

(Technical Data) Strength of Bolts, Screw Plugs, and Dowel Pins

■ Bolt strength

1) When a bolt takes the tensile load

$$P_t = t \times A_s \dots (1)$$

$$= d^2 t / 4 \dots (2)$$

Pt : Axial tensile load [kgf]
 b : the bolts yield stress [kgf / mm²]
 t : the bolts allowable stress [kgf / mm²]
 (t = b / safety factor)
 As : Effective bolt area [mm²]
 As = d² / 4
 d : Bolts effective diameter (shaft diameter) [mm]

(Example) The correct size is required for a socket head cap screw to take a repeat load (pulsating) with P= 200 kgf.
 (The materials of a socket head cap screw are: SCM435, 38 - 43HRC, strength category of 12.9.)

Using formula (1)

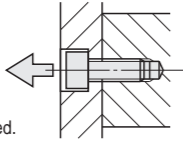
$$A_s = P_t / t$$

$$= 200 / 22.4$$

$$= 8.9 [\text{mm}^2]$$

A bolt with an effective area larger than that this is required, and a 14.2 [mm²] M5 would be selected.

Although, if we take into consideration the endurance strength, looking at the strength category of 12.9, we would choose the M6 with an allowable load of 213kgf.



2) For stripper bolts for example which take the impact load, the size is decided from the endurance strength. (Likewise for a load of 200kgf, the stripper bolt would be SCM435, 33 ~ 38HRC, with a strength category of 10.9.)

In the table to the right, the allowable load for load over 200kgf for a strength category of 10.9 is as M8 at 318 (kgf). Therefore, the MSB10 would be selected, with a screw diameter of 10mm like the M8. Please use dowel pins also to take the shearing load.

Unwin safety factor based on tensile strength

Material	Static load	Repeated load		Impact load
		Pulsating	Reversed	
Steel	3	5	8	12
Cast iron	4	6	10	15
Copper, soft metals	5	5	9	15

Allowable stress = $\frac{\text{Standard strength}}{\text{Safety factor}}$ Standard strength : The yield strength for ductile materials
 The breaking stress for brittle materials

The yield stress for a strength category of 12.9 is b = 112 [kgf / mm²]
 The allowable stress t = b / safety factor (safety factor of 5 from the above table)
 = 112 / 5
 = 22.4 [kgf / mm²]

The bolt endurance strength (For screws, the endurance strength is 2 million times use.)

Bolt size	Effective bolt area As [mm ²]	Strength category			
		12.9		10.9	
		Endurance strength* [kgf / mm ²]	Allowable load [kgf]	Endurance strength* [kgf / mm ²]	Allowable load [kgf]
M 4	8.78	13.1	114	9.1	79
M 5	14.2	11.3	160	7.8	111
M 6	20.1	10.6	213	7.4	149
M 8	36.6	8.9	326	8.7	318
M10	58	7.4	429	7.3	423
M12	84.3	6.7	565	6.5	548
M14	115	6.1	702	6	690
M16	157	5.8	911	5.7	895
M20	245	5.2	1274	5.1	1250
M24	353	4.7	1659	4.7	1659

Endurance strength* is an edited excerpt taken from " the measured values of the endurance limit for small screws, bolts, and meter screws for nuts " (Yamamoto).

■ Screw plug strength

Allowable load P is required for screw plug MSW30 to take an impact load. (The MSW30 : S45C, the tensile strength b of 34 - 43HRC is 65kgf / mm²)

When the root diameter section of the MSW is ruptured due to shearing strain,

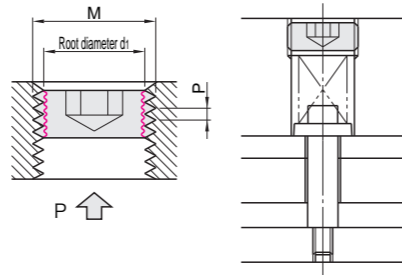
$$\text{the allowance load } P = t \times A$$

$$= 3.9 \times 107.4$$

$$= 419 [\text{kgf}]$$

Shear area A = root diameter d₁ x L
 (root diameter d₁ M - P)
 A = (M - P) L = (30 - 1.5) x 12
 = 107.4 [mm²]
 Yield stress 0.9 x tensile strength b = 0.9 x 65 = 58.2
 Shear stress 0.8 X yield stress
 = 46.6
 Allowable shear stress t = shear stress / safety factor 12
 = 46.6 / 12 = 3.9 [kgf / mm²]

When the tap is made of soft material, an allowable shear is required from the root diameter of the female screw.



■ Dowel pin strength

The correct size for a dowel pin is required in order for it to hold repeated shear weight (pulsating) of 800kgf. (Material of the dowel pin is SUJ2, hardness of 58HRC ~ .)

$$P = A \times$$

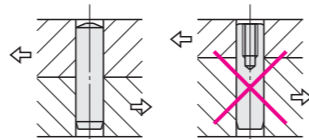
$$= D^2 t / 4$$

$$D = \sqrt{ (4P) / (t) }$$

$$= \sqrt{ (4 \times 800) / (3.14 \times 19.2) }$$

$$7.3$$

The applicable yield stress of SUJ2 b = 120 [kgf / mm²]
 Allowable shear strength = b x 0.8 / safety factor
 = 120 x 0.8 / 5
 = 19.2 [kgf / mm²]



Use dowel pins so that screw parts have no loading.

Everything noted here are only examples of strengths. In actual practice, the hole pitch precision, the perpendicular angle of the hole, surface coarseness, circularity, the plate materials, parallelism, whether its tempered or not, the precision of the injection molding machine, production quantity, tool wear, etc must be taken into consideration. Therefore these values should only be used as a guide. (These are not guaranteed figures.)