GM	WORLDWIDE ENGINEERING STANDARDS	Material Specification	GMW14656

Suspension Coil and Leaf Springs

1 Scope

1.1 Material Description. This standard describes the GM Worldwide requirements for the materials, manufacturing process and coatings used in the manufacture of automotive suspension coil and leaf springs.

1.2 Symbols. Not applicable.

1.3 Applicability. Applicable to all automotive suspension coil and leaf springs.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ASTM A29	ASTM E45	EN 10247	SAE J419
ASTM D3363	ASTM E92	ISO 2808	SAE J441
ASTM E8	ASTM E112	ISO 26910 - 1	SAE J827
ASTM E10	DIN 50601	JIS G0551	SAE J1123

2.2 GM Standards/Specifications.

GMW3059	GMW14700	GMW14872	GMW15487
GMW3286	GMW14729	GMW15272	GMW15891
GMW14270	GMW14829	GMW15282	

2.3 Additional References.

Safety and Industrial Hygiene (S&IH) Technical Standard (TS), S&IH TS 3.4-160-02

3 Requirements

3.1 Material. Various alloy steels.

3.2 Form. The incoming material for spring manufacture.

3.2.1 Leaf Spring. Flat rolled steel bar having two (2) flat or slightly concave surfaces and two (2) rounded (convex) edges. The radii of the arcs of the two (2) concave surfaces shall be of equal lengths. The radii of the rounded edges shall be at least three-quarter (¾) thickness of the bar. The cross-sectional tolerances are shown in Table 1 (reference SAE J1123). The typical widths and thicknesses for flat rolled steel bars are shown in Table 2 (reference SAE J1123). Tolerances for surface-prepared bars shall be noted on the part drawing.

3.2.2 Coil Spring. Tolerances from Specified Size and Out of Roundness for hot roll as rolled round bars are shown in Table 3. Tolerances for surface-prepared bars shall be noted on the part drawing.

3.3 Chemical Composition. The chemical compositions of alloy steel grades for leaf and coil spring applications are shown in Table 4. The grade shall be selected by the spring manufacturer from Table 4 and identified on the part drawing. The steel compositions listed in Table 4 are normally restricted to a tighter tolerance for certain elements by the coil spring manufacturer in order to provide reduced variation during heat treatment. Alternatively, steel hardenability may be specified using either Jominy or ideal diameter.

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Table 1: Leaf Spring Flat Bar Cross-Sectional Tolerances (All Dimensions in mm)

		Thickness (±) Note 1 and Flatness (-) Note 2			Maximum Difference in Thickness Note 3 for Thickness Listed Below		
Width	Width Tolerance (-0.00)	5.00 to 9.50	10.00 to 21.20	22.40 to 37.50	5.00 to 9.50	10.00 to 21.20	22.40 to 37.50
40.0	+0.75	0.13	0.15	-	0.05	0.05	-
45.0	+0.75	0.13	0.15	-	0.05	0.05	-
50.0	+0.75	0.13	0.15	-	0.05	0.05	-
56.0	+0.75	0.13	0.15	-	0.05	0.05	-
63.0	+0.75	0.13	0.15	-	0.05	0.05	-
75.0	+1.15	0.15	0.20	0.30	0.08	0.10	0.15
90.0	+1.15	0.15	0.20	0.30	0.08	0.10	0.15
100.0	+1.15	0.15	0.20	0.30	0.08	0.10	0.15
125.0	+1.65	0.18	0.25	0.40	0.10	0.13	0.20
150.0	+2.30	-	0.30	0.50	-	0.15	0.25

Note 1: Thickness measurements shall be taken at the edge of the bar where the flat surfaces intersect the rounded edge.
Note 2: This tolerance represents the maximum amount by which the thickness at the center of the bar may be less than the thickness at the edges. Thickness at the center may never exceed the thickness at the edges.
Note 3: Maximum difference in thickness between the two (2) edges of each bar.

Table 2: Typical Widths and Thicknesses of Leaf Spring Flat Bar (all Dimensions in mm)

Nominal Width	Nominal Thickness					
40.0 to 75.0	5.00	7.10	10.00	14.00	20.00	28.00
45.0 to 90.0	5.30	7.50	10.60	15.00	21.20	30.00
50.0 to 100.0	5.60	8.00	11.20	16.00	22.40	31.50
56.0 to 125.0	6.00	8.50	11.80	17.00	23.60	33.50
63.0 to 150.0	6.30	9.00	12.50	18.00	25.00	35.50
Over 150	6.70	9.50	13.20	19.00	26.50	37.50

Table 3: Size and Out of Round Tolerance for Hot Roll as Rolled Bar (All Dimensions in mm)

Specified Size	Tolerance for Specified Size	Out of Round Note 1, Note 2
To 7 inclusive (incl.)	± 0.13	0.20
Over 7 to 11 incl.	± 0.13	0.22
Over 11 to 15 incl.	± 0.18	0.27
Over 15 to 19 incl.	± 0.20	1.5% of specified size
Over 19 to 100	1% of specified size	1.5% of specified size

Note: Incl. = Inclusive
Note 1: Out of Round is the difference between the maximum and minimum diameters of the bar, measured at the same cross section.
Note 2: The tolerance shall be rounded to the nearest 0.1 mm after calculation.

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Table 4: Chemical Composition, Weight% Note 1

Grade	Regional or Common Names	Description	C	Mn	Si	P	S	Cr	Nb	V	Mo	Al	N
65MnCr4	5160	Chrome Alloy Steel	0.56 to 0.64	0.75 to 1.00	0.15 to 0.35	0.030	0.040	0.70 to 0.90	-	-	-	-	-
65MnCr4A	5160H SUP-9A	Chrome Alloy Steel	0.55 to 0.65	0.65 to 1.10	0.15 to 0.35	0.030	0.040	0.60 to 1.00	-	-	-	-	-
55Cr3	5155 SUP-9, 55Cr3	Chrome Alloy Steel	0.52 to 0.60	0.60 to 0.95	0.15 to 0.30	0.035	0.035	0.65 to 0.95	-	-	-	-	-
60Si7	SUP-7, 9260	Silicon Alloy Steel	0.56 to 0.64	0.70 to 1.00	1.80 to 2.20	0.035	0.035	-	-	-	-	-	-
55SiCr7	9254 SUP-12	Chrome Silicon Alloy Steel	0.52 to 0.60	0.70 to 1.00	1.50 to 1.80	0.050	0.050	0.63 to 0.77	-	-	-	-	-
55SiCr	9254 SHI-200	Chrome Silicon Alloy Steel	0.51 to 0.59	0.60 to 0.80	1.20 to 1.60	0.025	0.025	0.60 to 0.80	-	-	-	-	-
60SiCr7	60SiCr7	Chrome Silicon Alloy Steel	0.57 to 0.65	0.70 to 1.00	1.50 to 1.80	0.030	0.030	0.20 to 0.40	-	-	-	-	-
60SiCr3	9259	Chrome Silicon Alloy Steel	0.56 to 0.64	0.75 to 1.00	0.70 to 1.10	0.030	0.040	0.45 to 0.65	-	-	-	-	-
54SiCr6	54SiCr6 55CrSi B55SiCr	High Strength Spring Steel	0.51 to 0.59	0.50 to 0.80	1.20 to 1.60	0.025	0.025	0.50 to 0.80	-	-	-	-	-
54SiCrV6	54SiCrV6 55CrSiV, B55SiCrV SWI200-D	High Strength Spring Steel	0.51 to 0.59	0.50 to 0.80	1.20 to 1.60	0.025	0.025	0.50 to 0.80	-	0.10 to 0.25	-	-	-
51CrV4	51CrV4	Chrome Vanadium Alloy Steel	0.47 to 0.55	0.70 to 1.00	0.15 to 0.40	0.035	0.035	0.90 to 1.20	-	0.10 to 0.25	-	-	-
45CrMnSiVNb	92V45	High Strength Spring Steel	0.40 to 0.50	1.10 to 1.40	1.15 to 1.50	0.025	0.015	0.45 to 0.75	0.015 to 0.030	0.12 to 0.17	-	0.04	0.010
54CrSiNb	HDS-12	High Strength Spring Steel	0.51 to 0.59	0.40 to 0.60	1.45 to 1.75	0.025	0.025	0.70 to 0.90	0.02 to 0.06	0.25 to 0.25	0.08 to 0.15	-	-
57CrSiV	StelR, StelRMM	High Strength Spring Steel	0.50 to 0.64	0.60 to 0.90	0.80 to 1.35	0.020	0.025	0.40 to 0.60	0.05	0.08 to 0.13	0.06	0.005	0.02
60CrSiV	SRS60	High Strength Spring Steel	0.50 to 0.70	0.1 to 1.0	1.00 to 1.80	0.030	0.030	0.30 to 0.70	0.02 to 0.10 **Note 2**	0.03 to 0.50	-	-	-
45CrSiCuV **Note 3**	ND120S	High Strength Spring Steel	0.30 to 0.60	0.10 to 0.50	1.00 to 2.00	0.030	0.0015	0.40 to 1.00	-	0.10 to 0.30	-	-	-
40CrSiMoCoW **Note 4**	UHS1900	High Strength Spring Steel	0.30 to 0.49	0.10 to 0.50	1.00 to 3.00	0.030	0.030	0.50 to 1.50	-	-	0.10 to 0.50	-	-
47SiMnCrVB **Note 5**	POSHIS 120	High Strength Spring Steel	0.40 to 0.55	0.50 to 1.00	1.20 to 2.20	0.017	0.01	0.50 to 1.50	-	0.05 to 0.20	-	0.02 to 0.06	-

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Grade	Regional or Common Names	Description	C	Mn	Si	P	S	Cr	Nb	V	Mo	Al	N
54SiMnCrNbVCuNiTi **Note 6**	POSHIS 125	High Strength Spring Steel	0.40 to 0.60	0.50 to 1.00	1.00 to 2.00	0.017	0.01	0.50 to 1.00	0.01 to 0.04	0.05 to 0.20	-	0.04	-
52SiMnCrVB **Note 5**	POSHIS 130	High Strength Spring Steel	0.45 to 0.60	0.50 to 1.00	1.40 to 2.40	0.015	0.01	0.50 to 1.50	-	0.05 to 0.20	-	0.02 to 0.06	-

Note 1: Product analysis. Individual composition values are maximum. Iron is balance. All compositions are weight percentage unless otherwise noted. Unless otherwise specified, the residual elements are: 0.35% Cu, 0.25% Ni, 0.20% Cr, and 0.06% Mo.
Note 2: May contain 0.02% to 0.10% Zr or 0.02% to 0.10% Ti, instead of 0.02% to 0.10% Nb.
Note 3: Also contains the following: 1.01% to 1.20% Ni, 0.10% to 0.30% Copper, ≤ 0.0015% O, 0.001% Ca to 0.005% Ca. I ≤ 1.10% where I = 0.449% S to 10.839% S + 0.249% Ni + 0.295% Cr + 0.878% Cu + 0.843% V.
Note 4: Ni ≤ 1.00%, (0.10 to 3.00)% Co, (0.10 to 1.00)% W, 2.5% ≤ FP ≤ 4.5% where:
FP = (0.23[C] + 0.1) × (0.7[Si] + 1) × (3.5[Mn] + 1) × (2.2[Cr] + 1) × (0.4[Ni] + 1) × (3[Mo] + 1).
Note 5: Cu (0.10 to 0.30)%, Ni (0.10 to 0.50)%, Ti (0.01 to 0.05)%, B (0.001 to 0.005)%.
Note 6: Cu (0.20 to 0.40)%, Ni (0.20 to 0.40)%, Ti (0.01 to 0.07)%, B (0.005)% maximum.

3.4 Mechanical Properties in the Hardened and Tempered Condition. The spring manufacturer shall select from the property classes shown in Table 5 for Leaf and Coil Springs in the hardened and tempered condition. Mechanical Property values identified in bold are mandatory. Non-bold Mechanical Property values are for reference only and are not required for routine quality control. Classes 1 thru 4 are typically selected for hot-formed leaf and coil springs. Classes 5 thru 7 are typically pre-treated bars for cold-coiled applications. The Mechanical Property Class shall be noted on the part drawing.

3.5 Structure.

3.5.1 Microstructure. The microstructure in the hardened and tempered condition shall be fine-tempered martensite.

3.5.2 Austenite Grain Size. The austenite grain size shall be determined by either Method 1 described in 3.5.2.1 or Method 2 described in 3.5.2.2.

3.5.2.1 Austenite Grain Size Method 1. After a holding time of 90 minutes at 850 °C ± 10 °C and subsequent quenching in water at a temperature of 23 °C ± 5 °C. For the characteristic value of the grain size reference DIN 50601. Test coupons may be pre-treated at 1150 °C for 30 minutes in air.

3.5.2.2 Austenite Grain Size Method 2. Austenite grain size 5 or finer according to ASTM A29, ASTM E112 or JIS G0551.

3.5.3 Internal Cleanliness. The internal cleanliness shall be determined by one of the following methods:

3.5.3.1 Internal Cleanliness Method 1. The inclusions shall not exceed the size 3 of row q, according to EN 10247, Method M. Isolated inclusions larger than size 3, which are not representative of the heat, are acceptable as long as they do not detrimentally affect the service life of the spring.

3.5.3.2 Internal Cleanliness Method 2. The internal cleanliness shall meet the minimum requirements in Table 6 when tested according to ASTM E45, Method A.

Table 5: Mechanical Properties Note 1

Property Class	Application	Hardness, BHN 3000 kg Load Note 2	Vickers Hardness HV50 Note 2	Tensile Strength in MPa	0.2% Yield Strength in MPa
1	Leaf Spring	401 to 461	430 to 500	1390 to 1620	1250 to 1450
2	Leaf Spring	415 to 477	450 to 515	1450 to 1675	1300 to 1500
3	Coil Spring	461 to 514	500 to 550	1620 to 1820	1450 to 1600
4	Coil Spring	477 to 555	515 to 595	1675 to 1965	1500 to 1750

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