W7 Hull and machinery steel forgings

(1978) (Rev.1 1980) (Rev.2 July 2002) (Rev.3 May 2004) (Rev.4 Feb 2022)

1 Scope

1.1 These requirements are applicable to steel forgings intended for hull and machinery applications as specified in the relevant IACS Unified requirements (e.g. UR M72, UR M68, etc.) and/or requirements of the Classification Society. Where relevant, these requirements are also applicable to material for forging stock and to rolled bars intended to be machined into components of simple shape.

1.2 These requirements are applicable only to steel forgings where the design and acceptance tests are related to mechanical properties at ambient temperature. For other applications, additional requirements may be necessary especially when the forgings are intended for service at low or elevated temperatures.

1.3 Alternatively, forgings which comply with national or proprietary specifications may be accepted provided such specifications give reasonable equivalence to these requirements or are otherwise specially approved or required by the Classification Society.

2 Manufacture

2.1 Forgings are to be made at a manufacturer approved by the Classification Society.

2.2 The steel used in the manufacture of forgings is to be made by a process approved by the Classification Society. The works at which the steel was produced is to be approved by the Classification Society. Where the steel is produced at a separate works to the forging, the steel manufacturer is also to be approved by the Classification Society.

2.3 Adequate top and bottom discards are to be made to ensure freedom from piping and harmful segregations in the finished forgings.

Note:

1. Rev. 4 of this Unified Requirement is to be uniformly implemented by IACS Societies on ships contracted for construction on or after 1 July 2023.

2. The “contracted for construction” date means the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. For further details regarding the date of “contract for construction”, refer to IACS Procedural Requirement (PR) No. 29.

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2.4 The plastic deformation is to be such as to ensure soundness, uniformity of structure and satisfactory mechanical properties after heat treatment. The reduction ratio is to be calculated with reference to the average cross-sectional area of the cast material. Where the cast material is initially upset, this reference area may be taken as the average cross-sectional area after this operation. Unless otherwise approved the total reduction ratio is to be at least:

- for forgings made from ingots or from forged blooms or billets, 3:1 where L>D and 1.5:1 where L≤D
- for forgings made from rolled products, 4:1 where L>D and 2:1 where L≤D
- for forgings made by upsetting, the length after upsetting is to be not more than one-third of the length before upsetting or, in the case of an initial forging reduction of at least 1.5:1, not more than one-half of the length before upsetting
- for rolled bars, 6:1.

L and D are the length and diameter respectively of the part of the forging under consideration.

2.5 For crankshafts, where grain flow is required in the most favourable direction having regard to the mode of stressing in service, the proposed method of manufacture may require special approval by the Classification Society. In such cases, tests may be required to demonstrate that a satisfactory structure and grain flow are obtained.

2.6 The shaping of forgings or rolled slabs and billets by flame cutting, scarfing or arc-air gouging is to be undertaken in accordance with recognized good practice and, unless otherwise approved, is to be carried out before the final heat treatment. Preheating is to be employed when necessitated by the composition and/or thickness of the steel.
For certain components, subsequent machining of all flame cut surfaces may be required.

2.7 When two or more forgings are joined by welding to form a composite component, the proposed welding procedure specification is to be submitted for approval. Welding procedure qualification tests are to be required.

2.8 UR W28 is applicable to the requirements for welding procedure qualification tests of steel forgings intended to be used for the components of hull construction and marine structures. Requirements for other WPS and qualification thereof, for welder certification and for type approval of welding consumables are at the discretion of the Class Societies.

2.9 Welders intended to be engaged in fusion welding of steel forgings for hull structures are to be qualified in accordance with UR W32: Qualification scheme for welders of hull structural steels Rev.1 2020.

3 Quality of forgings

3.1 All forgings are to be free from surface or internal defects which would be prejudicial to their proper application in service.

4 Chemical composition

4.1 All forgings are to be made from killed steel and the chemical composition is to be appropriate for the type of steel, dimensions and required mechanical properties of the forgings being manufactured.

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4.2 The chemical composition of each heat is to be determined by the manufacturer on a sample taken preferably during the pouring of the heat. When multiple heats are tapped into a common ladle, the ladle analysis shall apply.

4.3 The chemical composition is to comply with the overall limits given in Tables 1 and 2 or, where applicable, the requirements of the approved specification.

4.4 At the option of the manufacturer, suitable grain refining elements such as aluminium, niobium or vanadium may be added. The content of such elements is to be reported.

4.5 Elements designated as residual elements in the individual specifications are not to be intentionally added to the steel. The content of such elements is to be reported.

Table 1 Chemical composition limits [1] for hull steel forgings [6]

Steel type	C	Si	Mn	P	S	Cr [4]	Mo [4]	Ni [4]	Cu [4]	Total residuals
C, C-Mn	0.23 [2, 3]	0.45	0.30-1.50	0.035	0.035	0.30	0.15	0.40	0.30	0.85
Alloy	[5]	0.45	[5]	0.035	0.035	[5]	[5]	[5]	0.30	-

[1] Composition in percentage mass by mass maximum unless shown as a range.

[2] The carbon content may be increased above this level provided that the carbon equivalent (Ceq) is not more than 0.41%, calculated using the following formula:

$$\text{Ceq} = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15} \ (\%)$$

[3] The carbon content of C and C-Mn steel forgings not intended for welded construction may be 0.65 maximum.

[4] Elements are considered as residual elements.

[5] Specification is to be submitted for approval.

[6] Rudder stocks and pintles should be of weldable quality.

Table 2 Chemical composition limits [1] for machinery steel forgings

Steel type	C	Si	Mn	P	S	Cr [4]	Mo [4]	Ni [4]	Cu [4]	Total residuals
C, C-Mn	0.23 [2, 3]	0.45	0.30-1.50	0.035	0.035	0.30	0.15	0.40	0.30	0.85
Alloy [5]	0.45	0.45	0.30-1.00	0.035	0.035	Min. 0.40 [6]	Min. 0.15 [6]	Min. 0.40 [6]	0.30	-

[1] Composition in percentage mass by mass maximum unless shown as a range or as a minimum.

[2] The carbon content may be increased above this level provided that the carbon equivalent (Ceq) is not more than 0.41%.

[3] The carbon content of C and C-Mn steel forgings not intended for welded construction may be 0.65 maximum.

[4] Elements are considered as residual elements unless shown as a minimum.

[5] Where alloy steel forgings are intended for welded constructions, the proposed chemical composition is subject to approval by the Classification Society.

[6] One or more of the elements is to comply with the minimum content.

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5 Heat treatment (including surface hardening and straightening)

5.1 At an appropriate stage of manufacture, after completion of all hot working operations, forgings are to be suitably heat treated to refine the grain structure and to obtain the required mechanical properties.

5.2 Except as provided in 5.6 and 5.7 forgings are to be supplied in one of the following conditions:

(a) Carbon and carbon-manganese steels

Fully annealed
Normalized
Normalized and tempered
Quenched and tempered

(b) Alloy steels

Normalized
Normalized and tempered
Quenched and tempered

For all types of steel the tempering temperature is to be not less than 550°C.

The delivery condition shall meet the design and application requirements, it is the manufacturers responsibility to select the appropriate heat treatment method to obtain the required mechanical properties. Where forgings for gearing are not intended for surface hardening, lower tempering temperature may be allowed.

5.3 Heat treatment is to be carried out in properly constructed furnaces which are efficiently maintained and have adequate means for control and recording of temperature. The furnace dimensions are to be such as to allow the whole furnace charge to be uniformly heated to the necessary temperature. In the case of very large forgings alternative methods of heat treatment will be specially considered by the Classification Society.

Sufficient thermocouples are to be connected to the furnace charge to measure and record that its temperature is adequately uniform unless the temperature uniformity of the furnace is verified at regular intervals.

5.4 If for any reasons a forging is subsequently heated for further hot working the forging is to be reheat treated.

5.5 Where it is intended to surface harden forgings, full details of the proposed procedure and specification are to be submitted for the approval of the Classification Society. For the purposes of this approval, the manufacture may be required to demonstrate by test that the proposed procedure gives a uniform surface layer of the required hardness and depth and that it does not impair the soundness and properties of the steel.

5.6 Where induction hardening or nitriding is to be carried out, forgings are to be heat treated at an appropriate stage to a condition suitable for this subsequent surface hardening.

5.7 Where carburizing is to be carried out, forgings are to be heat treated at an appropriate stage (generally either by full annealing or by normalizing and tempering) to a condition suitable for subsequent machining and carburizing.

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5.8 If a forging is locally reheated or any straightening operation is performed after the final heat treatment consideration is to be given to a subsequent stress relieving heat treatment. The manufacturer shall have strict control of this temperature in order to avoid any detrimental effects to the final heat treatment and resultant microstructure and mechanical properties of the forging.

5.9 The forge is to maintain records of heat treatment identifying the furnace used, furnace charge, date, temperature and time at temperature. The records are to be presented to the surveyor on request.

6 Mechanical tests

6.1 Test material, sufficient for the required tests and for possible retest purposes, is to be provided with a cross-sectional area of not less than that part of the forging which it represents. This test material is to be integral with each forging except as provided in 6.8 and 6.11. Where batch testing is permitted according to 6.11, the test material may alternatively be a production part or separately forged. Separately forged test material is to have a reduction ratio similar to that used for the forgings represented.

6.2 For the purpose of these requirements a set of tests is to consist of one tensile test specimen and, when required, three Charpy V-notch impact test specimens.

6.3 Test specimens are normally to be cut with their axes either mainly parallel (longitudinal test) or mainly tangential (tangential test) to the principal axial direction of each product.

6.4 The test specimen shall be positioned as follows:

a) For forgings having a thickness, t, or diameter D up to maximum 50mm, the longitudinal axis of the test specimen is to be located at a distance of t/2 or D/2 below the heat treated surfaces.

b) For forgings having a thickness, t, or diameter D greater than 50mm, the longitudinal axis of the test specimen is to be located at a distance of t/4 or D/4 (mid-radius) or 80mm, whichever is less, below any heat treated surface. Test specimen is to be located with its longitudinal axis at a distance from any heat treated surface as shown in Fig. 1.

c) For ring and disc forgings (noting that the test specimen locations for these shaped forgings may be different to elongated or free form forgings), tangential sample shall be taken at t/2 for thickness $\leq$ 25mm and 12.5mm below the surface for thickness >25mm, in both the vertical and horizontal direction.

Where achievable, for thickness >25mm, no part of the test material shall be closer than 12.5 mm to any heat treated surface, as shown in Fig. 1.

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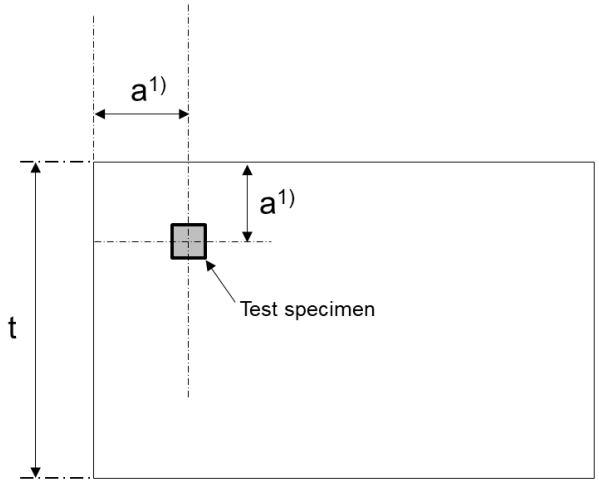

1) "a" is the distance from the test specimen to heat treated surface based on the above b) or c).

Fig.1 Position of the test specimen

6.5 Where the manufacturer can demonstrate that a proposed testing location or orientation is more representative of the required mechanical properties of a component, this may be agreed with the Classification Society. In such cases, the heat treatment process, a proposed testing location or orientation, and technical justification shall be submitted to the Classification Society for approval.

6.6 Except as provided in 6.11 the number and direction of tests is to be as follows.

(a) Hull components such as rudder stocks, pintles etc. General machinery components such as shafting, connecting rods, etc.

One set of tests is to be taken from the end of each forging in a longitudinal direction except that, at the discretion of the manufacture, the alternative directions or positions as shown in Fig. 2, 3 and 4 may be used. Where a forging exceeds both 4 tonnes in mass and 3m in length, one set of tests is to be taken from each end. These limits refer to the 'as forged' mass and length but excluding the test material.

(b) Pinions

Where the finished machined diameter of the toothed portion exceeds 200mm one set of tests is to be taken from each forging in a tangential direction adjacent to the toothed portion (test position B in Fig. 5). Where the dimensions preclude the preparation of tests from this position, tests in a tangential direction are to be taken from the end of the journal (test position C in Fig. 5). If however, the journal diameter is 200mm or less the tests are to be taken in a longitudinal direction (test position A in Fig. 5). Where the finished length of the toothed portion exceed 1.25m, one set of tests is to be taken from each end.

(c) Small pinions

Where the finished diameter of the toothed portion is 200mm or less one set of tests is to be taken in a longitudinal direction (test position A in Fig. 5).

(d) Gear wheels

One set of tests is to be taken from each forging in a tangential direction (test position A or B in Fig. 6).

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(e) Gear wheel rims (made by expanding)

One set of tests is to be taken from each forging in a tangential direction (test position A or B in Fig. 7). Where the finished diameter exceeds 2.5m or the mass (as heat treated including test material) exceeds 3 tonnes, two sets of tests are to be taken from diametrically opposite positions (test positions A and B in Fig. 7). The mechanical properties for longitudinal test are to be applied.

(f) Pinion sleeves

One set of tests is to be taken from each forging in a tangential direction (test position A or B in Fig. 8). Where the finished length exceeds 1.25m one set of tests is to be taken from each end.

(g) Crankwebs

One set of tests is to be taken from each forging in a tangential direction.

(h) Solid open die forged crankshafts

One set of tests is to be taken in a longitudinal direction from the driving shaft end of each forging (test position A in Fig. 9).
Where the mass (as heat treated but excluding test material) exceeds 3 tonnes tests in a longitudinal direction are to be taken from each end (test positions A and B in Fig. 9). Where, however, the crankthrows are formed by machining or flame cutting, the second set of tests is to be taken in a tangential direction from material removed from the crankthrow at the end opposite the driving shaft end (test position C in Fig. 9).

(i) Forged Rings (such as slewing rings)

One set of tests is to be taken from each forging in a tangential direction (test positions are shown in Fig. 10). Where the finished diameter exceeds 2.5m or the mass (as heat treated, including test material) exceeds 3 tonnes then two sets of tests are to be taken diametrically opposite positions.

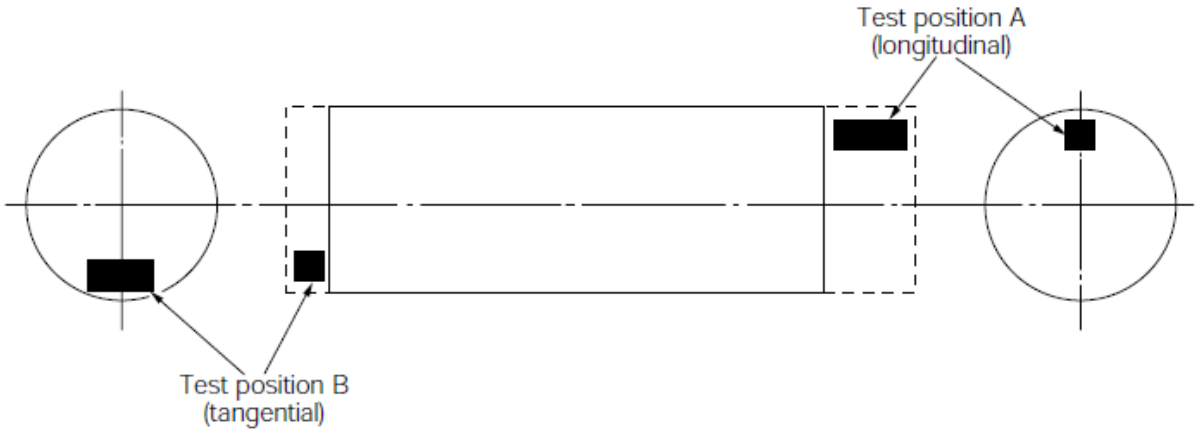

Fig. 2 Plain shaft

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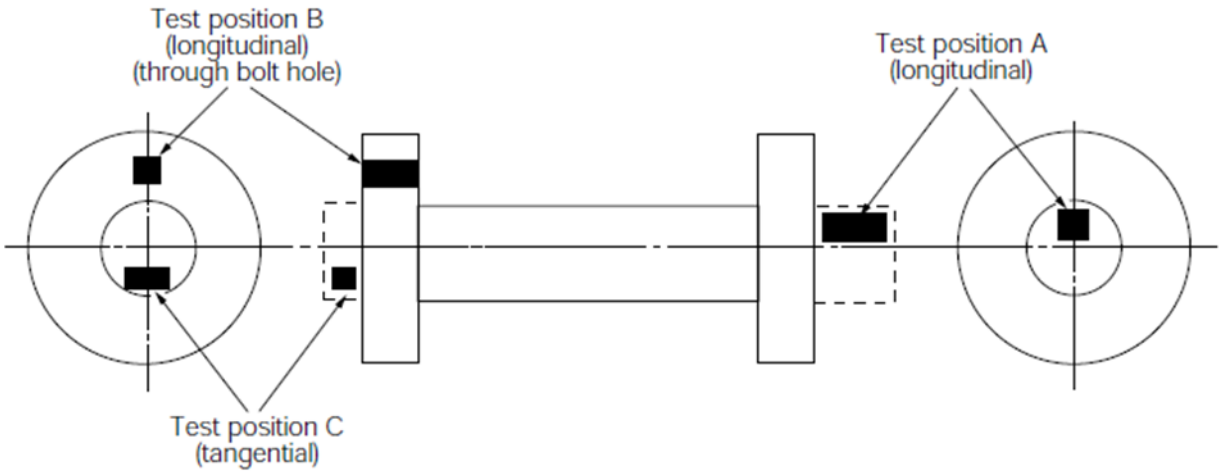

Fig. 3 Flanged shaft

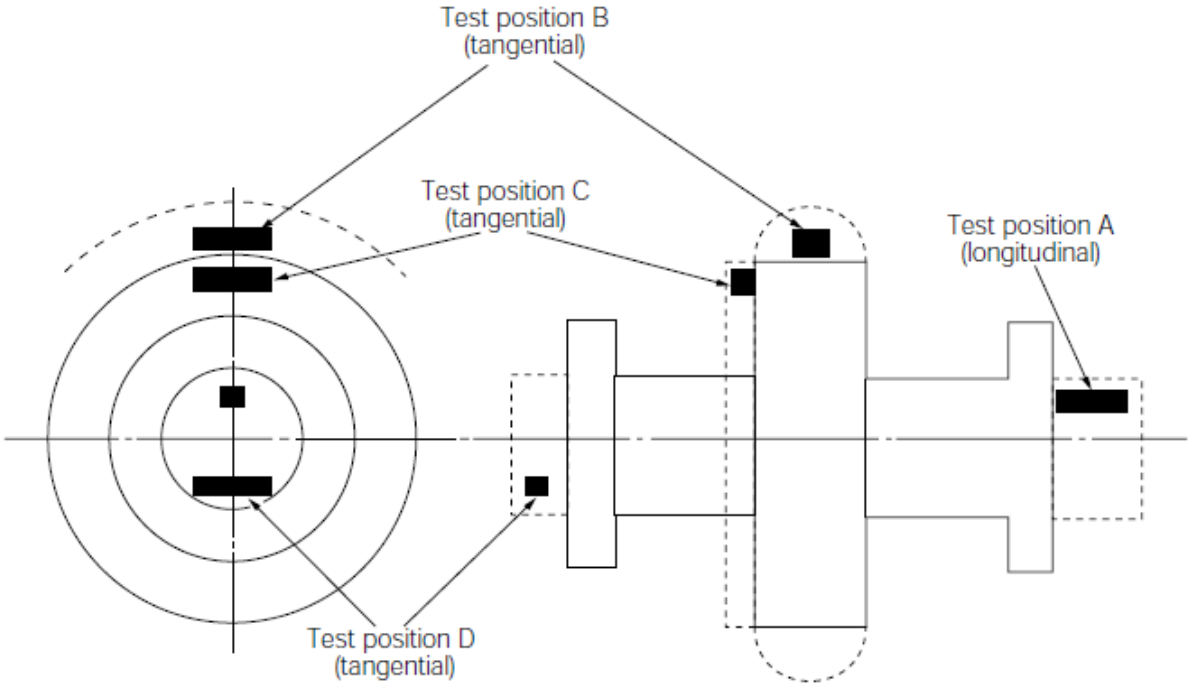

Fig. 4 Flanged shaft with collar

6.7 For closed die crankshaft forgings and crankshaft forgings where the method of manufacture has been specially approved in accordance with 2.5, the number and position of test specimens is to be agreed with the Classification Society having regard to the method of manufacture employed.

6.8 When a forging is subsequently divided into a number of components, all of which are heat treated together in the same furnace charge, for test purposes this may be regarded as one forging and the number of tests required is to be related to the total length and mass of the original multiple forging.

6.9 Except for components which are to be carburized or for hollow forgings where the ends are to be subsequently closed, test material is not to be cut from a forging until all heat treatment has been completed.

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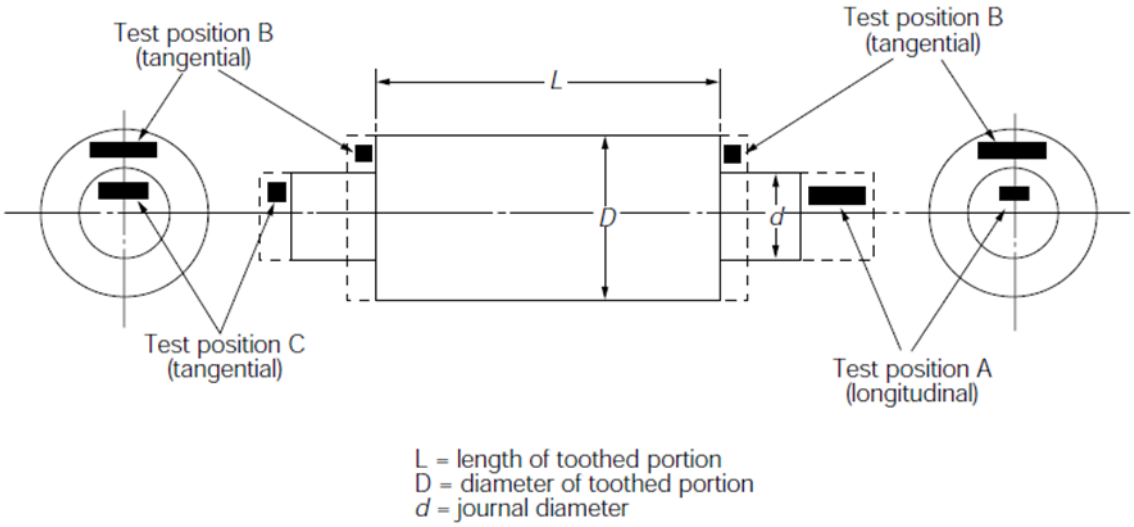

L = length of toothed portion
D = diameter of toothed portion
d = journal diameter

Fig. 5 Pinion

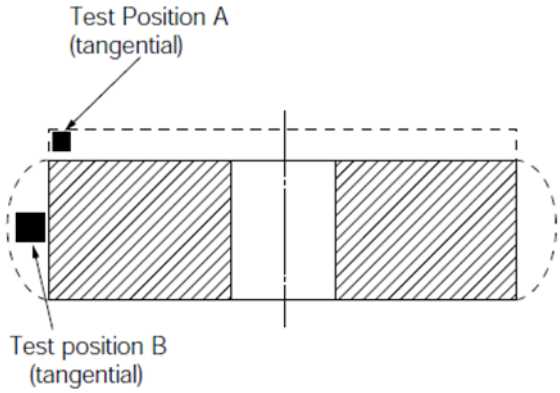

Fig. 6 Gear wheel

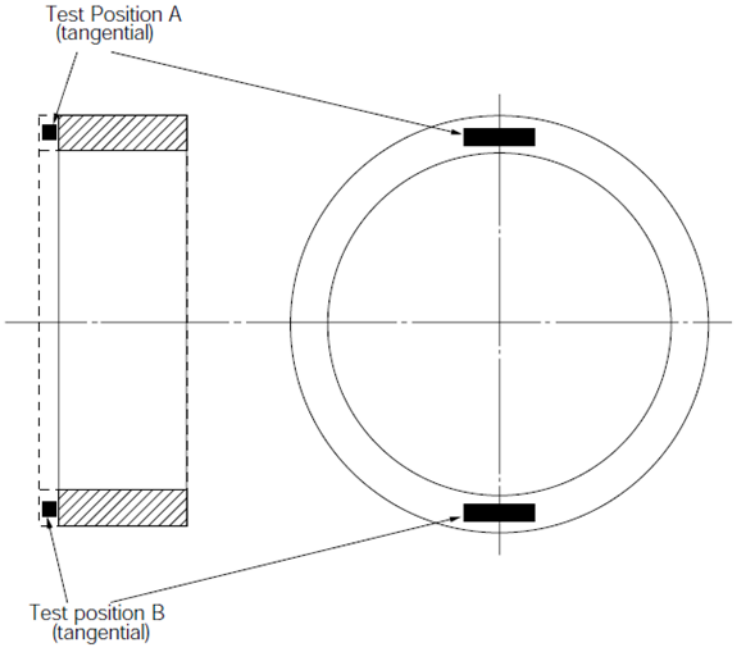

Fig. 7 Gear rim (made by expanding)

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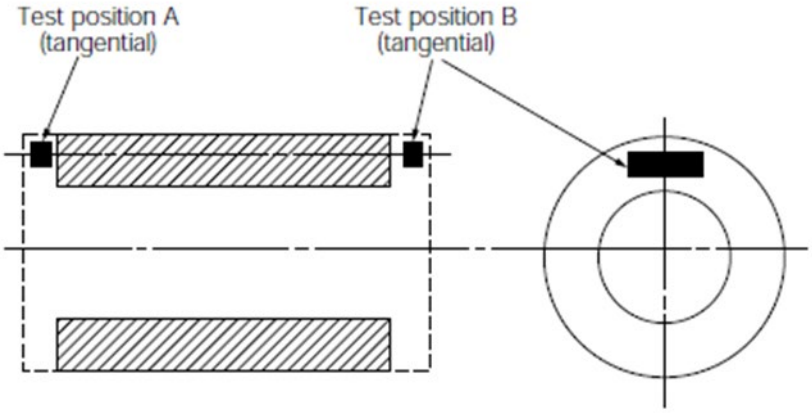

Fig. 8 Pinion sleeve

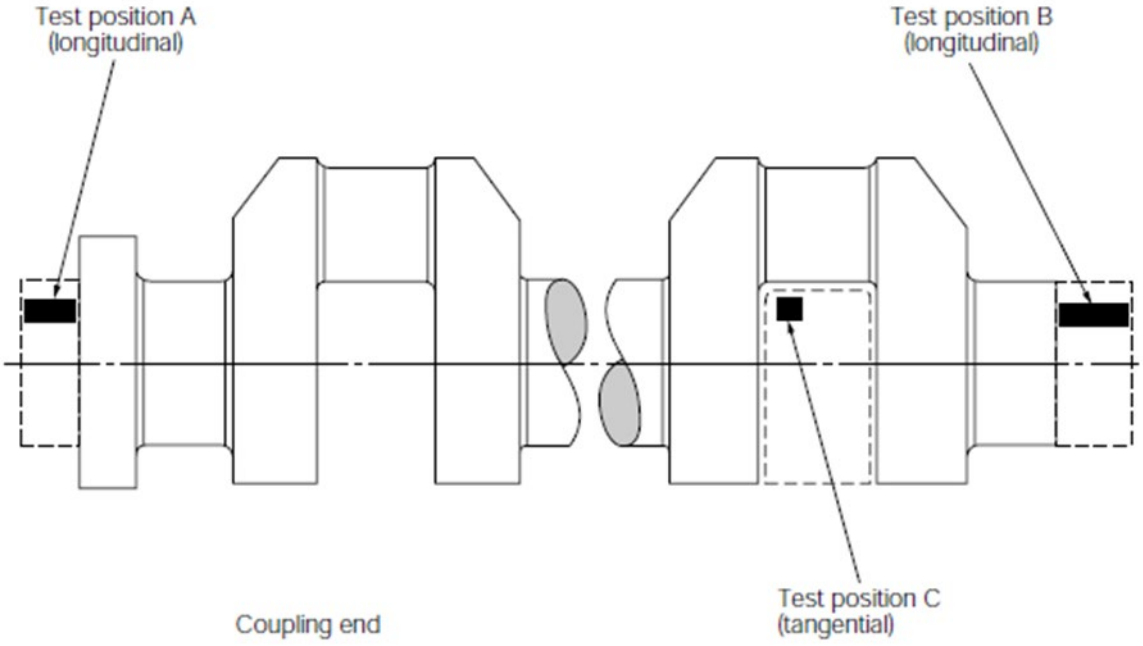

Fig. 9 Solid forged crankshaft

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Examples of
acceptable tangential
test positions

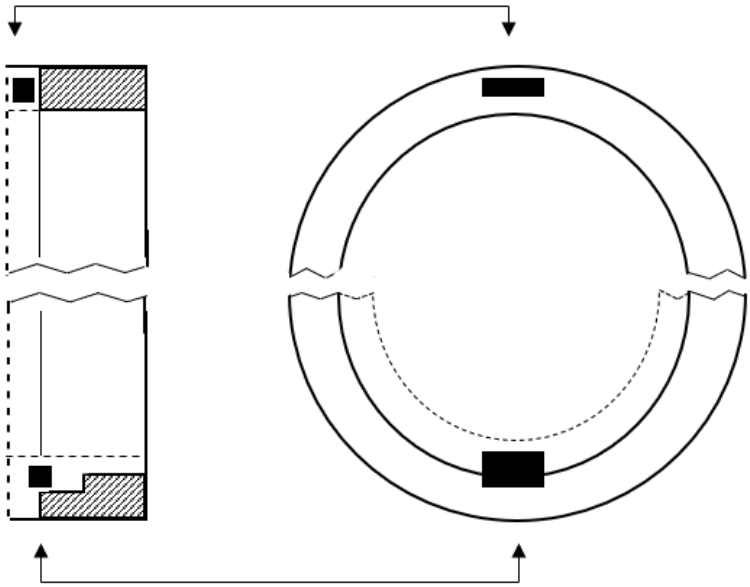

Fig. 10 Forged rings

6.10 When forgings are to be carburized, sufficient test material is to be provided for both preliminary tests at the forge and for final tests after completion of carburizing.

For this purpose duplicate sets of test material are to be taken from positions as detailed in 6.6, except that irrespective of the dimensions or mass of the forging, tests are required from one position only and, in the case of forgings with integral journals, are to be cut in a longitudinal direction.

This test material is to be machined to a diameter of D/4 or 60mm, whichever is less, where D is the finished diameter of the toothed portion.

For preliminary tests at the forge one set of test material is to be given a blank carburizing and heat treatment cycle simulating that which subsequently will be applied to the forging. For final acceptance tests, the second set of test material is to be blank carburized and heat treated along with the forgings which they represent.

At the discretion of the forgemaster or gear manufacture test samples of larger cross section may be either carburized or blank carburized, but these are to be machined to the required diameter prior to the final quenching and tempering heat treatment.

Alternative procedures for testing of forgings which are to be carburized may be specially agreed with the Classification Society.

6.11 Normalized forgings with mass up to 1000kg each and quenched and tempered forgings with mass up to 500kg each may be batch tested. A batch is to consist of forgings of similar shape and dimensions, made from the same heat of steel, heat treated in the same furnace charge and with a total mass not exceeding 6 tonnes for normalized forgings and 3 tonnes for quenched and tempered forgings, respectively.

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6.12 A batch testing procedure may also be used for hot rolled bars. A batch is to consist of either:

(i) material from the same rolled ingot or bloom provided that where this is cut into individual lengths, these are all heat treated in the same furnace charge, or

(ii) bars of the same diameter and heat, heat treated in the same furnace charge and with a total mass not exceeding 2.5 tonnes.

6.13 The preparation of test specimens and the procedures used for mechanical testing are to comply with the relevant requirements of W2. Unless otherwise agreed all tests are to be carried out in the presence of the Surveyor.

7 Mechanical properties

7.1 Tables 3 and 4 give the minimum requirements for yield stress, elongation, reduction of area and impact test energy values corresponding to different strength levels but it is not intended that these should necessarily be regarded as specific grades. Where it is proposed to use a steel with a specified minimum tensile strength intermediate to those given, corresponding minimum values for the other properties may be obtained by interpolation.

7.2 Forgings may be supplied to any specified minimum tensile strength selected within the general limits detailed in Tables 3 or 4 but subject to any additional requirements of the relevant Unified Requirements.

7.3 The mechanical properties are to comply with the requirements of Tables 3 or 4 appropriate to the specified minimum tensile strength or, where applicable, the requirements of the approved specification.

7.4 At the discretion of individual Classification Societies hardness tests may be required on the following:

(i) Gear forgings after completion of heat treatment and prior to machining the gear teeth. The hardness is to be determined at four positions equally spaced around the circumference of the surface where teeth will subsequently be cut. Where the finished diameter of the toothed portion exceeds 2.5m, the above number of test positions is to be increased to eight. Where the width of a gear wheel rim forging exceeds 1.25m, the hardness is to be determined at eight positions at each end of the forging.

(ii) Small crankshaft and gear forgings which have been batch tested. In such cases at least one hardness test is to be carried out on each forging.

The results of hardness tests are to be reported and, for information purposes, typical Brinell hardness values are given in Table 4.

7.5 Hardness tests may also be required on forgings which have been induction hardened, nitrided or carburized. For gear forgings these tests are to be carried out on the teeth after, where applicable, they have been ground to the finished profile. The results of such tests are to comply with the approved specifications (see 5.5).

7.6 Re-test requirements for tensile tests are to be in accordance with UR W2.

7.7 Re-test requirements for Charpy impact tests are to be in accordance with UR W2.

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7.8 The additional tests detailed in 7.6 and 7.7 are to be taken, preferably from material adjacent to the original tests, but alternatively from another test position or sample representative of the forging or batch of forgings.

7.9 At the option of the manufacturer, when a forging or a batch of forgings has failed to meet the test requirements, it may be reheat treated and re-submitted for acceptance tests.

Table 3 Mechanical properties for hull steel forgings

Steel type	Tensile strength [1] R_m min. N/mm^2	Yield stress R_e min. N/mm^2	Elongation A_5 min. %		Reduction of area Z min. %		Charpy V-notch impact test[2]	
			Long.	Tang.	Long.	Tang.	Test temperature (°C)	Minimum average energy (J)
								Long. / Tang.
C and C-Mn	400	200	26	19	50	35	0	27 / 18
	440	220	24	18	50	35		
	480	240	22	16	45	30		
	520	260	21	15	45	30		
	560	280	20	14	40	27		
	600	300	18	13	40	27		
Alloy	550	350	20	14	50	35		
	600	400	18	13	50	35		
	650	450	17	12	50	35		

1) The following ranges for tensile strength may be additionally specified:

specified minimum tensile strength: $< 600\ N/mm^2$ $\geq 600\ N/mm^2$

tensile strength range: $120\ N/mm^2$ $150\ N/mm^2$

2) Special consideration may be given to alternative requirements for Charpy V-notch test, depending on design and application, and subject to agreement by Society.

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Table 4 Mechanical properties for machinery steel forgings

Steel type	Tensile strength [1] R_m min. N/mm^2	Yield stress R_e min. N/mm^2	Elongation A_5 min. %		Reduction of area Z min. %		Hardness[3] (Brinell)	Charpy V-notch impact test[2, 4]		
			Long.	Tang.	Long.	Tang.		Test temperature (°C)	Minimum average energy (J)	
									Long.	Tang.
C and C-Mn	400	200	26	19	50	35	110-150	AT[5]	27	18
	440	220	24	18	50	35	125-160			
	480	240	22	16	45	30	135-175			
	520	260	21	15	45	30	150-185			
	560	280	20	14	40	27	160-200			
	600	300	18	13	40	27	175-215			
	640	320	17	12	40	27	185-230			
	680	340	16	12	35	24	200-240			
	720	360	15	11	35	24	210-250			
	760	380	14	10	35	24	225-265			
Alloy	600	360	18	14	50	35	175-215			
	700	420	16	12	45	30	205-245			
	800	480	14	10	40	27	235-275			
	900	630	13	9	40	27	260-320			
	1000	700	12	8	35	24	290-365			
	1100	770	11	7	35	24	320-385			

[1] The following ranges for tensile strength may be additionally specified:

specified minimum tensile strength:	< 900 N/mm^2	≥ 900 N/mm^2
tensile strength range:	150 N/mm^2	200 N/mm^2

[2] For materials used for machinery exposed to sea water temperature, such as propeller shafts and shaft bolts, intended for ships with ice class notation IA Super, IA, IB and IC, Charpy V-notch impact testing is to be carried out for all steel types at –10°C and the average energy value is to be minimum 20J (longitudinal test). One individual value may be less than the required average value provided that it is not less than 70% of this average value.

[3] The hardness values are typical and are given for information purposes only.

[4] Special consideration may be given to alternative requirements for Charpy V-notch test, depending on design and application, and subject to agreement by Society.

[5] AT refers to Ambient Temperature (i.e. 23°C±5°C), which is specified in ISO 148-1:2016.

8 Inspection

8.1 All forgings should be subjected to a 100% visual examination of all accessible surfaces by the manufacturer and made available to the Surveyor. Where applicable, this visual examination is to include the examination of internal surfaces and bores. Unless otherwise agreed, the verification of dimensions is the responsibility of the manufacturer.

8.2 When required by the relevant Unified Requirement, or by the approved procedure for welded composite components (see 2.7) appropriate non-destructive testing is also to be carried out before acceptance and the results are to be reported by the manufacturer.

8.3 Where required by the appropriate Unified Requirement or Recommendation 68, ultrasonic examination is to be carried out after the forgings have been machined to a condition suitable for this type of examination and after the final heat treatment. Both radial

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and axial scanning are to be carried out where appropriate for the shape and the dimensions of the forgings being examined.

8.4 The method and the extent of inspection, NDT and acceptance criteria are to be agreed with the Classification Society. IACS Recommendation No. 68 is regarded as an example of an acceptable standard.
For mass produced forgings the extent of examination is to be established at the discretion of the individual Society.

8.5 Unless otherwise agreed, examinations are to be carried out by the manufacturer, although Surveyors may request to be present in order to verify that the examination is being carried out in accordance with the agreed procedure.

8.6 If the forging is supplied in the 'as forged' condition for machining at a separate works, the manufacturer is to ensure that a suitable ultrasonic examination is carried out to verify the internal quality of the forging.

8.7 Where advanced ultrasonic testing methods are applied, e.g. PAUT or TOFD, reference is made to UR W34 Advanced non-destructive testing of materials and welds –Dec. 2019, for general approach in adopting and application of these advanced methods.
In such cases, acceptance levels regarding accept/reject criteria may be as per the applicable section in the IACS Recommendation No. 68.

8.8 When required by the conditions of approval for surface hardened forgings (5.5 refers) additional test samples are to be processed at the same time as the forgings which they represent. These test samples are subsequently to be sectioned in order to determine the hardness, shape and depth of the locally hardened zone and which are to comply with the requirements of the approved specification.

8.9 In the event of any forging proving defective during subsequent machining or testing, it is to be rejected notwithstanding any previous certification.

9 Rectification of defective forgings

9.1 Defects may be removed by grinding or chipping and grinding provided the component dimensions are acceptable. The resulting grooves are to have a bottom radius of approximately three times the groove depth and are to be blended into the surrounding surface so as to avoid any sharp contours. Complete elimination of the defective material is to be verified by magnetic particle testing or liquid penetrant testing.

9.2 Repair welding of forgings except those subjected to torsional fatigue, such as crankshaft forgings and propeller shaft forgings, may be permitted subject to prior approval of the Classification Society. In such cases, full details of the extent and location of the repair, the proposed welding procedure, heat treatment and subsequent inspection procedures are to be submitted for the approval.

9.3 The forging manufacturer is to maintain records of repairs and subsequent inspections traceable to each forging repaired. The records are to be presented to the surveyor on request.

W7 (cont)

10 Identification of forgings

10.1 The manufacturer is to adopt a system of identification which will enable all finished forgings to be traced to the original cast and the Surveyor is to be given full facilities for so tracing the forgings when required.

10.2 Before acceptance, all forgings which have been tested and inspected with satisfactory results are to be clearly marked by the manufacturer. At the discretion of individual Classification Societies any of the following particulars may be required:

(i) Steel quality.
(ii) Identification number, cast number or other marking which will enable the full history of the forging to be traced.
(iii) Manufacturer's name or trade mark.
(iv) Test pressure where applicable.
(v) Date of final inspection.
(vi) The Classification Society's name, initials or symbol.
(vii) Abbreviated name of the Classification Society's local office.
(viii) Personal stamp of Surveyor responsible for inspection.

10.3 Where small forgings are manufactured in large numbers, modified arrangements for identification may be specially agreed with the Classification Society.

11 Certification

11.1 The manufacturer is to provide the required type of inspection certificate giving the following particulars for each forging or batch of forgings which has been accepted:

(i) Purchaser's name and order number.
(ii) Description of forgings and steel quality.
(iii) Identification number.
(iv) Steelmaking process, cast number and chemical analysis of ladle sample.
(v) Results of mechanical tests.
(vi) Results of non-destructive tests, where applicable.
(vii) Details of heat treatment, including temperature and holding times.

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