

CARES Technical Approval Report TA13 5037



ROLDAN SA

ROLDAN SA
Lean Duplex Stainless Steel ACX 903

Assessment of the Lean
Duplex Stainless Steel
ACX 903 Reinforcing Bar
Product and Quality System
for Production



Product

Roldan SA
Lean Duplex Stainless
Steel ACX 903
Reinforcing Bar

Produced by:

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1 Product Summary

Lean duplex, austenitic-ferritic, stainless steel, ACX 903 in the size range 6mm to 40mm bar and coil for the reinforcement of and use in concrete complying with the mechanical and physical property requirements of BS 6744:2001 + A2:2009 Grade 500.

1.1 Scope of Application

Roldan SA lean duplex stainless steel, ACX 903, in the size range 6mm to 40mm, has been evaluated for use in accordance with CARES Appendix TA13.

1.2 Design Considerations

This solid bar product meets the mechanical and physical property requirements of BS 6744:2001 + A2 2009. Roldan ACX 903 lean duplex stainless steel reinforcing bar is for the reinforcement of and use in concrete where corrosion resistance is required in the presence of chlorides and high pH conditions. The relevant design standards are BS 8110 and EC2. Although BS 8110 has no specific requirements for stainless steel there are no special design considerations and it may be used in similar configurations as any other reinforcement bars made of a similar strength grade.



1.3 Conclusion

It is the opinion of UK CARES that Roldan ACX 903 lean duplex stainless steel reinforcing bar is satisfactory for use within the limits stated in paragraph 1.1 when applied and used in accordance with the manufacturer's instructions and the requirements of this certificate.

B. Bowsher
Executive Director

January 2012



2 Technical Specification

2.1 General

Roldan SA ACX 903 lean duplex stainless steel reinforcing bar is for the reinforcement of and use in concrete where corrosion resistance to chlorides is of primary concern.

2.2 Standard sizes

The size of bars and coils shall be 6 to 40 mm.

2.3 Dimensions, mass and tolerances

2.3.1 Effective cross-sectional area and mass per metre run

The effective cross-sectional area and mass per metre run of the bars shall be calculated using the method described in Annex A of BS 6744:2001 + A2:2009.

The values for the nominal cross-sectional area and nominal mass per metre run of individual bars shall be as given in **Table 1**.

NOTE The values for the nominal mass per metre run are calculated from the values of the nominal cross-sectional area using density value of 7800 kg/m³ (EN 10088-1).

Table 1 - Nominal cross-sectional area and nominal mass per metre run

Nominal size mm	Nominal cross-sectional area mm ²	Nominal mass per metre run kg
6	28.3	0.221
8	50.3	0.392
10	78.5	0.612
12	113.1	0.882
14	153.9	1.200
16	201.1	1.569
20	314.2	2.451
25	490.9	3.829
32	804.2	6.273
40	1256.6	9.801

Tolerances on mass per metre run shall be as described in **Table 4** of BS 6744:2001 + A2:2009.

2.4 Length

The nominal length of bars shall be agreed at the time of enquiry and order. The preferred length is 6m. Bar lengths available are: diameters 6 to 14mm: 3 - 8m, diameters 16 to 40mm: 3 - 12m.

Unless otherwise agreed at the time of enquiry and order, the permissible deviation from the nominal length shall be plus 100mm and minus 0mm.

2.5 Steelmaking process

Unless a special steelmaking process is agreed when ordering, the steelmaking process shall be at the discretion of the manufacturer.

2.6 Chemical composition

2.6.1 Cast analysis

The chemical composition of the steel, based on cast analysis, shall be in accordance with **Table 2**. In cases of dispute, the appropriate methods of test given in BS EN 10088-3 shall be used.

Table 2 - Cast analysis % by weight

Steel Designation Number	C max	Si max	Mn min/max	S max	Cr min/max	Ni min/max	Mo min/max	Cu max	P max	N min/max
Roldan ACX 903	0.03	1.0	4.0/6.0	0.030	19.5/21.5	1.0/3.0	0.1/0.6	1.0	0.035	0.05/0.17

2.6.2 Product analysis

The maximum deviations in product analysis from the values specified for cast analysis shall be in accordance with those given in BS EN 10088-3.



2 Technical Specification

2.7 Surface quality

All bars shall be free from defects or other surface contamination which can be shown to adversely affect the corrosion or mechanical properties of the steel specified in this Technical Approval. If more exact requirements for surface quality are necessary, these shall be agreed at the time of enquiry and order, where appropriate, on the basis of BS EN 10221.

2.8 Surface geometry

Bars shall have a ribbed surface.

Measurement of geometrical characteristics shall be in accordance with Annex C of BS 6744: 2001 + A2:2009. The stainless steel products covered by this Technical Approval are characterized by their surface geometry, which enables them to bond with the concrete.

2.8.1 Relative rib area

The relative rib area, f_R , shall be regarded as the ruling criterion for the bond performance of ribbed products. The value of f_R as a function of the nominal size, as determined in accordance with Annex C.3 of BS 6744 2001+A2:2009, shall be in accordance with **Table 3**.

Table 3 - Minimum relative rib area, f_R

Nominal size / mm	f_R min
6	0.039
8	0.045
10	0.052
12 to 40	0.056

2.9 Conditions of supply

Ribbed bar shall be supplied in coil or straight lengths, or fabricated in accordance with the customer's requirements in the hot rolled and descaled condition or cold rolled.

2.10 Mechanical and physical properties

2.10.1 Tensile properties

The 0.2 % proof strength, $R_{p0.2}$, stress ratio, $R_m/R_{p0.2}$, elongation at fracture, A_5 and A_{gt} , of the steel obtained from test samples selected, prepared and tested in accordance with Annex D of BS 6744: 2001 + A2:2009, shall be as specified in **Table 4**.

For routine testing the 0.2 % proof strength shall be considered a minimum value. For determination of long term quality level, the values given in the table shall be for the characteristic strength (see Definitions 3.1.22 of BS 6744: 2001 + A2:2009).

Table 4 - Tensile and impact properties

Grade	0.2 % proof strength $R_{p0.2}$ MPa	Stress ratio $R_m/R_{p0.2}$ (min)	Elongation at fracture A_5 (min) %	Total elongation at maximum force, A_{gt} (min)	Impact energy (Charpy) (ISO - V) (min) J
500	500	1.10	14	5	100

The properties comply with Annex C of Eurocode 2.

Total elongation at maximum force, A_{gt}

The total elongation at maximum force, A_{gt} , shall be determined in accordance with ISO 15630-1.

Measurements shall be made and recorded and shall be made available for inspection, but if the total elongation is below the minimum value specified in **Table 4**, this shall not be a cause of non-conformity with this standard.

2.11 Bend test

When test samples, selected and prepared in accordance with Annex E of BS 6744: 2001 + A2:2009, undergo the bend test described in Annex E of BS 6744: 2001 + A2:2009, the test samples shall show no sign of fracture or irregular bending deformation.

2.12 Fatigue test

Ribbed bar shall be subjected to type testing as described in Annex F of BS 6744: 2001 + A2:2009 to determine the characteristics of a particular geometric shape and grade. The fatigue characteristics shall be verified every five years or after 1,000 tonnes produced for each size and grade manufactured, whichever is sooner.

The batch shall be deemed to conform to this Technical Approval if all five test samples endure 5×10^6 cycles of stress.

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2.13 Charpy impact test

Three impact tests shall be performed for each batch. Impact testing shall be carried out in accordance with BS EN ISO 148 on test pieces with a V-notch. The average obtained from three test pieces shall be considered to be the test result (see also BS EN 10021). The values obtained shall conform to **Table 4**.

2.14 Intergranular corrosion testing

An intergranular corrosion test shall be carried out on one sample per batch in accordance with BS EN ISO 3651-2.


2.15 Retests

If any test sample fails to meet the stress ratio, proof strength, elongation to fracture, bend test or impact energy requirements, two additional test samples shall be taken from different bars of the same batch and subjected to the test or tests in which the original sample failed. If both additional test samples pass the test or tests, the batch from which they were taken shall be deemed to conform to this standard. If either of them fails, the batch shall be deemed not to conform to this Technical Approval.

2.16 Product identification

2.16.1 Product marking

Ribbed bars shall be identified by rolled-on legible marks on the surface at intervals not greater than 1.5 m to indicate the origin of manufacture.

Standard	Bar Mark	Number
BS6744		7-3

Bar marking ROLDAN SA Lean duplex Stainless Steel ACX 903

2.16.2 Product labelling

Each bundle of bar, or each coil shall have a label attached containing the following information:

- reference to this Technical Approval and CARES;
- specification;
- grade;
- size;
- cast number;
- batch reference;
- name of the manufacturer.

3 Product Performance and Characteristics

Full destructive tests have been carried out to demonstrate compliance with performance requirements as defined in CARES Appendix TA13:

CARES APPENDIX TA13

- Product dimensions – including cross sectional area and rib geometry
- Tensile properties
- Total elongation at maximum force
- Bend test
- Fatigue test
- Charpy impact test
- Pitting resistance

Pitting resistance

Alloy ACX 903 shows good corrosion resistance in alkaline concrete solutions and, in presence of carbonated solutions and/or with chloride ion concentration. In experiments, it was found that the corrosion resistance of alloy ACX 903 is midway between that of 1.4301 and 1.4436 stainless steels, when examined in solutions simulating the concrete pore liquid.



Guidance on the use of stainless steel reinforcement for different service conditions (see also annex B of BS6744:2001 +A2:2009)

Eurocode 2, 4.3 gives guidance on requirements for durability.

Grade in accordance with BS EN 10088-1	Service condition			
	For structures or components with either a long design life, or which are inaccessible for future maintenance	For structures or components exposed to chloride contamination with no relaxation in durability design (e.g. concrete cover, quality or water proofing treatment requirements)	Reinforcement bridging joints, or penetrating the concrete surface and also subject to chloride contamination (e.g. dowel bars or holding down bolts)	Structures subject to chloride contamination where reductions in normal durability requirements are proposed (e.g. reduced cover, concrete quality or omission of water proofing treatment)
Roldan ACX 903	1	1	5	3
Key 1 – Appropriate choice for corrosion resistance and cost. 3 – May be suitable in some instances: specialist advice should be obtained. 5 – Unsuitable for this application.				

The corrosion resistance of stainless steels is very dependent on the type of environment and can therefore not always be clearly ascertained through laboratory tests. It is therefore advisable to draw on the available experience of the use of the steels. For specific applications, consult with a corrosion expert.



4 Installation

Lapping with carbon steel is normally acceptable except in certain conditions depending upon the design and volume per cent of stainless steel and carbon steel. For more specific advice please refer to a corrosion expert.

5 Safety Considerations

The reinforcing bars are supplied in bundles or coils and have a maximum weight of 2500 kg and must be handled with appropriate lifting equipment. It is advisable to wear protective gloves during handling of the containers and reinforcement; during the cutting, bending and fixing processes. For additional alloy safety precautions, consult Roldan SA Material Safety Data Sheet.

6 Product Testing and Evaluation

Roldan SA ACX 903 lean duplex stainless steel reinforcing bars have been tested to satisfy the requirements of CARES Appendix TA13. The testing comprised the following elements:

- Product dimensions
- Tensile properties
- Elongation at fracture
- Total elongation at maximum force
- Bend test
- Fatigue test
- Pitting resistance

Testing has been undertaken at Exova Group Limited, R-TECH Services and CAPCIS; the report numbers are listed in Section 9, References.

7 Quality Assurance

The products are subject to a programme of periodic testing to ensure that they remain within the performance limits of this technical approval.

Roldan SA ACX 903 lean duplex stainless steel reinforcing bars are produced under an ISO 9001 quality management system certified by CARES. The quality management system scheme monitors the production of the reinforcing bar and ensures that materials remain within the limits of this technical approval.

8 Building Regulations

Eurocodes

BS 8110 was withdrawn in April 2010 after its coexistence period with Eurocode 2 ended. Although not yet formally endorsed by the Secretary of State it is anticipated that under building regulations Eurocode 2 will be accepted in lieu of BS 8110.

8.1 The Building Regulations (England and Wales)

Structure, Approved Document A

Roldan SA ACX 903 lean duplex stainless steel, when used in BS 8110 based designs using the data contained within this technical approval, satisfies the relevant requirements of The Building Regulations (England and Wales), Approved Document A.

Materials and Workmanship, Approved Document, to support regulation 7

This technical approval gives assurance that the Roldan SA ACX 903 lean duplex stainless steel complies with the material requirements of BS8110.

8.2 The Building Regulations (Northern Ireland)

Part B, Materials and Workmanship

This technical approval gives assurance that Roldan SA ACX 903 lean duplex stainless steel complies with the material requirements of BS8110 by virtue of regulation *B3, Deemed to satisfy provisions regarding the fitness of materials and workmanship.*

8.3 The Building Standards (Scotland) Regulations

Part B, Fitness of Materials

This technical approval gives assurance that Roldan SA ACX 903 lean duplex stainless steel complies with the material requirements of BS8110 by virtue of *Clause B2.1.*

Part C, Structure

Roldan SA ACX 903 lean duplex stainless steel when used in BS8110 based designs using the data contained within this technical approval, satisfies the requirements of *The Building Standards (Scotland) Regulations 1990, Part C, C2.1 clause b. construction,ii.*



9 References

- BS 6744: 2001 + A2 2009 Stainless steel bars for the reinforcement of and use in concrete – Requirements and test methods.
- BS EN ISO 15630-1 Steel for the reinforcement and prestressing of concrete - Test methods - Part1: Reinforcing bars, wire rod and wire.
- BS EN ISO 148-1: 2010 - Metallic materials: Charpy pendulum impact test. Test method.
- BS8110: Part 1: 1997 (Revised 2005): Structural Use of Concrete, Code of Practice for Design and Construction.
- BS EN 1992-1-1:2004 Eurocode 2 Design of concrete structures - General rules for buildings.
- BS EN ISO 9001: 2008 Quality management systems - Requirements.
- CARES Appendix TA13: Quality and Operations Schedule for the Technical Approval of Ribbed duplex stainless steel reinforcing bar.
- R-TECH Services Limited Test Certificates: 09449A, 09465 Issue 2 and 11287.
- Exova Group Limited Test Certificates: D9866, D9867, D11888 and D12698.
- CAPCIS Test Certificate: GE8323 Rev 0 February 2008.
- UK Highways Agency Design Manual for roads and bridges –Volume 1 Highway Structures: Approval Procedures and General Design Section 3 General Design Part 15 BA 84/02 Use of Stainless Steel Reinforcement in Highway Structures.
- Concrete Society Technical Report 51 Guidance on the use of stainless steel reinforcement.

This Technical Approval will prevail in the event of any inconsistency with a referenced document.

10 Conditions

1. The quality of the materials and method of manufacture have been examined by CARES and found to be satisfactory. This technical approval will remain valid providing that:
 - a. The product design and specification is unchanged.
 - b. The materials and method of manufacture are unchanged.
 - c. The manufacturer complies with CARES regulations for technical approvals.
 - d. The manufacturer holds a valid CARES Certificate of Product Assessment.
 - e. The product is installed and used as described in this report.
2. CARES make no representation as to the presence or absence of patent rights subsisting in the product and/or the legal right of Roldan SA to market the product.
3. Any references to standards, codes or legislation are those which are in force at the date of this certificate.
4. Any recommendations relating to the safe use of this product are the minimum standards required when the product is used. These requirements do not purport to satisfy the requirements of the Health and Safety at Work act 1974 or any other relevant safety legislation.
5. CARES does not accept any responsibility for any loss or injury arising as a direct or indirect result of the use of this product.
6. This Technical Approval Report should be read in conjunction with CARES Certificate of Product Assessment No 5037. Confirmation that this technical approval is current can be obtained from UK CARES.





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