimensions**

The dimensions of the components of the tension rod systems shall correspond to the drawings given in Annexes 3 to 15. The dimensions and tolerances of the components of the tension rod systems not indicated in Annexes 3 to 15 shall correspond to the respective values and information laid down in the technical documentation<sup>7</sup> to this European technical approval.

<sup>7</sup>

The technical documentation to this European technical approval is deposited with Deutsches Institut für Bautechnik and, as far as relevant for the tasks of the approved bodies involved in the attestation of conformity procedure is handed over to the approved bodies.

## 2.1.2 Material properties

The material properties of the components of the tension rod systems shall correspond to the details given in Annexes 2.1 (system 355), 2.2 (system 460), 2.3 (system S460), 2.4 (system 520) and 2.5 (system S520). The material characteristics of the components of the tension rod systems not indicated in Annexes 2.1 to 2.5 shall correspond to the respective values and information laid down in the technical documentation to this European technical approval.

Concerning the acceptable combination of components the indications according to Annex 16 apply.

Gusset plates made of steel according to EN 1993-1-1:2005 may be used for the connection of fork end connectors made of stainless steel when contact corrosion is suspended through corrosion protection provisions (see section 4.3).

The inner and outer nature of steel cast fork end connectors has to be in accordance with quality class SM2, LM2 and AM2 according to EN 1369:1997 and quality class 2 according to EN 12680-1:2003.

As maximum permissible characteristic for the inner nature of stainless steel cast fork end connectors reference pictures ASTM - E 192<sup>8</sup> according to Tabelle A.1 of EN 12681:2003 with the following characteristics of inner nature is defined:

- Shrinkage cavity/hollow space - Picture 2 for component thickness  $\leq 25$  mm
- Shrinkage cavity/hollow space - Picture 3 for component thickness  $> 25$  mm
- Gas holes - Picture 4
- Inclusions, cracks, chaplets and chills - not allowed.

Discontinuities of the outer nature of stainless steel cast fork end connectors shall not be assigned to a quality class worse than quality class 6 according to Table 2 and quality class 5 according to Table 3 of EN 1371-2:1998.

## 2.1.3 Design values of resistance

The design value  $N_{Rd}$  of the tension resistance of the entire tension rod system (systems 355, 460, S460, 520 or S520) is the design tension resistance  $N_{Rd, \text{Tension Rod}}$  of the tension rod.

The design value shall be determined according to EN 1993-1-1:2005 and EN 1993-1-8:2005 as follows:

$$N_{Rd, \text{Tension Rod}} = \min \{ A \cdot f_{y,k} / \gamma_{M1}; 0.9 \cdot A_s \cdot f_{u,k} / \gamma_{M2} \}$$

$A$  = minimum cross section of the unthreaded part of the tension rod  
 $A_s$  = cross section of the threaded part of the tension rod  
 $f_{y,k}$  =  $R_{p0.2}$  characteristic value of the yield strength of the tension rod  
 $f_{y,k}$  = 355 N/mm<sup>2</sup> for  $D \leq 40$  mm respective 335 N/mm<sup>2</sup> for 40 mm  $< D \leq 80$  mm respective 315 N/mm<sup>2</sup> for  $D > 81$  mm for system 355  
           = 460 N/mm<sup>2</sup> for systems 460 and S460  
           = 520 N/mm<sup>2</sup> for systems 520 and S520  
 $f_{u,k}$  =  $R_m$  characteristic value of the tensile strength of the tension rod  
 $f_{u,k}$  = 490 N/mm<sup>2</sup> for  $D \leq 40$  mm respective 470 N/mm<sup>2</sup> for  $D > 40$  mm for system 355  
           = 610 N/mm<sup>2</sup> for systems 460 and S460  
           = 660 N/mm<sup>2</sup> for systems 520 and S520  
 $\gamma_{M1}$  = 1.1  
 $\gamma_{M2}$  = 1.25

The values given for the partial safety factors  $\gamma_{M1}$  and  $\gamma_{M2}$  are recommended values. They should be used in cases where no values are given in national regulations of the Member State where

<sup>8</sup>

ASTM - E 192

Standard Reference Radiographs of Investment Steel Castings of Aerospace Applications

the tension rod system is used or in the respective National Annex to Eurocode 3 (EN 1993).

#### **2.1.4 Safety in case of fire**

The tension rod system is considered to satisfy the requirements of performance class A1 of the characteristic reaction to fire according to EN 13501-1:2007+A1:2009.

### **2.2 Methods of verification**

#### **2.2.1 General**

The assessment of fitness of the tension rod systems for the intended use in relation to the requirements for mechanical resistance and stability, safety in case of fire and safety in use in the sense of the essential requirements No. 1, No. 2 and No. 4 has been made in accordance with section 3.2 of the Common Procedural Rules for Requesting, Preparing and the Granting of European technical approvals set out in the Annex to Commission Decision 94/23/EC<sup>9</sup>.

#### **2.2.2 Essential requirement No. 2: Safety in case of fire**

The tension rod systems are considered to satisfy the requirements of performance class A 1 of the characteristic reaction to fire, in accordance with the provisions of EC Decision 96/603/EC (as amended) without the need for testing on the basis of its listing in that decision.

#### **2.2.3 Essential requirement No. 1: Mechanical resistance and stability**

##### **Essential requirement No. 4: Safety in use**

In order to verify that the tension resistances of the fork end connectors, couplers, turnbuckles and gusset plates are higher than the tension resistances of the corresponding tension rods and thus not relevant to the resistance of the tension rod systems, the characteristic values of the tension resistances of the couplers, turnbuckles and gusset plates were assessed by calculation according to EN 1993-1-1:2005+AC:2009 and EN 1993-1-8:2005+AC:2009 and the characteristic values of tension resistance of the fork end connectors were assessed by the evaluation of the results of tension tests. Tension tests were carried out on eight system sizes of the standard fork end connectors (M10, M16, M20, M30, M76, M85, M90 and M100). In addition tension tests were carried out on system size M76 made of stainless steel as well as tension tests on three system sizes of fork end connectors Spade-End (M10, M30, M56).

The comparison of the characteristic values of resistance of the fork end connectors, couplers, turnbuckles and gusset plates with the characteristic values of resistance of the corresponding tension rods calculated according to EN 1993-1-1:2005+AC:2009 and EN 1993-1-8:2005+AC:2009 has shown that the tension resistances of the fork end connectors (including pins), couplers, turnbuckles and gusset plates are not relevant to the tension resistance of the tension rod systems. Thus it is sufficient to calculate only the tension resistance of the tension rods in order to determine the tension resistance of the tension rod systems.

### **3 Evaluation and attestation of conformity and CE marking**

#### **3.1 System of attestation of conformity**

According to the Decision 98/214/EC of the European Commission<sup>9</sup> system 2+ of the attestation of conformity applies.

This system of attestation of conformity is defined as follows:

System 2+: Declaration of conformity of the product by the manufacturer on the basis of:

- (a) Tasks for the manufacturer:
  - (1) initial type-testing of the product;
  - (2) factory production control;

<sup>9</sup>

Official Journal of the European Communities L 80 of 18.03.1998

- (3) testing of samples taken at the factory in accordance with a prescribed test plan.
- (b) Tasks for the approved body:
  - (4) certification of factory production control on the basis of:
    - initial inspection of factory and of factory production control;
    - continuous surveillance, assessment and approval of factory production control.

Note: Approved bodies are also referred to as "notified bodies".

## **3.2 Responsibilities**

### **3.2.1 Tasks for the manufacturer**

#### **3.2.1.1 Factory production control**

The manufacturer shall exercise permanent internal control of production. All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures, including records of results performed. This production control system shall insure that the product is in conformity with this European technical approval.

The manufacturer may only use initial materials stated in the technical documentation of this European technical approval.

The factory production control shall be in accordance with the control plan which is part of the technical documentation of this European technical approval. The control plan is laid down in the context of the factory production control system operated by the manufacturer and deposited with Deutsches Institut für Bautechnik.<sup>10</sup>

The results of factory production control shall be recorded and evaluated in accordance with the provisions of the control plan.

#### **3.2.1.2 Other tasks for the manufacturer**

The manufacturer shall, on the basis of a contract, involve a body which is approved for the tasks referred to in section 3.1 in the field of "Tension rod systems" in order to undertake the actions laid down in section 3.2.2. For this purpose, the control plan referred to in sections 3.2.1.1 and 3.2.2 shall be handed over by the manufacturer to the approved body involved.

The manufacturer shall make a declaration of conformity, stating that the construction product is in conformity with the provisions of this European technical approval.

### **3.2.2 Tasks for the approved bodies**

The approved body shall perform the

- initial inspection of factory and of factory production control,
- continuous surveillance, assessment and approval of factory production control,

in accordance with the provisions laid down in the control plan.

The approved body shall retain the essential points of its actions referred to above and state the results obtained and conclusions drawn in a written report.

The approved certification body involved by the manufacturer shall issue an EC certificate of conformity of the factory production control stating the conformity with the provisions of this European technical approval.

<sup>10</sup> The "control plan" is a confidential part of the European technical approval and only handed over to the approved body involved in the procedure of attestation of conformity. See section 3.2.2.



In cases where the provisions of the European technical approval and its control plan are no longer fulfilled the certification body shall withdraw the certificate of conformity and inform Deutsches Institut für Bautechnik without delay.

### 3.3 CE marking

The CE marking shall be affixed on each packaging of the tension rod system. The letters "CE" shall be followed by the identification number of the approved certification body, where relevant, and be accompanied by the following additional information:

- the name and address of the producer (legal entity responsible for the manufacture),
- the last two digits of the year in which the CE marking was affixed,
- the number of the EC certificate for the factory production control,
- the number of the European technical approval,
- the name of the product,
- the system size and type (e.g., M 36).

## 4 Assumptions under which the fitness of the products for the intended use was favourably assessed

### 4.1 Manufacturing

The European technical approval is issued for the products on the basis of agreed data/information, deposited with Deutsches Institut für Bautechnik, which identifies the product that has been assessed and judged. Changes to the product or production process, which could result in this deposited data/information being incorrect, should be notified to Deutsches Institut für Bautechnik before the changes are introduced. Deutsches Institut für Bautechnik will decide whether or not such changes affect the approval and consequently the validity of the CE marking on the basis of the approval and if so whether further assessment or alterations to the approval shall be necessary.

### 4.2 Installation

The installation is carried out such that the tension rod system is accessible for repair or maintenance at any time.

The installation is only carried out according to the manufacturer's instructions. The manufacturer hands over the assembly instructions to the assembler. From the assembly instructions it is followed that, prior to installation, all components of the tension rod systems shall be checked for their perfect condition and that damaged components shall not be used.

The fork end connectors are not subjected to sudden or impact loads (for instance pins of fork end connectors may not be adjusted by hammer blows).

The minimum thread engagement is marked in an appropriate way. The keeping of the minimum thread engagements given in Annexes 3 and 4 (fork end connector, Spade-End type), 7 to 12 (couplers and turnbuckles) is checked by the assembler. How to do this is described in the assembly instructions.

The conformity of the installed tension rod system with the provisions of the ETA is attested by the executing assembler.

#### 4.3 Design

The loading is predominantly static.

Dimensions, material properties and the thread engagement as stated in the ETA are observed.

The tension rod systems are not subjected to systematic bending.

The verification concept stated in EN 1990:2002+A1:2005/AC:2010 as well as the design values of resistance stated in section 2.1 are used for design.

The rules given in EN 1090-2:2008+A1:2011, EN 1993-1-4:2006, EN ISO 10684:2004+AC:2009 and EN ISO 12944:1998 are taken into account.

Design is carried out by the designer of the structure experienced in the field of steel structures.

The tension rod systems are not used, when constructions are susceptible to vibrations under wind loads or wind-induced cross vibrations of the entire construction appear.<sup>11</sup>

#### 5 Indications to the manufacturer

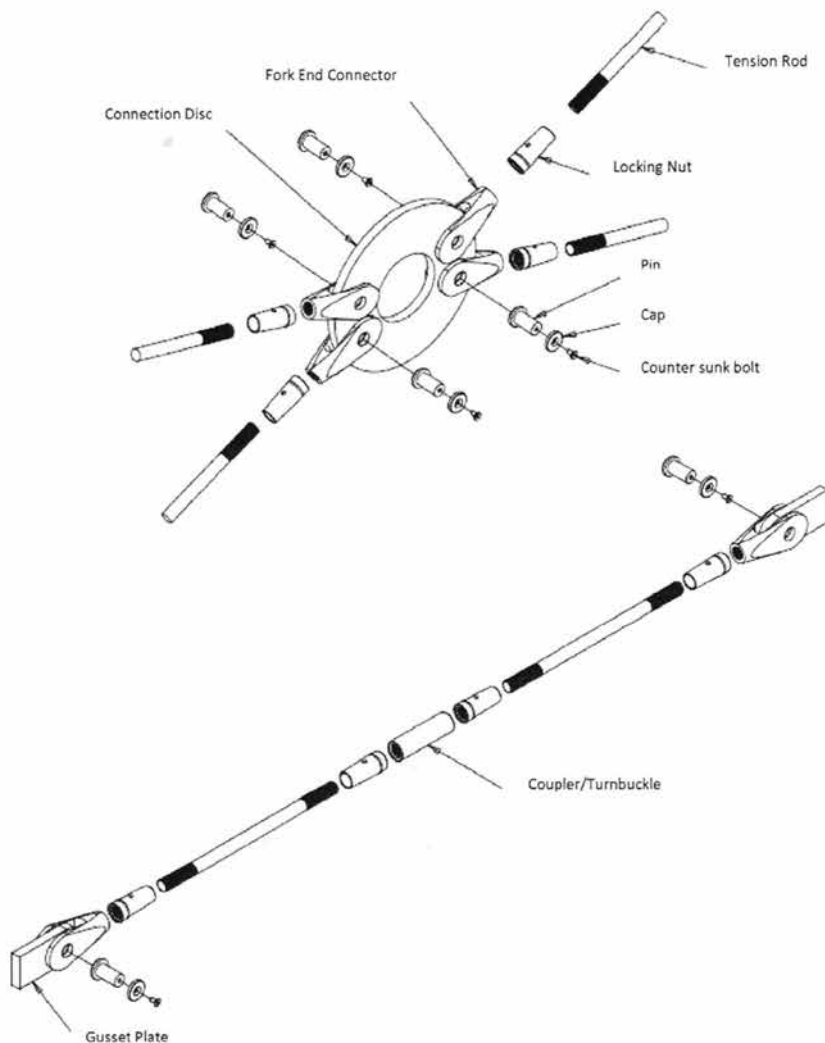
The manufacturer shall ensure that the information on the specific conditions according to 1, 2, 4.2 and 4.3 (including Annexes referred to) is given to those who are concerned. This information may be given by reproduction of the respective parts of the European technical approval. In addition all essential installation data (e.g., minimum thread engagement according to Annexes 3 and 4, 7 to 12) shall be shown clearly on the package and/or on an enclosed instruction sheet, preferably using illustration(s).

The prefabricated tension rod system shall be packaged and delivered as a complete unit only (tension rods, fork end connectors incl. pins, turnbuckles and couplers).

Georg Feistel  
Head of Department

*beglaubigt:*  
Hahn

<sup>11</sup> The national provisions of the Member State applicable for the location where the product is incorporated in the works shall be taken into account.



Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

System, components

Annex 1

Component	Annex	System-size	Material	Technical Delivery Condition	Mechanical Properties (Minimum Values)	
					Yield Strength $R_{e0.2}$ [N/mm <sup>2</sup> ]	Tensile Strength $R_m$ [N/mm <sup>2</sup> ]
Fork End Connector	3	M10 – M100	G20Mn5	acc. to technical documentation <sup>1)</sup>	335	600
		M20 – M56	G20NiMoCr4 S355J2G3	acc. to technical documentation <sup>1)</sup> EN ISO 10250-2:1999	380 <sup>3)</sup>	550
Spade-End Type	4	M10 – M56	G20Mn5	acc. to technical documentation <sup>1)</sup>	335	600
			G20NiMoCr4			
Pin	5	M10 – M16	8.8	acc. to technical documentation <sup>1)</sup>	665	800
		M20 – M100	8.8		685	822
Tension Rod Coupler	8	M10 – M36	S355 J2	acc. to technical documentation <sup>1)</sup>	355	490
		M42 – M76	S355 J2	acc. to technical documentation <sup>1)</sup>	335	470
Turnbuckle	10, 12	M85 – M100	S355 J2	acc. to technical documentation <sup>1)</sup>	315	470
Gusset plate	13	M10 – M100	≥ S355 <sup>2)</sup>	at least steel grade S355 or higher (EN 1993-1-1:2010)	acc. to EN 1993-1-1:2010	

<sup>1)</sup> The technical documentation is deposited at Deutsches Institut für Bautechnik and contains specifications for the chemical composition as well as values for the elongation after fracture  $A_5$  and the Charpy impact value ISO-V.  
<sup>2)</sup> At least steel grade S355 or higher strength (acc. EN 1993-1-1:2010)  
<sup>3)</sup>  $R_o$

Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

Material Properties of Steel/Steel Cast Components  
Tension Rod System MACALLOY 355

Annex 2.1

Component	Annex	System-size	Material	Technical Delivery Condition	Mechanical Properties (Minimum Values)	
					Yield Strength $R_{y0.2}$ [N/mm <sup>2</sup> ]	Tensile Strength $R_m$ [N/mm <sup>2</sup> ]
Fork End Connector	3	M10 – M100	G20Mn5	acc. to technical documentation <sup>1)</sup>	335	600
		M20 – M56	G20NiMoCr4 S355J2G3	acc. to technical documentation <sup>1)</sup> EN ISO 10250-2:1999	380 <sup>3)</sup>	550
Spade-End Type	4	M10 – M56	G20Mn5	acc. to technical documentation <sup>1)</sup>	335	600
Pin	5	M10 – M16	8.8	acc. to technical documentation <sup>1)</sup>	665	800
		M20 – M100	8.8	acc. to technical documentation <sup>1)</sup>	685	822
Tension Rod Coupler Turnbuckle Gusset plate	7 9, 11 13	M10 – M100	460	acc. to technical documentation <sup>1)</sup>	460	610
at least steel grade S355 or higher (EN 1993-1-1:2010)					acc. to EN 1993-1-1:2010	

<sup>1)</sup> The technical documentation is deposited at Deutsches Institut für Bautechnik and contains specifications for the chemical composition as well as values for the elongation after fracture  $A_5$  and the Charpy impact value ISO-V.  
<sup>2)</sup> At least steel grade S355 or higher strength (acc. EN 1993-1-1:2010)  
<sup>3)</sup>  $R_o$

Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

Material Properties of Steel/Steel Cast Components  
Tension Rod System MACALLOY 460

Annex 2.2

Component	Annex	System-size	Material	Technical Delivery Condition	Mechanical Properties (Minimum Values)	
					Yield Strength $R_{e0.2}$ [N/mm <sup>2</sup> ]	Tensile Strength $R_m$ [N/mm <sup>2</sup> ]
Fork End Connector	3	M10 – M76	Stainless steel cast 4A	acc. to technical documentation <sup>1)</sup>	335	600
Pin	6	M10 – M24	316S11	acc. to technical documentation <sup>1)</sup>	640	800
			316S13			
			316S31			
			316S33			
Tension Rod Coupler Turnbuckle	7 9, 11	M30 – M76	1.4462	EN 10088-3:2005 <sup>3)</sup>	835	1030
			7M	acc. to technical documentation <sup>1)</sup>		
			316S11	acc. to technical documentation <sup>1)</sup>	460	610
			316S13			
			316S31			
Gusset plate	13	M10 – M76	316S33	EN 10088-3:2005 <sup>3)</sup>	acc. to technical documentation <sup>1)</sup>	acc. to technical documentation <sup>1)</sup>
			1.4460			
			1.4462			
			1.4507			

<sup>1)</sup> The technical documentation is deposited at Deutsches Institut für Bautechnik and contains specifications for the chemical composition as well as values for the elongation after fracture  $A_5$  and the Charpy impact value ISO-V.

<sup>2)</sup> At least steel grade S355 or higher strength (acc. EN 1993-1-1:2010)

<sup>3)</sup>  $R_e$

Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

Material Properties of Steel/Steel Cast Components  
Tension Rod System MACALLOY S460

Annex 2.3

Component	Annex	System-size	Material	Technical Delivery Condition	Mechanical Properties (Minimum Values)	
					Yield Strength $R_{e2}$ [N/mm <sup>2</sup> ]	Tensile Strength $R_m$ [N/mm <sup>2</sup> ]
Fork End Connector	3	M10 – M100	G20Mn5 G20NiMoCr4	acc. to technical documentation <sup>1)</sup>	335	600
Spade-End Type	4	M10 – M56	G20Mn5 G20NiMoCr4	acc. to technical documentation <sup>1)</sup>	355	600
Pin	5	M10 – M16 M20 – M100	8.8 8.8	acc. to technical documentation <sup>1)</sup>	665 685	800 822
Tension Rod Coupler Turnbuckle	7 9, 11	M10 – M100	520	acc. to technical documentation <sup>1)</sup>	520	690
Gusset plate	13	M10 – M100	≥ S355 <sup>2)</sup>	at least steel grade S355 or higher (EN 1993-1-1:2010)	acc. to EN 1993-1-1:2010	

<sup>1)</sup> The technical documentation is deposited at Deutsches Institut für Bautechnik and contains specifications for the chemical composition as well as values for the elongation after fracture  $A_5$  and the Charpy impact value ISO-V.

<sup>2)</sup> At least steel grade S355 or higher strength (acc. EN 1993-1-1:2010)

Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

Material Properties of Steel/Steel Cast Components  
Tension Rod System MACALLOY 520

Annex 2.4

Component	Annex	System-size	Material	Technical Delivery Condition	Mechanical Properties (Minimum Values)	
					Yield Strength R <sub>0.2</sub> [N/mm <sup>2</sup> ]	Tensile Strength R <sub>m</sub> [N/mm <sup>2</sup> ]
Fork End Connector	3	M10 – M76	Stainless steel cast 4A	acc. to technical documentation <sup>1)</sup>	335	600
Pin	6	M10 – M24	316S11	acc. to technical documentation <sup>1)</sup>	640	800
			316S13			
			316S31			
			316S33			
			1.4462	EN 10088-3:2005 <sup>3)</sup>		
Tension Rod Coupler Turnbuckle	7 9, 11	M30 – M76	7M	acc. to technical documentation <sup>1)</sup>	835	1030
		M10 – M76	316S11	acc. to technical documentation <sup>1)</sup>	520	690
			316S13			
			316S31			
			316S33			
					1.4460	EN 10088-3:2005 <sup>3)</sup>
			1.4462			
			1.4507			
Gusset plate	13	M10 – M76	≥ S355 <sup>2)</sup>	acc. to technical documentation <sup>1)</sup>	acc. to technical documentation <sup>1)</sup>	

1) The technical documentation is deposited at Deutsches Institut für Bautechnik and contains specifications for the chemical composition as well as values for the elongation after fracture A<sub>5</sub> and the Charpy impact value ISO-V.

2) At least steel grade S355 or higher strength (acc. EN 1993-1-1:2005)

1) The technical documentation is deposited at Deutsches Institut für Bautechnik and contains specifications for the chemical composition as well as values for the elongation after fracture  $A_5$  and the Charpy impact value ISO-V.

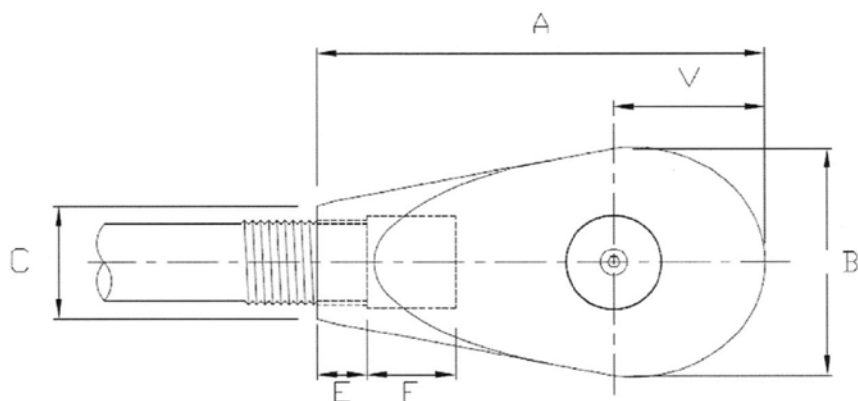
2) At least steel grade S355 or higher strength (acc. EN 1993-1-1:2005)

Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

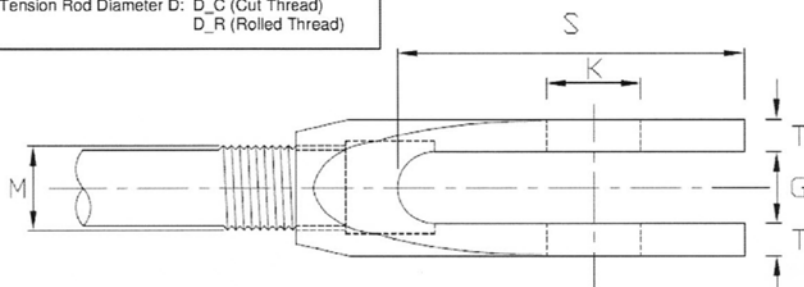
Material Properties of Steel/Steel Cast Components  
Tension Rod System MACALLOY S520

Annex 2.5





Tension Rod Diameter D: D\_C (Cut Thread)  
D\_R (Rolled Thread)

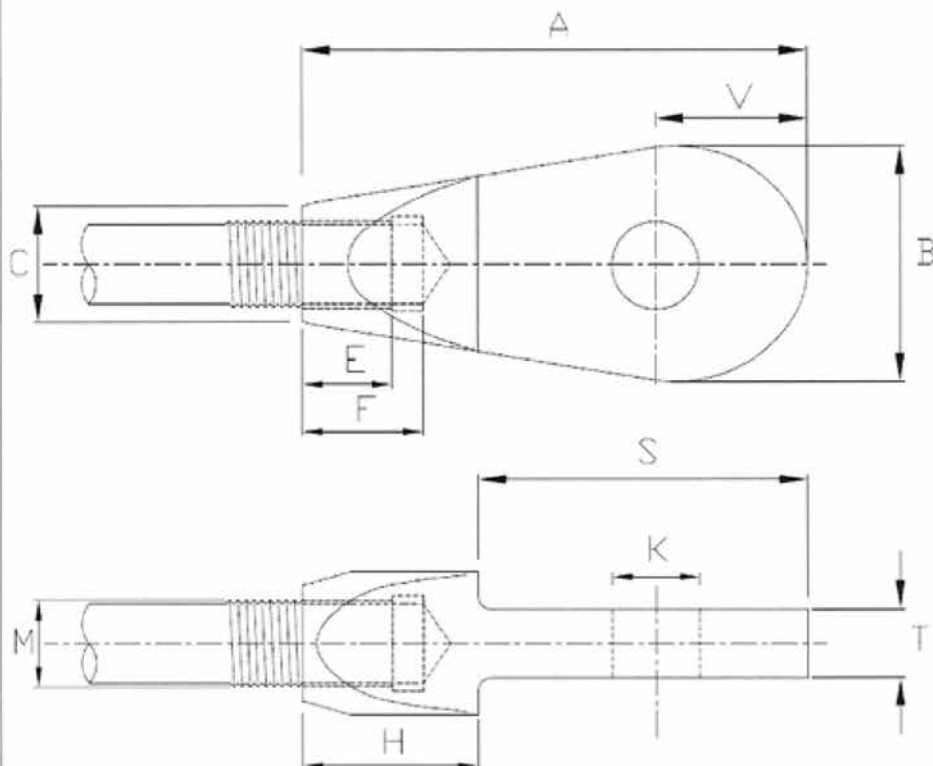


Thread M	M10	M12	M16	M20	M24	M30	M36	M42	M48	M56	M64	M76	M85	M90	M100
A (mm)	63	75	99	122	148	178	204	232	266	314	348	410	459	489	555
B (mm)	30	34	45	53	64	81	93	109	123	147	169	201	236	248	289
C (mm)	17	19	25	29	35	44	52	60	69	80	91	108	121	129	143
E (mm)	12	14	18	24	27	32	38	44	50	58	66	78	87	92	102
F (mm)	8	10	14	16	22	28	34	41	46	55	49	49	49	49	49
G (mm)	11	12	15	19	24	26	34	39	44	49	59	76	78	86	91
K (mm)	11,5	13	17	21,5	25,5	31,5	37,5	43,5	49,5	57,5	65,5	78,5	91,5	96,5	111,5
S (mm)	46	54	70	85	104	127	148	167	191	227	259	309	349	374	430
T (mm)	4	4,5	6	8,5	9,5	11,5	14,5	17,5	21	23,5	27,5	34,5	37	41	41
V (mm)	18	22	29	34	42	53	61	70	81	97	111	132	153	162	188

Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

Dimensions of Fork End Connector  
Systems 355 / 460 / 520 (M10 - M100); System S460 / S520 (M10 - M76)

Annex 3

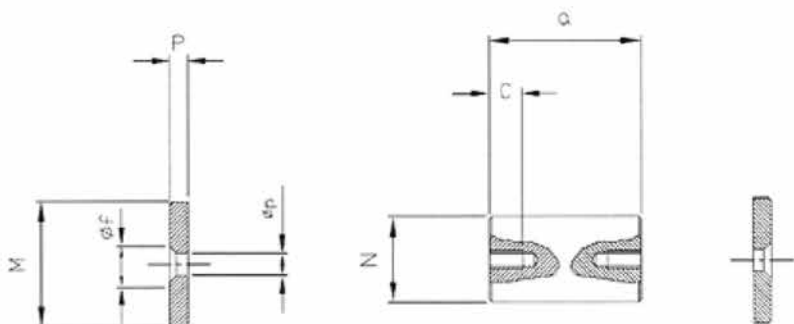


Thread M	M10	M12	M16	M20	M24	M30	M36	M42	M48	M56
A (mm)	78	92	118	147	174	213	249	284	321	355
B (mm)	28	32	44	51	62	80	94	107	122	147
C (mm)	17	19	25	29	35	43	52	60	68	80
E (mm)	20	24	32	22	26	34	38	44	50	58
F (mm)	26	30	40	40	48	62	72	84	96	112
H (mm)	32	38	48	60	70	85	100	115	127	150
K (mm)	11,5	13	17,5	21,5	25,5	31,5	37,5	43,5	49,5	57,5
S (mm)	46	54	70	87	104	128	149	169	194	215
T (mm)	8	9	12	15	20	22	30	35	40	45
V (mm)	17,5	21,5	29	33	41	52	61	69	80	96

Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

Dimensions of Spade-End Type  
Systems 355 / 460 / 520 (M10 - M56)

Annex 4

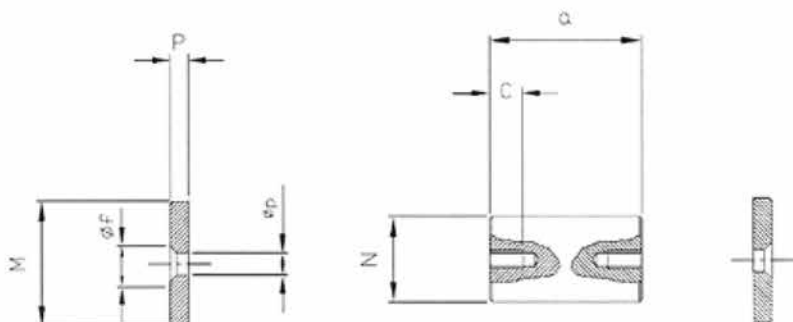


Thread M	M10	M12	M16	M20	M24	M30	M36	M42	M48	M56	M64	M76	M85	M90	M100
Screw	10	10	10	16	16	16	16	20	25	25	25	25	25	25	25
a (mm)	22	24	30	39	46	52	66	78	91	100	120	151	158	175	180
c (mm)	7	7	7	12	12	12	12	14	18	18	18	18	18	18	18
Øf	9	9	11,2	13,4	13,4	13,4	13,4	17,9	22,4	22,4	22,4	22,4	22,4	22,4	22,4
M (mm)	15	18	24	28	31	40	45	55	65	75	85	95	105	110	120
N (mm)	10,5	12	16	20	24	29	35	41	47	54,5	62,5	75,5	89	93	108
P (mm)	4	4	4	5	5	5	5	8	10	10	10	10	10	10	10
Øp	4,5	4,5	5,5	6,5	6,5	6,5	6,5	9	12	12	12	12	12	12	12

Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

Dimensions of Pins for Fork End Connector and Spade-End Type  
Systems 355 / 460 / 520 (M10 - M100)

Annex 5

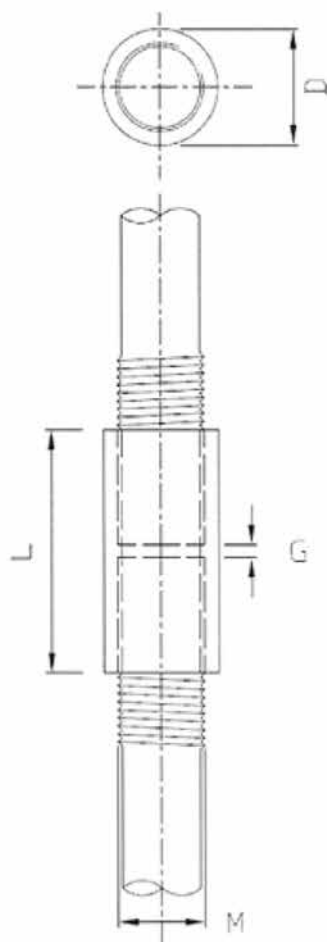


Thread M	M10	M12	M16	M20	M24	M30	M36	M42	M48	M56	M64	M76
Screw	10	10	10	16	16	16	16	20	25	25	25	25
a (mm)	22	24	30	39	46	52	66	78	91	100	120	151
c (mm)	7	7	7	12	12	12	12	14	18	18	18	18
$\varnothing f$	9	9	11.2	13.4	13.4	13.4	13.4	17.9	22.4	22.4	22.4	22.4
M (mm)	15	17	22	27	31	40	45	55	60	70	80	95
N (mm)	11	12.5	16.5	20.5	24.5	30	36	42	48	56	63.5	76.5
P (mm)	4	4	4	5	5	5	5	8	10	10	10	10
$\varnothing p$	4.5	4.5	5.5	6.5	6.5	6.5	6.5	9	12	12	12	12

Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

Dimensions of Pins for Fork End Connector  
Systems S460 / S520 (M10 – M76)

Annex 6

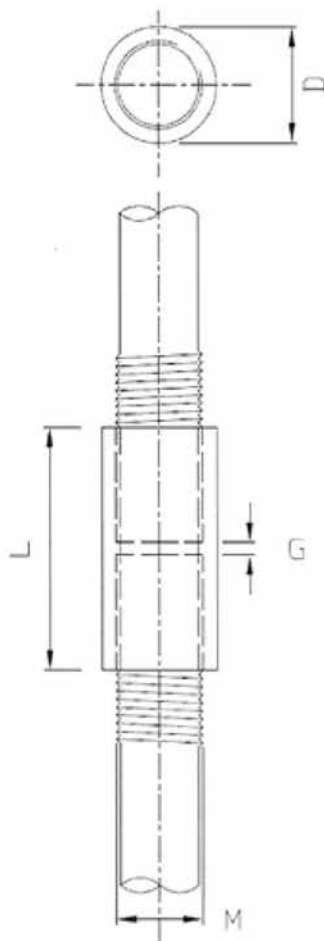


Thread M	M10	M12	M16	M20	M24	M30	M36	M42	M48	M56	M64	M76	M85	M90	M100
D (mm)	17	19	25	29	35	43	52	60	68	80	91	108	121	129	143
G (mm)	$1 \leq G \leq 5$														
L (mm)	25	29	37	45	53	65	77	89	101	117	133	157	175	185	205

Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

Dimensions of couplers  
Systems 460 / 520 (M10 - M100); Systems S460 / S520 (M10 - M76)

Annex 7

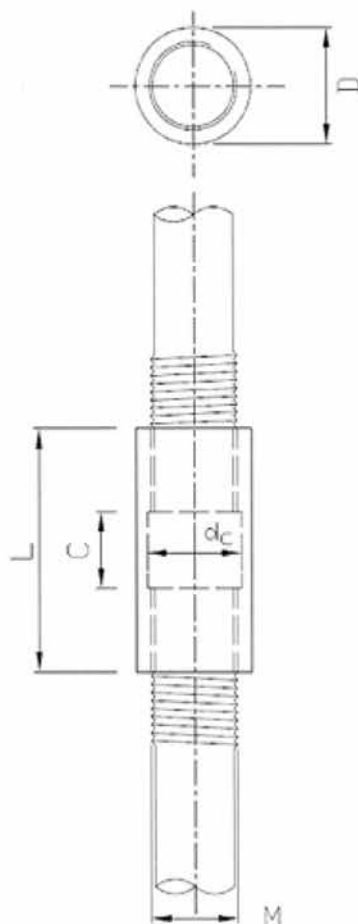


Thread M	M10	M12	M16	M20	M24	M30	M36	M42	M48	M56	M64	M76	M85	M90	M100
D (mm)	17	20	26	32	38	47	56	66	75	87	99	119	135	143	160
G (mm)	$1 \leq G \leq 5$														
L (mm)	25	29	37	45	53	65	77	89	101	117	133	157	175	185	205

Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

Dimensions of couplers  
System 355 (M10 - M100)

Annex 8

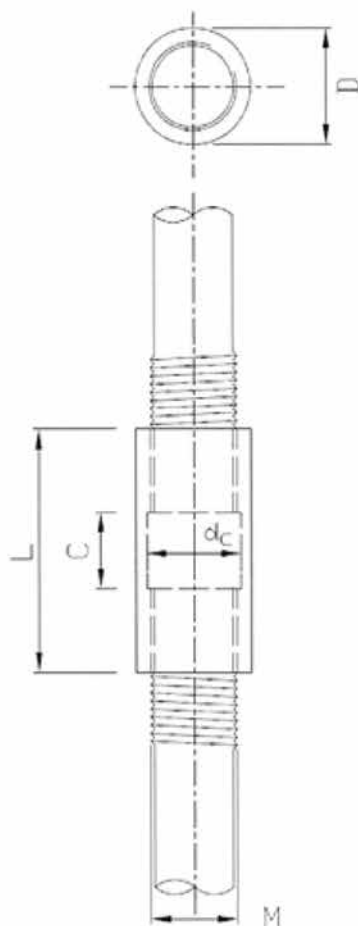


Thread M	M10	M12	M16	M20	M24	M30	M36	M42	M48	M56	M64	M76	M85	M90	M100
d <sub>c</sub> (mm)	12	14	18	22	28	32	38	44	50	58	66	78	87	92	102
C (mm)	50	50	50	50	50	100	100	100	100	100	100	100	100	100	100
D (mm)	17	19	25	29	35	43	52	60	68	80	91	108	121	129	143
L (mm)	74	78	86	90	98	160	172	184	196	212	228	252	270	280	300

Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

Dimensions of turnbuckles  
Systems 460 / 520 (M10 - M100); Systems S460 / S520 (M10 - M76)

Annex 9



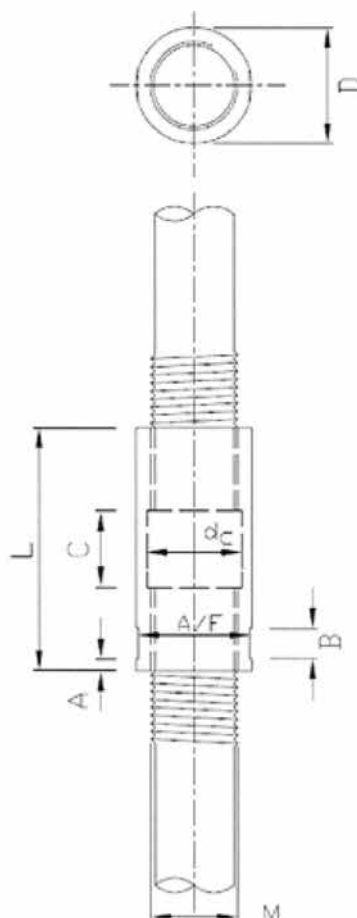
Thread M	M10	M12	M16	M20	M24	M30	M36	M42	M48	M56	M64	M76	M85	M90	M100
d <sub>c</sub> (mm)	12	14	18	22	26	32	38	44	50	58	66	78	87	92	102
C (mm)	50	50	50	50	50	100	100	100	100	100	100	100	100	100	100
D (mm)	17	20	26	32	38	47	56	66	75	87	99	119	135	143	160
L (mm)	74	78	86	90	98	160	172	184	196	212	228	252	270	280	300

Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

Dimensions of turnbuckles  
System 355 (M10 - M100)

Annex 10



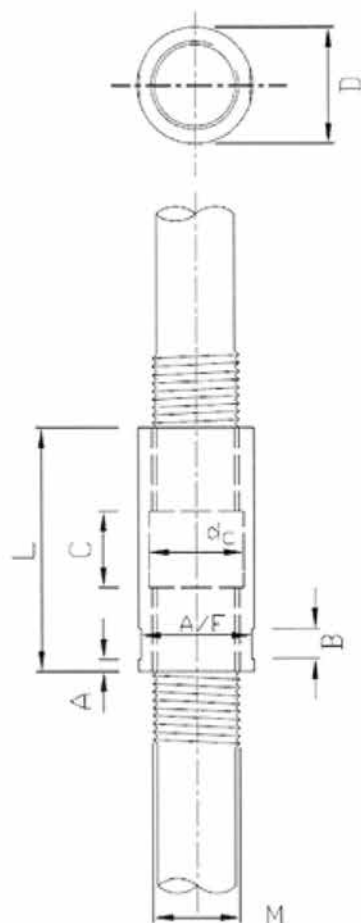


Thread M	M10	M12	M16	M20	M24	M30	M36	M42	M48	M56	M64	M76	M85	M90	M100
d <sub>c</sub> (mm)	12	14	18	22	26	32	38	44	50	58	66	78	87	92	102
A/F (mm)	15	17	22	27	29	37	46	54	62	74	85	102	115	123	137
A (mm)	4	4	5	5	5	5	5	10	10	10	10	15	15	15	15
B (mm)	8	8	10	10	16	16	20	32	32	32	32	32	38	38	38
C (mm)	50	50	50	50	50	100	100	100	100	100	100	100	100	100	100
D (mm)	17	19	25	29	35	43	52	60	68	80	91	108	121	129	143
L (mm)	74	78	86	90	98	160	172	184	196	212	228	252	270	280	300

Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

Dimensions of turnbuckles with spanner flats  
Systems 460 / 520 (M10 - M100); Systems S460 / S520 (M10 - M76)

Annex 11

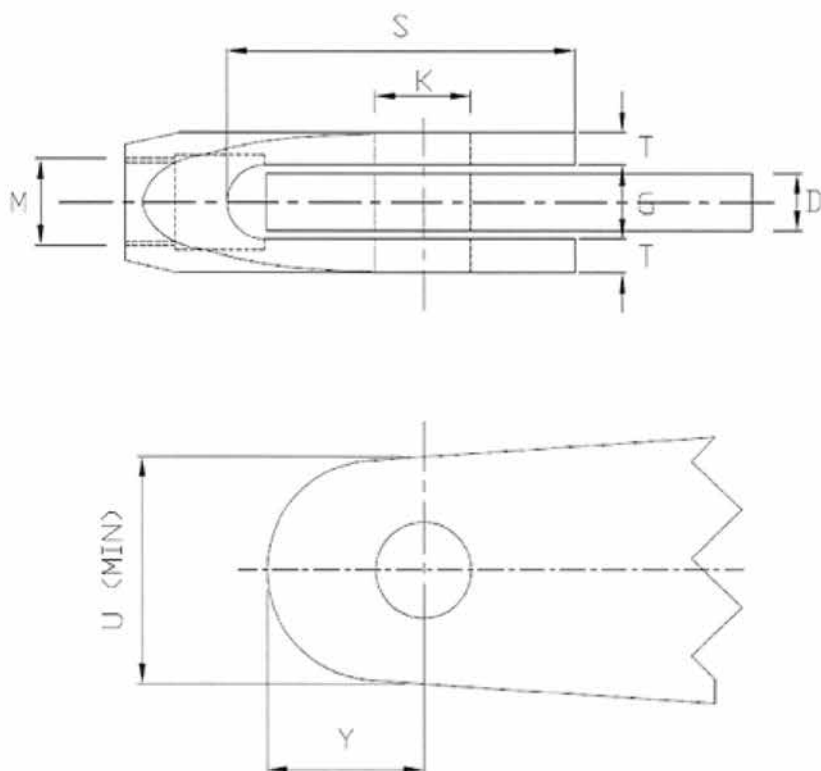


Thread M	M10	M12	M16	M20	M24	M30	M36	M42	M48	M56	M64	M76	M85	M90	M100
dc (mm)	12	14	18	22	26	32	38	44	50	58	66	78	87	92	102
A/F (mm)	15	18	22	29	31	40	48	58	67	79	91	110	126	134	150
A (mm)	4	4	5	5	5	5	5	10	10	10	10	15	15	15	15
B (mm)	8	8	10	10	16	16	20	32	32	32	32	38	38	38	38
C (mm)	50	50	50	50	50	100	100	100	100	100	100	100	100	100	100
D (mm)	17	20	26	32	38	47	56	66	75	87	99	119	135	143	160
L (mm)	74	78	86	90	98	160	172	184	196	212	228	252	270	280	300

Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

Dimensions of turnbuckles with spanner flats  
System 355 (M10 - M100)

Annex 12

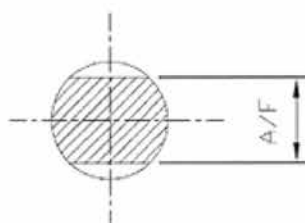


Thread M	M10	M12	M16	M20	M24	M30	M36	M42	M48	M58	M64	M76	M85	M90	M100
D (mm)	10	10	12	15	20	22	30	35	40	45	55	70	70	80	85
G (mm)	11	12	15	19	24	26	34	39	44	49	59	76	78	88	91
K (mm)	11,5	13	17	21,4	25,5	31,5	37,5	43,5	49,5	57,5	65,5	78,5	91,5	98,5	111,5
S (mm)	46	54	70	85	104	127	148	167	191	227	259	309	349	374	430
T (mm)	4	4,5	6	8,5	9,5	11,5	14,5	17,5	21	23,5	27,5	34,5	37	41	41
U (mm)	28	34	48	60	68	90	103	118	135	163	180	211	259	266	317
Y (mm)	18	22	30	37	43	56	64	74	84	101	112	132	160	166	196

Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

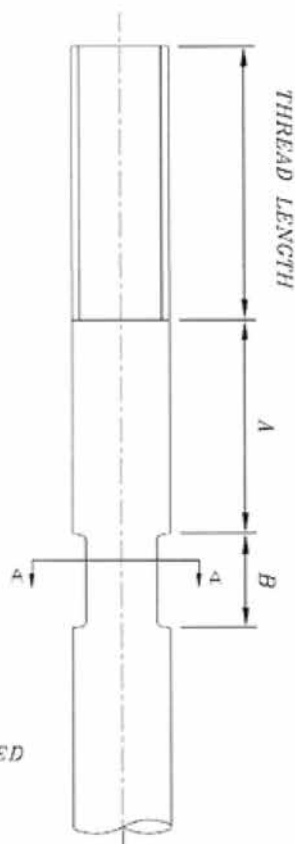
Dimensions of gusset plate  
Systems 355 / 460 / 520 (M10 - M100); Systems S460 / S520 (M10 - M76)

Annex 13



SECTION A-A

ALL SPANNER FLATS TO BE MACHINED

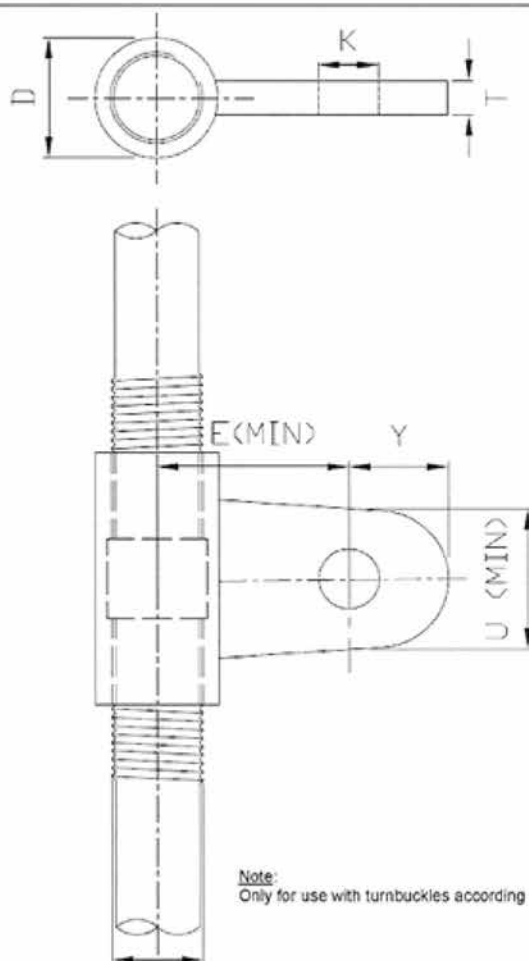


Thread M	M10	M12	M16	M20	M24	M30	M36	M42	M48	M56	M64	M76	M85	M90	M100
A (mm)	110	130	150	180	200	240	280	320	350	390	440	500	550	575	625
B (mm)	20	20	20	25	25	25	25	25	32	32	40	40	50	50	50
A/F (mm)	8	9	12	16	19	25	30	36	42	48	57	68	77	81	90

Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

Dimensions of spanner flats  
Systems 355 / 460 / 520 (M10 - M100); Systems S460 / S520 (M10 - M76)

Annex 14



Thread M	M10	M12	M16	M20	M24	M30	M36	M42	M48	M56	M64	M76	M85	M90	M100
Y (mm)	18	22	30	37	43	56	64	74	84	101	112	132	160	166	196
U (MIN) (mm)	28	34	48	60	68	90	103	118	135	163	180	211	259	266	317
E (MIN) (mm)	28	32	39	44	52	63	71	80	91	107	121	142	163	172	198
D (mm)	17	20	26	32	38	47	56	66	75	87	99	119	135	143	160
K (mm)	11,5	13	17	21,4	25,5	31,5	37,5	43,5	49,5	57,5	65,5	78,5	91,5	98,5	111,5
T (mm)	10	10	12	15	20	22	30	35	40	45	55	70	70	80	85

Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

Dimensions of fin plates for turnbuckles  
Systems 355 / 460 / 520 (M10 - M100)

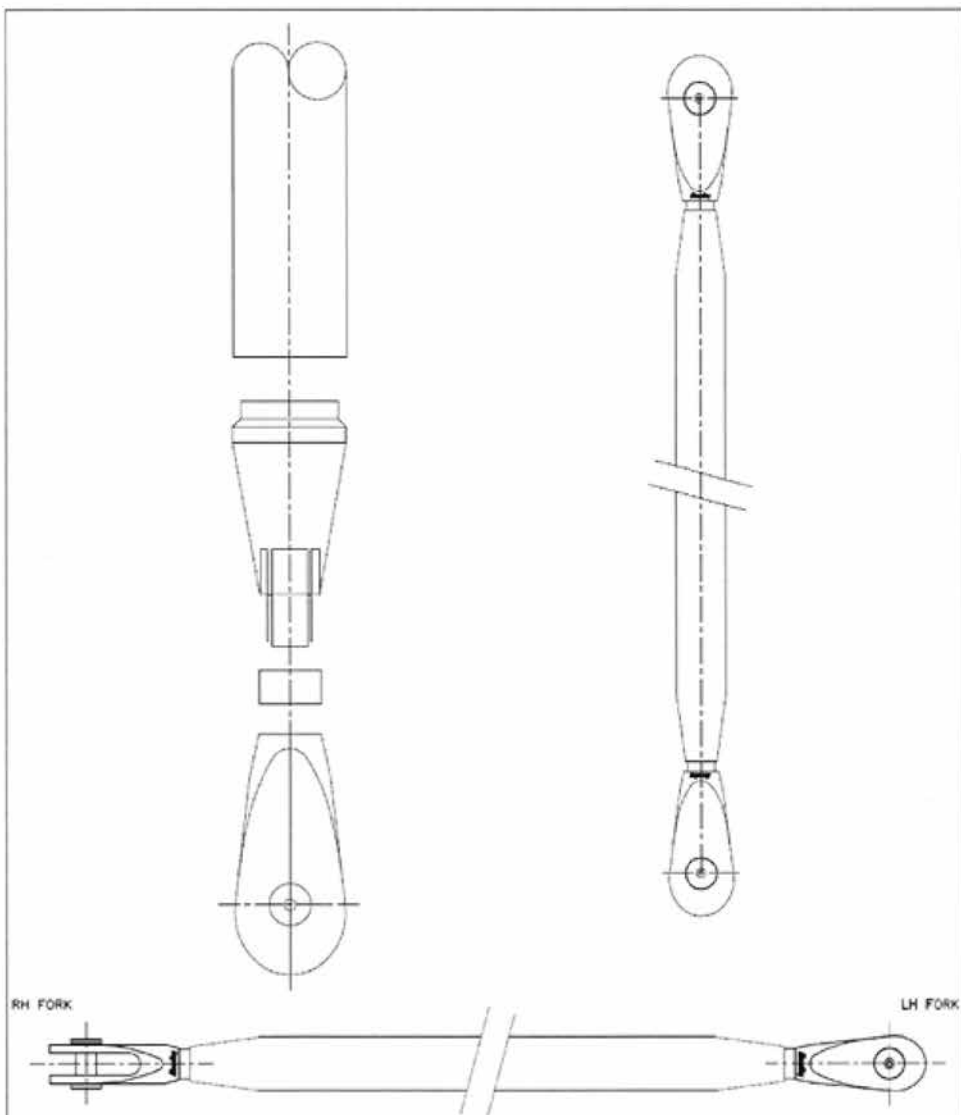
Annex 15

		Steel and steel cast			Stainless steel and stainless steel cast	
		Tension Rod 355 M10 - M100	Tension Rod 460 M10 - M100	Tension Rod 520 M10 - M100	Tension Rod S460 M10 - M76	Tension Rod S520 M10 - M76
Steel and steel cast	Fork End Connector Annex 3	possible	possible	possible		
	Spade-End Type Annex 4	possible	possible	possible		
	Pin Annex 5	possible	possible	possible		
	Coupler Systems 460/520 Annex 7	possible	possible	possible		
	Coupler System 355 Annex 8	possible	possible	possible		
	Tumbuckle Systems 460/520 Annex 9 / 11	possible	possible	possible		
	Turnbuckle System 355 Annex 10 / 12	possible	possible	possible		
	Spanner flats 355/460/520/S460/S520 Annex 14	possible	possible	possible	possible	possible
	fin plates for turnbuckles System 355 Annex 15	possible	possible	possible		
Stainless steel and stainless steel cast	Fork End Connector Annex 3				possible	possible
	Pin Annex 6				possible	possible
	Coupler Systems S460/S520 Annex 7				possible	possible
	Tumbuckle Systems S460/S520 Annex 9 / 11				possible	possible

Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

Assembly Combinations dependant on Material Grade and System

Annex 16



Tension Rod Systems MACALLOY 355, 460, S460, 520 and S520

Compression Struts – Fork End Connector Type Standard and Type Spade-End  
Tension Rod System MACALLOY 520

Annex 17

Fußgängerbrücke Walverdang,  
Luxembourg  
Contractor: Bohlen AG, Speicher



Clarke Quay, Singapore  
Contractor: Hightex GmbH

Treetop Walkway  
at Lough Key Forest Park  
Co. Roscommon, Republic of Ireland



This publication provides the technical details currently used by Macalloy in the manufacture of its components.  
The company reserves the right to amend technical details as and where necessary in line with its policy of continuous development.

Macalloy, Caxton Way, Dinnington, Sheffield S25 3QE, U.K. Tel: +44 (0)1909 519200. Fax: +44 (0)1909 519201

Website: [www.macalloy.com](http://www.macalloy.com) Email: [sales@macalloy.com](mailto:sales@macalloy.com)



is a Registered Trade Mark of McCalls Special Products Ltd.