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HOT COILED SPRINGS

Modulus of Elasticity, E in tension, is 29 000 000 psi (200 000 MPa) and G in bending is 10 750 000 psi (74 100 MPa).

These moderately reduced values allow for some slight decarburization and coarse surface.
The Elastic Limit, as a percentage of the ultimate tensile strength for hot rolled carbon steel bars in tension is 65 – 75% and in torsion is 50 – 60%.

For all alloy steel bars, the values are somewhat higher; in tension they are 78 – 85% and in torsion equal 60 – 70 %.

Rockwell Hardness of the carbon steel bars after hardening and tempering should be C40 – C44 and the alloy steel bars, C45 – C50.

Tensile Strength for carbon steel bars varies between 175 000 to 195 000 psi (1200 – 1345 MPa) and alloy steel bars from 180 000 – 200 000 psi (1240 – 1380 MPa).

Tolerances on diameters are in an extremely wide range, depending upon the size of bar stock used and the type of finish.

Permissible variations for all types of hot-rolled bars are covered in 31 tables listed in ASTM A29.

HOT ROLLED CARBON STEEL BARS

- Available in round and square sections. The plain high-carbon spring steel is most widely used. In heavy sections this steel has fairly poor hardenability and lowered mechanical properties, especially in resistance to shock loading, overloading, and settling in service.

HOT ROLLED ALLOY STEEL BARS

- Hot-rolled Chromium Alloy steel bars. ASTM A 331, SAE 5160
  Available in round and square sections in the annealed or oil-tempered condition.
  SAE 5150 & SAE 5155 have slightly lower percentages of carbon, but are also commonly used.

- Hot-rolled Silicon-Manganese Alloy steel bars. ASTM A331, SAE 9260
  Available in round, square, & rectangular sections in the annealed or oil-tempered condition.
  SAE 9255 also used.

- Hot-rolled Chromium-Molybdenum Alloy steel bars. ASTM A 331, SAE 4150 and SAE 4161.
  Available in round, square, & rectangular shapes.

- Hot-rolled Nickel-Chromium-Molybdenum Alloy steel bars. ASTM A 331, SAE 8645, SAE 8655, SAE 8660.
  Available in round, square, & rectangular shapes.

DESIGN FORMULAS FOR HOT COILED SPRINGS

The effective modulus of rigidity for hot coiled springs is reduced by 5 – 10%. Hot-rolled bars use a modulus of 10.5×10^6 psi. If turned or centerless bars are used, the apparent modulus can be increased to 11×10^6 psi.

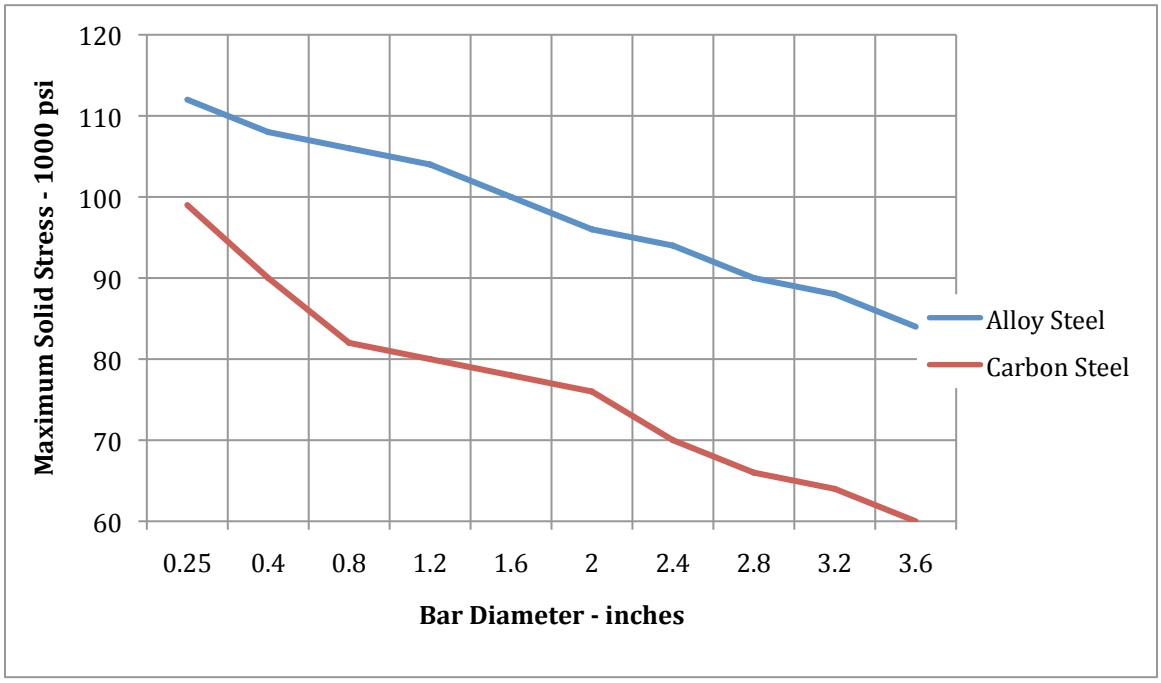
The calculated height of hot coiled compression springs may be lower than for comparable cold coiled springs if there is a taper-forging at the ends. A calculation is to reduce ½ of the bar diameter, than for cold coiled springs $H = d(N - 1/2)$.

When spring rate is specified, it should only apply to the deflection range from 20 – 60% of total deflections. The tolerance on spring rate should not be less than ± 10%.

The magnitude of allowable stress for hot coiled springs is limited by the grade and condition of material used, mechanical properties developed by heat treatment, & the service application required.

For static loading or variable but infrequent loading at relatively low stress ranges, the important considerations are the solid stress and the maximum working stress. For highly variable, shock & dynamic loading, please contact our engineering sales staff.

SOLID DESIGN STRESS (UNCORRECTED) FOR HOT COILED COMPRESSION SPRINGS



TOLERANCES FOR HOT COILED SPRINGS

Permissible Variations in Outside Diameter of Spring, ± IN.

	Nominal Free Height or Length of Spring, in.					
Nominal Outside Diameter, (inclusive range) in.	up to 10	Over 10 to 18	Over 18 to 26	Over 26 to 34	Over 34 to 42	Over 42 to 60
Up to 6	1/16	3/32	1/8	5/32	3/16	-
Over 6 to 8	3/32	1/8	3/16	¼	¼	-
Over 8 to 12	1/8	3/16	¼	¼	¼	-
Over 12 to 16	-	¼	¼	¼	5/16	3/8
Over 16 to 20	-	-	5/16	5/16	5/16	3/8
Over 20 to 24	-	-	3/8	3/8	3/8	7/16

Permissible Variations in Solid Height

Nominal Solid Height (inclusive range) in.	Deviation Above Nominal Solid Height, max, in.
Up to 7	1/16
Over 7 to 10	3/32
Over 10 to 13	1/8
Over 13 to 16	5/32
Over 16 to 19	3/16
Over 19 to 22	7/32
Over 22 to 25	¼
Over 25 to 28	9/32
Over 28 to 31	5/16

Permissible Variations in Free Height, Loaded Height and Permanent Set

Nominal Total Deflection (inclusive range) in.	Deviation from Nominal Free Height, max, in. ±	Deviation from Nominal Loaded Height, max, in. ±	Permanent Set, max, in.
Up to 3	5/32	4/32	3/64
Over 3 to 4	8/32	5/32	4/64
Over 4 to 5	8/32	6/32	4/64
Over 5 to 6	11/32	7/32	5/64
Over 6 to 7	11/32	8/32	5/64
Over 7 to 8	14/32	9/32	6/64
Over 8 to 9	14/32	10/32	6/64
Over 9 to 10	11/32	11/32	7/64
Over 10 to 11	17/32	12/32	7/64
Over 11 to 12	20/32	13/32	8/64
Over 12 to 13	20/32	14/32	8/64
Over 13 to 14	23/32	15/32	8/64
Over 14 to 15	23/32	16/32	9/64
Over 15 to 16	26/32	17/32	9/64
Over 16 to 17	26/32	18/32	10/64
Over 17 to 18	29/32	10/32	10/64
Over 18 to 19	29/32	20/32	11/64
Over 19 to 20	1	21/32	11/64
Over 20 to 21	1	22/32	12/64
Over 21 to 22	1 3/32	23/32	12/64
Over 22 to 23	1 3/32	24/32	13/64
Over 23 to 24	1 6/32	25/32	13/64
Over 24 to 25	1 6/32	26/32	14/64
Over 25 to 26	1 9/32	27/32	14/64
Over 26 to 27	1 9/32	28/32	15/64
Over 27 to 28	1 12/32	29/32	15/64
Over 28 to 29	1 15/32	31/32	16/64
Over 29 to 30	1 15/32	31/32	16/64

*if two loads are specified, no tolerance shall apply to the free height

Permissible Out-Of-Squareness for Springs with Un-ground Ends

Mean Diameter (inclusive range) in.	Deviation, degree
Up to 12	3 ½
Over 2 to 4	3
Over 4 to 6	2 ½
Over 6 to 8	2 ½
Over 8 to 10	2 ¼
Over 10 to 12	2 ¼
Over 12 to 14	2 ¼
Over 14 to 16	2 ¼

Permissible Out-of-Squareness for springs with Ground Ends

Total Travel (inclusive range) in.	Mean Diameter, in.									
		Over 2 - 4	Over 4 -6	Over 6-8	Over 8 - 10	Over 10-12	Over 12-14	Over 14-16	Over 16-18	Over 18 -20
Up to 2	1 ¼	1 ¼	1	1	1	1	-	-	-	-
Over 2 – 4	1 ¾	1 ½	1 ¼	1 ¼	1	1	1	-	-	-
Over 4 -6	2 ¼	1 ¾	1 ½	1 ¼	1 ¼	1 1	-	-	-	-
Over 6 – 8	-	2 ¼	1 ¾	1 ½	1 ¼	1 ¼	1	1	-	-
Over 8 – 10	-	2 ½	2	1 ½	1 ½	1 ¼	1 ¼	1	-	-
Over 10 – 12	-	-	2 ¼	1 ¾	1 ½	1 ½	1 ¼	1 ¼	1	1
Over 12-14	-	-	2 ½	2	1 ¾	1 ¾	1 ½	1 ½	1 ¼	1 ¼
Over 14-16	-	-	-	2 ¼	2	2	1 ¾	1 ¾	1 ½	1 1/2
Over 16-18	-	-	-	-	2 ¼	2	2	1 ¾	1 ¾	1 ½
Over 18 – 20	-	-	-	-	2 ½	2 ¼	2 ¼	2	2	1 ¾
Over 20 – 22	-	-	-	-	-	2 ¼	2 ¼	2	2	1 ¾
Over 22 – 24	-	-	-	-	-	2 ¼	2 ¼	2	2	1 ¾
Over 24 – 26	-	-	-	-	-	2 ½	2 ½	2 ¼	2 ¼	2
Over 26 – 28	-	-	-	-	-	-	2 ½	2 ¼	2 ¼	2
Over 28 – 30	-	-	-	-	-	-	2 ½	2 ¼	2 ¼	2

Tensile Strength vs. Hardness of Quenched & Tempered Spring Steel