



Metallurgical and Mechanical Properties of Wheel Bolts and Studs

1 Scope

This standard covers the metallurgical, processing and mechanical requirements for passenger car and truck wheel bolts and studs.

1.1 Material Description. This specification describes serrated and non-serrated shank wheel bolts and studs. Serrated shank wheel bolts and studs include carburized and quenched and tempered requirements. Non-serrated quenched and tempered bolts and studs are also described. The type of wheel bolt or stud is described by a suffix added to the basic specification. Type 1 is carburized serrated shank wheel bolts and studs. Type 2 is quenched and tempered shank bolts and studs. Type 3 is through hardened non-serrated shank bolts and studs.

1.2 Symbols. Not applicable.

1.3 Applicability. Metric serrated and non-serrated wheel bolts and studs.

1.4 Remarks. None.

2 References

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

2.1 External Standards/Specifications.

ISO 683-1	ISO 6157-3	SAE J403	SAE J423
ISO 898-1	ISO 8992		

2.2 GM Standards/Specifications.

GMW25	GMW3059
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2.3 Additional References. None.

3 Requirements

3.1 Material.

3.1.1 Type 1 Carburized Serrated Shank Bolts and Studs. SAE Steel Grade 1541 per specification SAE J403 or Steel Grade 42Mn6 per ISO 683-1, fine grain steel shall be used for metric sizes through 14 mm diameter. Medium carbon alloy steel, fine grain with hardenability that will produce a minimum hardness of HRC 47 at center of threaded section (see 7.1), one (1) diameter from end of bolt after oil quenching shall be used for metric sizes over 14 mm.

3.1.2 Type 2 and Type 3 Serrated Shank/Non-serrated Shank Bolts and Studs. Medium carbon or medium carbon alloy steel per GMW25 property class 10.9.

3.2 Type Requirements.

3.2.1 Type 1 Carburized Serrated Shank Bolts and Studs.

3.2.1.1 Carburization. Carburized serrated shank bolts and studs shall be carburized in a non-nitriding atmosphere to a total case depth of 0.10 mm to 0.30 mm, oil quenched and tempered at a minimum temperature of 450 °C. Case depth shall be measured on a transverse section through the serrations according to SAE J423 using visual methods.

3.2.1.2 Hardness. The surface hardness of carburized serrated shank bolts and studs shall be HR15N 81.5 or HV 412 maximum. Base metal hardness at the mid radius one (1) diameter from the end shall be HRC 28 to HRC 34 or HV 286 to HV 336.

3.2.1.3 Tensile Strength. The tensile strength and tensile load shall meet the requirements of Table 1 when tested according to ISO 898-1 using the fixture shown in Appendix A, Figure A1.

Table 1: Mechanical Properties of Carburized Serrated Shank Bolts and Studs

Tensile Strength			
Minimum Tensile Strength R_m , minimum	Thread Size	Nominal Stress Area A_s , nominal	Minimum Ultimate Tensile Load (A_s , nominal $\times R_m$, minimum)/1000
910 MPa	M12 $\times$ 1.5	88.1 mm ²	80.2 kN
910 MPa	M14 $\times$ 1.5	125 mm ²	114 kN
910 MPa	M18 $\times$ 1.5	216 mm ²	197 kN
910 MPa	M20 $\times$ 1.5	272 mm ²	248 kN
910 MPa	M22 $\times$ 1.5	333 mm ²	303 kN

3.2.2 Type 2 Quenched and Tempered Serrated Shank Bolt.

3.2.2.1 Quenched and Tempering. Quenched and tempered serrated shank bolts shall meet the requirements of GMW25 Grade 10.9 with the following modifications: The bolts shall be processed in a non-nitriding carbon enriching atmosphere. Slight carburization is permissible with a maximum surface hardness of 400 HV0.3. The part shall be oil quenched and tempered at a minimum temperature of 425 °C. Decarburization is not permitted when evaluated according to ISO 898-1. Carbon enrichment and decarburization shall be measured on a transverse section through the threads and serrations.

3.2.2.2 Hardness. Base metal hardness range shall be HRC 34 to HRC 39 or 340 HV10 to 380 HV10. Hardness testing shall be conducted according to ISO 898-1.

3.2.2.3 Tensile Strength. The tensile strength and tensile load shall meet the requirements of Table 2 when tested according to ISO 898-1 using the fixture shown in Appendix A, Figure A1.

Table 2: Mechanical Properties of Quenched and Tempered Serrated Shank Bolt

Tensile Strength			
Minimum Tensile Strength R_m , minimum	Thread Size	Nominal Stress Area A_s , nominal	Minimum Ultimate Tensile Load (A_s , nominal $\times R_m$, minimum)/1000
1040 MPa	M12 $\times$ 1.5	88.1 mm ²	91.6 kN
1040 MPa	M14 $\times$ 1.5	125 mm ²	130 kN
1040 MPa	M18 $\times$ 1.5	216 mm ²	225 kN
1040 MPa	M20 $\times$ 1.5	272 mm ²	283 kN
1040 MPa	M22 $\times$ 1.5	333 mm ²	346 kN

3.2.3 Type 3 Non-serrated Shank Bolt. Type 3 Non-serrated shank bolts shall meet the requirements of GMW25 property class 10.9.

3.3 Surface Discontinuities. Serrated shank bolts and studs shall not have surface discontinuities exceeding those indicated in ISO 6157-3. The surface discontinuity test is applied to Test Program A bolts before machining.