

W23 Approval of Welding Consumables for High Strength Quenched and Tempered Steels for Welded Structures

(1995)
(Rev.1
1997
Rev.2
Apr 2018)

1. General

1.1 Scope

1.1.1 These requirements supplements the UR W17 and give the conditions of approval and inspection of welding consumables used for high strength ~~quenched and tempered~~ or TMCP steels for welded structures according to UR W16 with yield strength levels from 420 N/mm² up to ~~690~~ 960 N/mm², and impact grades A, D, E and F, except that impact grade F is not applicable for 890 N/mm² and 960 N/mm² yield strength levels.

Where no special requirements are given, those of UR W17 apply in analogous manner.

1.1.2 The welding consumables preferably to be used for the steels concerned are divided into several categories as follows:

- covered electrodes for manual welding,
- wire-flux combinations for ~~multi-run~~ multi-run* submerged arc welding,
- solid wire-gas combinations for arc welding (including rods for gas tungsten arc welding),
- flux cored wire with or without gas for arc welding.

1.2 Grading, Designation

1.2.1 Based on the yield strength of the weld metal, the welding consumables concerned are divided into ~~six~~ eight (yield) strength groups:

- Y42 - for welding steels with minimum yield strength 420 N/mm²
- Y46 - for welding steels with minimum yield strength 460 N/mm²
- Y50 - for welding steels with minimum yield strength 500 N/mm²
- Y55 - for welding steels with minimum yield strength 550 N/mm²
- Y62 - for welding steels with minimum yield strength 620 N/mm²

* Wire-flux combinations for single or two-run technique are subject to special consideration of the Classification Society.

Note:

1. Rev.2 of this UR is to be uniformly implemented by IACS Societies when an application for approval is dated on or after 1 July 2019.

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- Y69 - for welding steels with minimum yield strength 690 N/mm²
- Y89 - for welding steels with minimum yield strength 890 N/mm²
- Y96 - for welding steels with minimum yield strength 960 N/mm²

1.2.2 Each of the ~~six~~ eight (yield) strength groups is further divided into three main grades in respect of Charpy V-notch impact test requirements (test temperatures):

- Grade 3, test temperature -20°C
- Grade 4, test temperature -40°C
- Grade 5, test temperature -60°C

1.2.3 ~~Analogously~~ Analogously to the designation scheme used in UR W17 the welding consumables for high strength ~~quenched and tempered~~ steels are subject to classification designation and approval as follows:

- According to 1.2.2 with the quality grades **3, 4 or 5**
- With the added symbol Y and an appended code number designating the minimum yield strength of the weld metal corresponding 1.2.1: Y42, Y46, Y50, Y55, Y62, and Y69, Y89 and Y96.
- With the added symbol H10 or H5 for controlled hydrogen content of the weld metal,
- With the added symbol **S** (= semi-automatic) for semi-mechanised welding,
- With the added symbol **M** designating ~~multi-run~~ multi-run technique* (and is applicable only to welding consumables for fully mechanised welding).

~~*) see footnote on page 2~~

1.2.4 Each higher quality grade includes the one (or those) below Grade A... and D... steels acc. to UR W16 are to be welded using welding consumables of at least quality grade 3, grade E... steels using at least quality grade 4 and grade F... steels using at least quality grade 5., see the following table:

Consumable Grade	Steel Grades covered
3Y..	D.. and A..
4Y..	E.., D.. and A..
5Y..	F.., E.., D.. and A..

* Wire-flux combinations for single or two-run technique are subject to special consideration of the Classification Society.

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Welding consumables approved with grades ..Y42, ..Y46 and ..Y50 are also considered suitable for welding steels in the two strength levels below that for which they have been approved. Welding consumables approved with grades ..Y55, ..Y62 and ..Y69 are also considered suitable for welding steels in the one strength level below that for which they have been approved.

Welding consumables with grade Y89 are considered suitable for welding steels in the same strength level only. Welding consumables with grade Y96 are also considered suitable for welding steels in the one strength level below that for which they have been approved.

Where the design requirements permit undermatching weld joint, then welding consumables within the scope of this UR can be considered subject to Society discretion and Manufacturer's recommendations.

The Society may, in individual cases, restrict the range of application in (up to) such a way, that approval for any one strength level does not justify approval for any other strength level.

1.3 Manufacture, testing and approval procedure

1.3.1 Manufacturer's plant, production methods and quality control measures shall be such as to ensure reasonable uniformity in manufacture, see also UR W17.

1.3.2 Testing and approval procedure shall be in accordance with UR W17, sections 2 and 3 and as required in UR W17 for the individual categories (types) of welding consumables mentioned in 1.1.2 above.

2. Testing of the weld metal

2.1 For testing the deposited weld metal, test pieces analogous to those called for in UR W17, sections 4.2, 5.2, 6.2 or 6.3 respectively shall be prepared, depending on the type of the welding consumables (and according to the welding process). ~~†~~The base metal used shall be a fine-grained structural steel compatible with the properties of the weld metal, or the side walls of the weld shall be buttered with a weld metal of the same composition.

2.2 The chemical composition of the deposited weld metal shall be determined and certified in a manner analogous to that prescribed in UR W17, section 4.2.2. The results of the analysis shall not exceed the limit values specified in the standards or by the manufacturer, the narrower tolerances being applicable in each case.

2.3 Depending on the type of the welding consumables (and according to the welding process), the test specimens prescribed in UR W17, sections 3.1 and 4.2, 5.2, 6.2 or 6.3 respectively shall be taken from the weld metal test pieces in a similar manner.

2.4 The mechanical properties must meet the requirements stated in Tables 1 and 2. The provisions of UR W17 apply in analogous manner to the performance of the tests, including in particular the maintenance of the test temperature in the notched bar impact test and the carrying out of results.

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Table 1 Required toughness properties of the weld metal

Quality grade	Test temperature [°C]	Minimum notch impact energy [J] ¹⁾
3	-20	Y42: ≥ 47
4	-40	Y46: ≥ 47 Y50: ≥ 50
5	-60	Y55: ≥ 55 Y62: ≥ 62 Y69: ≥ 69 <u>Y89: ≥ 69²⁾</u> <u>Y96: ≥ 69²⁾</u>

1) Charpy V-notch impact test specimen, mean value of three specimens; for requirements regarding minimum individual values and retests, see UR W17, section 3.3.2.

2) Quality grade 5 is not applicable for Y89 and Y96 grade consumables.

Table 2 Required strength properties of the weld metal

Symbols added to quality grade	Minimum yield strength or 0.2% proof stress [N/mm ²]	Tensile Strength ⁴⁾	Minimum elongation
		[N/mm ²]	[%]
Y42	420	530 <u>520-680</u>	20
Y46	460	570 <u>540-720</u>	20
Y50	500	640 <u>590-770</u>	18
Y55	550	670 <u>640-830</u> <u>820</u>	18
Y62	620	720 <u>700-890</u>	18
Y69	690	770-940	17
<u>Y89</u>	<u>890</u>	<u>940-1100</u>	<u>14</u>
<u>Y96</u>	<u>960</u>	<u>980-1150</u>	<u>13</u>

4) ~~The tensile strength of the weld metal may be up to 10% below the requirements, provided that the results obtained with the transverse tensile specimens taken from the welded joints meet the minimum tensile strength requirements stated in Table 3. The elongation is to be stated in the test report.~~

Note:
For welding very large plate thicknesses where the “supporting effect” of the base material on either side of the weld no longer applies and the tensile strength of the weld metal also determines the tensile strength of the welded joint, it may be necessary, when applying footnote 1), to choose welding consumables of the next higher strength category (next higher added Symbol).

3. Testing on welded joints

3.1 Depending on the type of the welding consumables (and according to the welding process), the testing on the welded joints shall be performed on butt-weld test pieces in analogous manner to UR W17, sections 4.3, 5.2, 6.2, 6.3, or 6.4 respectively.

3.2 Depending on the type of the welding consumables (and according to the welding process), the butt-weld test pieces called for in para. 3.1 shall be welded in a manner analogous to that prescribed in UR W17. The base metal used shall be a high-strength fine-

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grained structural steel with an appropriate minimum yield strength and tensile strength matching the consumable grade being approved and compatible with the added symbol for which application is made.

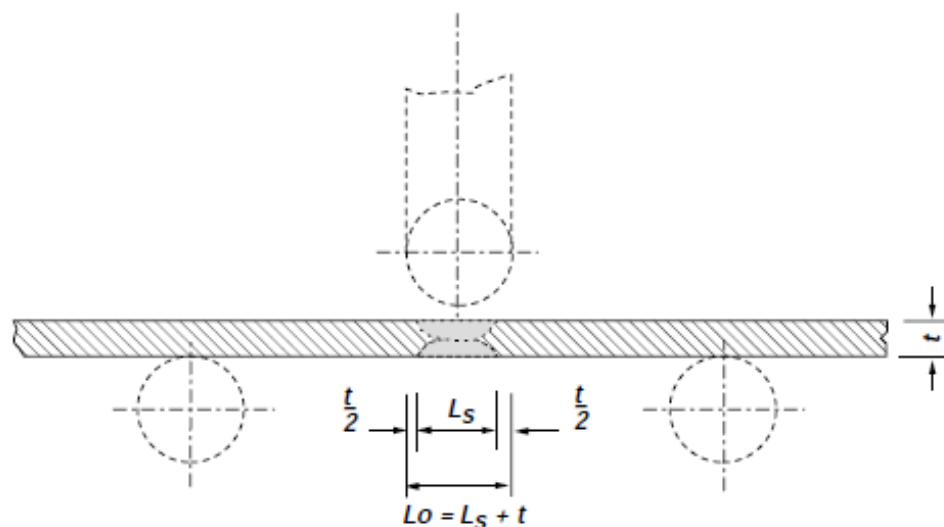
3.3 Depending on the type of the welding consumables (and according to the welding process), the test specimens described in UR W17 shall be taken from the butt-weld test pieces.

3.4 The mechanical properties must meet the requirements stated in Table 3. The provisions of UR W17 apply in analogous manner to the performance of the tests, including in particular the maintenance of the test temperatures in the notched bar impact test and the requirements regarding the retest specimens.

Table 3 Required properties of welded joints

Quality grade	Added symbol	Minimum tensile strength [N/mm ²]	Minimum notch impact energy, test temperature	Minimum bending angle ¹⁾	Bend ratio D/t ²⁾
3 to 5 accordance with Table 1	Y42	530 520	Depending on the quality grade & yield strength in accordance Table 1	120°	4
	Y46	570 540			4
	Y50	640 590			4
	Y55	670 640			5
	Y62	720 700			5
	Y69	770			5
	<u>Y89</u>	<u>940</u>			<u>6</u>
	<u>Y96</u>	<u>980</u>			<u>7</u>
<p>1) Bending angle attained before the first incipient crack, minor pore exposures up to a maximum length of 3mm allowed.</p> <p>2) D = Mandrel diameter, t = specimen thickness</p>					

3.5 Where the bending angle required in Table 3 is not achieved, the specimen may be considered as fulfilling the requirements, if the bending elongation on a gauge length L_0 fulfills the minimum elongation requirements stated in Table 2. The gauge length $L_0 = L_s + t$ (L_s = width of weld, t = specimen thickness), see sketch below.



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4. Hydrogen test

4.1 The welding consumables, other than solid wire-gas combinations, shall be subjected to a hydrogen test in accordance with the mercury method to ISO 3690, or any other method such as the gas chromatographic method which correlates with that method, in respect of cooling rate and delay times during preparation of the weld samples, and the hydrogen volume determinations.

4.2 The diffusible hydrogen content of the weld metal determined in accordance with the provisions of UR W17, section 4.5 shall not exceed the limits given in table 4.

Table 4 Allowable diffusible hydrogen content

Yield strength group	Hydrogen symbol	Maximum hydrogen content [cm ³ /100 g deposited weld metal]
Y42 Y46 Y50	H 10 (HH)	10
Y55 Y62 Y69	H 5 (HHH)	5
<u>Y89</u> <u>Y96</u>	<u>H 5</u>	<u>5</u>

5. Annual repeat test

The annual repeat tests specified in UR W17 shall entail the preparation and testing of weld metal test pieces as prescribed under 2. For grades Y69 to Y96 annual hydrogen test is required. In special cases, the Society may require more extensive repeat tests.

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