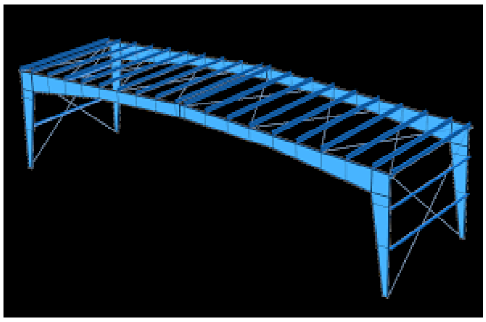
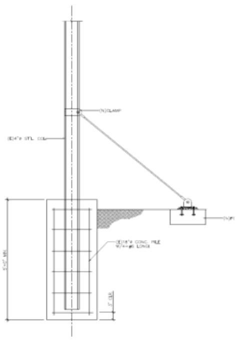
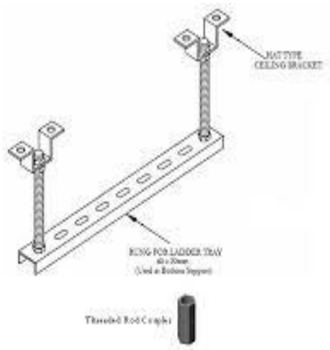
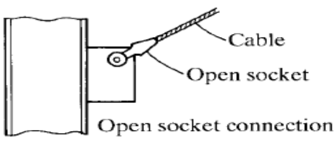
THREADED RODS (FASTENERS) (BARS)

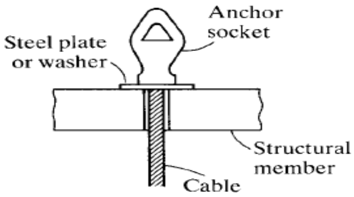
When slenderness is not a consideration, rods with circular cross sections and cables are often used as tension members. The distinction between the two is that rods are solid and cables are made from individual strands wound together in ropelike fashion. Rods and cables are frequently used in suspended roof systems and as hangers or suspension members in bridges. Rods are also used in bracing systems; in some cases, they are pre tensioned to prevent them from going slack when external loads are removed. Figure below illustrates typical rod and cable connection methods. When the end of a rod is to be threaded, an upset end is sometimes used. This is an enlargement of the end in which the threads are to be cut. Threads reduce the cross-sectional area, and upsetting the end produces a larger gross area to start with. Standard upset ends with threads will actually have more net area in the threaded portion than in the unthreaded part. Upset ends are relatively expensive, however, and in most cases unnecessary.

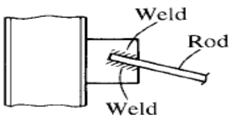


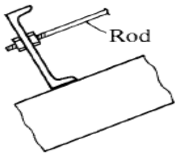




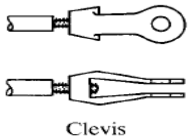












Tension and Shear Strength of Bolts and Threaded Parts

The design tension or shear strength, ϕRn, and the allowable tension or shear strength, Rn/Ω, of a snug-tightened or pre tensioned high-strength bolt or threaded part shall be determined according to the limit states of tensile rupture and shear rupture as follows:

$Rn = Fn\,Ab$ (J3-1)

ϕ= 0.75 (LRFD) Ω= 2.00 (ASD)

Where

Fn = nominal tensile stress Fnt, or shear stress, Fnv from Table (J3.2)

Fnt = 0.75 Fu , ksi.

Ab = nominal unthreaded body area of bolt or threaded part in2

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TABLE J3.2
Nominal Stress of Fasteners and Threaded Parts, ksi (MPa)

Description of Fasteners	Nominal Tensile Stress, F_{nt}, ksi (MPa)	Nominal Shear Stress in Bearing-Type Connections, F_{nv}, ksi (MPa)
A307 bolts	45 (310) [a][b]	24 (165) [b][c][f]
A325 or A325M bolts, when threads are not excluded from shear planes	90 (620) [e]	48 (330) [f]
A325 or A325M bolts, when threads are excluded from shear planes	90 (620) [e]	60 (414) [f]
A490 or A490M bolts, when threads are not excluded from shear planes	113 (780) [e]	60 (414) [f]
A490 or A490M bolts, when threads are excluded from shear planes	113 (780) [e]	75 (520) [f]
Threaded parts meeting the requirements of Section A3.4, when threads are not excluded from shear planes	0.75 F_u [a][d]	0.40 F_u
Threaded parts meeting the requirements of Section A3.4, when threads are excluded from shear planes	0.75 F_u [a][d]	0.50 F_u

[a] Subject to the requirements of Appendix 3.
[b] For A307 bolts the tabulated values shall be reduced by 1 percent for each 1/16 in. (2 mm) over 5 diameters of length in the grip.
[c] Threads permitted in shear planes.
[d] The nominal tensile strength of the threaded portion of an upset rod, based upon the cross-sectional area at its major thread diameter, A_D, which shall be larger than the nominal body area of the rod before upsetting times F_y.
[e] For A325 or A325M and A490 or A490M bolts subject to tensile fatigue loading, see Appendix 3.
[f] When bearing-type connections used to splice tension members have a fastener pattern whose length, measured parallel to the line of force, exceeds 50 in. (1270 mm), tabulated values shall be reduced by 20 percent.

The value of fu depending on the steel types as lisited in Table (2-5)

Table 2-5

Applicable ASTM Specifications for Various Types of Structural Fasteners

ASTM Designation		F_y Min. Yield Stress (ksi)	F_u Tensile Stress[a] (ksi)	Diameter Range (in.)	High-Strength Bolts: Conventional	High-Strength Bolts: Twist-Off-Type Tension-Control	Common Bolts	Nuts	Washers	Direct-Tension-Indicator Washers	Threaded Rods	Steel Headed Stud Anchors	Anchor Rods: Hooked	Anchor Rods: Headed	Anchor Rods: Threaded & Nutted
A108		—	65	0.375 to 0.75, incl.								■			
A325[d]		—	105	over 1 to 1.5, incl.	■										
		—	120	0.5 to 1, incl.	■										
A490[d]		—	150	0.5 to 1.5	■										
F1852[d]		—	105	1.125		■									
		—	120	0.5 to 1, incl.		■									
F2280[d]		—	150	0.5 to 1.125, incl.		■									
A194 Gr. 2H		—	—	0.25 to 4				▒							
A563		—	—	0.25 to 4				■							
F436[b]		—	—	0.25 to 4					■						
F959		—	—	0.5 to 1.5						■					
A36		36	58-80	to 10							■		▒		▒
A193 Gr. B7[e]		—	100	over 4 to 7							▒		▒		▒
		—	115	over 2.5 to 4							▒		▒		▒
		—	125	2.5 and under							▒		▒		▒
A307 Gr. A		—	60	0.25 to 4			■								
A354 Gr. BD		—	140	2.5 to 4, incl.							▒		▒	▒	▒
		—	150	0.25 to 2.5, incl.							▒		▒	▒	▒
A449		—	90	1.75 to 3, incl.	c						▒		▒	▒	▒
		—	105	1.125 to 1.5, incl.	c						▒		▒	▒	▒
		—	120	0.25 to 1, incl.	c						▒		▒	▒	▒
A572	Gr. 42	42	60	to 6							▒		▒		▒
	Gr. 50	50	65	to 4							▒		▒		▒
	Gr. 55	55	70	to 2							▒		▒		▒
	Gr. 60	60	75	to 1.25							▒		▒		▒
	Gr. 65	65	80	to 1.25							▒		▒		▒
A588		42	63	Over 5 to 8, incl.							▒		▒		▒
		46	67	Over 4 to 5, incl.							▒		▒		▒
		50	70	4 and under							▒		▒		▒
A687		105	150 max.	0.625 to 3							▒		▒		▒
F1554	Gr. 36	36	58-80	0.25 to 4									■	■	■
	Gr. 55	55	75-95	0.25 to 4									■	■	■
	Gr. 105	105	125-150	0.25 to 3									▒	▒	▒

■ = Preferred material specification
▒ = Other applicable material specification, the availability of which should be confirmed prior to specification
□ = Material specification does not apply

— Indicates that a value is not specified in the material specification.
[a] Minimum unless a range is shown or maximum (max.) is indicated.
[b] Special washer requirements may apply per RCSC *Specification* Table 6.1 for some steel-to-steel bolting applications and per Part 14 for anchor-rod applications.
[c] See AISC *Specification* Section J3.1 for limitations on use of ASTM A449 bolts.
[d] When atmospheric corrosion resistance is desired, Type 3 can be specified.
[e] For anchor rods with temperature and corrosion resistance characteristics.

Summary of Designs of Threaded Rod

LRFD Method (θ= 0.75)	ASD METHOD (Ω= 2)
Properties of material Steel fy fu (Table 2-5 / page 2-41 in AISC Manual) Pu= 1.2D.l +1.6L.l (Pu≤ θPn)	Properties of material Steel fy fu (Table 2-5 / page 2-41 in AISC Manual) Pa= D.l +L.l (Pa≤ Pn/Ω)
$Pu = 0.75x0.75\ xAbxFu$ $Ab = \frac{Pu}{0.75x0.75xfu}$ where: Ab = gross area for threaded rod Fu=Minimum ultimate tensile strength	$Pn/\Omega = 0.75\ xAbxFu/2$ $Ab = \frac{Pax2}{0.75Fu}$ where: Ab = gross area for threaded rod Fu=Minimum ultimate tensile strength

Example
A threaded rod is to be used as a bracing member that must resist a service tensile load of 2 kips dead load and 6 kips live load. What size of threaded rod is required if A36 steel is used?
solution

Steel fy fu (Table 2-5 / page 2-41 in AISC Manual)
A36 36 58

Nominal Bolt Diameter, in.	Nominal Bolt Area, in.^{2}
5/8	0.307
¾	0.442
7/8	0.601
1	0.785
1 1/8	0.994
1 1/4	1.23
1 3/8	1.48
1 1/2	1.77
1 3/4	2.40
2	3.14

a- By using LRFD method

Pu=1.2Dl+1.6Ll= 1.2x2+1.6x6 =12 kips

$$Ab = \frac{Pu}{0.75x0.75xfu}$$

$= \frac{12}{0.75x0.75x58} = 0.3678\ in^2$

$Ab=\pi D^2/4$

$0.3678=3.14xD^2/4 = 0.684$ in

use ¾ Diam. of threaded road

or use the above Table to find the Diameter of threaded road

b- By using ASD method

Pa=Dl+Ll= 2+x6 =8 kips

$$Ab = \frac{Pa\ \Omega}{0.75xfu}$$

$= \frac{8\ x2}{0.75x58} = 0.3678\ in^2$

$Ab=\pi D^2/4$

$0.3678=3.14xD^2/4 = 0.684$ in

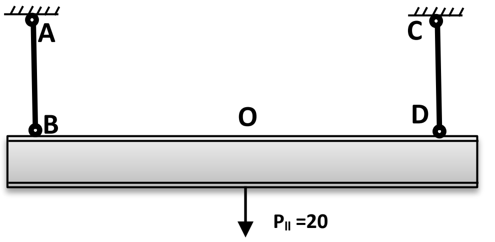
Use ¾ Diam. of threaded road

Or use the above Table to find the Diameter of threaded road

Example

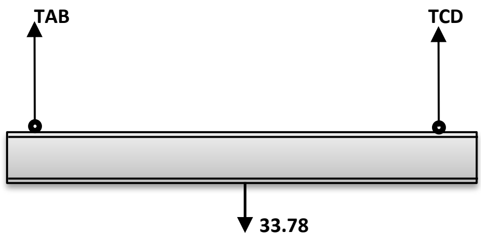
A 30 ft. of W14x48 is supported by two tension threaded rod AB &CD as shown in the Fig below. If 20 kip is a service live load, determine the rod diameter use A36 steel material and LRFD method.

Steel	fy	fu	
A36	36	58	(Table 2-5 / page 2-41 in AISC Manual



$P_u = 1.2xD_{ll} + 1.6\ P_{ll}$

$= 1.2x\ (48/1000x30) + 1.6x20 = 33.78$ kips



∑M@O=0

TAB=TCD

∑Fy=0

TAB+TCD=33.78=2TAB=33.78

TAB=TCD=16.864 =Pu

$$Ab = \frac{Pu}{0.75x0.75xfu}$$

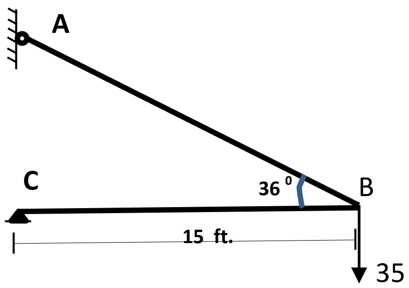
$$Ab = \frac{16.864}{0.75x0.75x85} = 0.5169\ in^2$$

Use 7/8 in Diam. of threaded rod

Example

What is the size of ASTM F1554 G36 threaded rod is required for member AB shown in the Fig. below if the service live load is 35 kip (neglect the self-weight of members) Use LRFD method

Steel	fy	fu	
ASTM F1554 G36	36	58	(Table 2-5 / page 2-41 in AISC Manual)



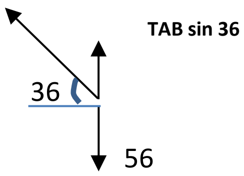
$P_u = 1.2P_{Dl} + 1.6P_{Ll}$

$1.6x35 = 56$ kips

For joint B

∑fy=0

TAB sin (36)=56



TAB=95.27 kip

$$Ab = \frac{Pu}{0.75x0.75xfu}$$

$$Ab = \frac{95.27}{0.75x0.75x58} = 2.92\ in^2$$

Use 2 in Diam. of threaded rod

Homework

What is the size of ASTM F1554 G105 threaded rod is required for member AB shown in the Fig. below if the service live load is 35 kip and 1 k/ft as dead load Use LRFD method