

CARES Technical Approval Report TA10 5019

Assessment of the Ribbed Duplex
(1.4362) Stainless Steel
Reinforcing Bar Product and
Quality System for Production

Arminox
Duplex Stainless Steel 1.4362



Product

Arminox 1.4362 Duplex Stainless Steel Reinforcing Bar

Produced by:

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1 Product Summary

Duplex, austenitic-ferritic, stainless steel, 1.4362, in the size range 6mm to 12mm bar and coil for the reinforcement of and use in concrete complying with the mechanical and fatigue property requirements of BS 6744 2001 Grade 500.

1.1 Scope of Application

ARMINOX duplex stainless steel, 1.4362, in the size range 6mm to 12mm, has been evaluated for use in accordance with CARES Appendix TA10.

1.2 Design Considerations

This solid bar product meets the mechanical and physical property requirements of BS 6744:2001. ARMINOX 1.4362 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. 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 ARMINOX 1.4362 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

February 2008



2 Technical Specification

2.1 General

ARMINOX 1.4362 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 shall be 6 to 12 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.

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

The tolerances on mass per metre run shall be in accordance with **Table 2**.

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
7	38.5	0.300
8	50.3	0.392
10	78.5	0.612
12	113.1	0.882

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

2.4 Length

The product shall be supplied in coil format.

2.5 Steelmaking Process

Unless a special steelmaking process is agreed when ordering, the steelmaking process for steels conforming to BS EN 10088 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

BS EN 10088-1 Steel Designation No	C max	Si max	Mn max	S max	Cr min/max	Ni min/max	Mo min/max	Cu min/max	P max	N min/max
1.4362	0.03	1.0	2.0	0.015	22.0/24.0	3.5/5.5	0.10/0.60	0.10/0.60	0.035	0.05/0.20

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.

2.7 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 Technical Specification

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. 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, shall be in accordance with **Table 3**.

Table 3
Minimum relative rib area, f_R

Nominal size / mm	f_R min.
6	0.039
7	0.045
8	0.045
10	0.052
12	0.056

2.9 Conditions of Supply

Ribbed bar shall be supplied in cold rolled condition in coil or straight lengths or processed according to BS8666 or customer requirements.

2.10 Mechanical and Physical Properties

2.10.1 Tensile Properties

The 0.2 % proof strength, $R_{p0.2}$, stress ratio, $R_m/R_{p0.2}$, and elongation at fracture, A_5 , of the steel obtained from test samples selected, prepared and tested in accordance with Annex D of BS 6744 2001, 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).

Table 4 - Tensile and impact properties

Grade	0.2 % Proof strength $R_{p0.2}$, MPa	Stress ratio $R_{m/R_{p0.2}}$ (min) MPa	Elongation at fracture A_5 (min) %	Total elongation at maximum force, A_{gt} (min)
500	500	1.10	14	5

Total elongation at maximum force, A_{gt}

The total elongation at maximum force, A_{gt} , shall be determined in accordance with ISO 15630. 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 for non-conformity with this Technical Approval.

2.11 Bend Test

When test samples, selected and prepared in accordance with Annex E of BS 6744 2001, undergo the bend test described in Annex E of BS 6744 2001, 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 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 British Standard if all five test samples endure 5×10^6 cycles of stress.

2.13 Retests

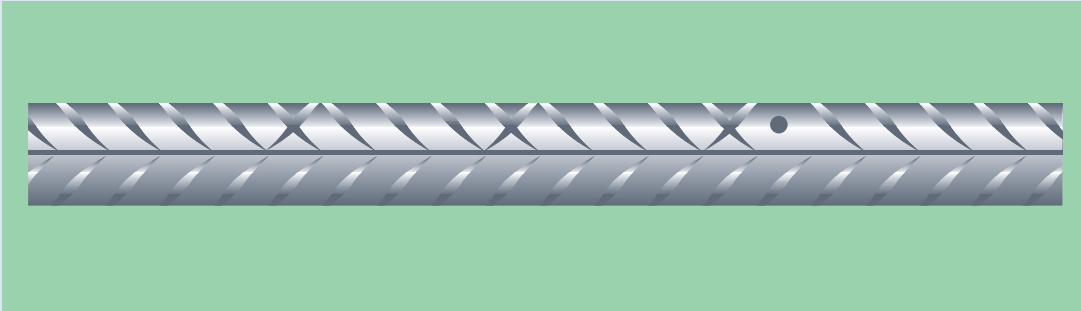
If any test sample fails to meet the stress ratio, proof strength, elongation to fracture or bend test, two additional test samples shall be taken from different bars of the same batch and subjected to the test or tests in which the original sample failed. If both additional test samples pass the test 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.



2.14 Product identification

2.14.1 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.



2.14.2 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

The full destructive tests have been carried out to demonstrate compliance with performance requirements defined in CARES Appendix TA10:

CARES APPENDIX TA10

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

Pitting Resistance

Alloy 1.4362 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 1.4362 is similar or better than 304L or 316L stainless steels, when examined in solutions simulating the concrete pore liquid. An additional advantage of using alloy 1.4362 over austenitic alloys is its excellent resistance to stress corrosion cracking.

Guidance on the use of stainless steel reinforcement for different service conditions

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)
1.4362	2	2	1	1
Key 1 – Appropriate choice for corrosion resistance and cost. 2 – Over-specification of corrosion resistance for the application.				

* For specific applications, consult with a corrosion expert and ARMINOX.



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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. 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 the containers and reinforcement; during the cutting, bending and fixing processes.

6 Product Testing and Evaluation

Arminox 1.4362 duplex stainless steel reinforcing bars have been tested to satisfy the requirements of CARES Appendix TA10. The testing comprised the following elements:

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

Testing has been undertaken at Bureau Veritas and CAPCIS; the report numbers are listed in Section 9, References.

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

7 Quality Assurance

Arminox 1.4362 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

8.1 The Building Regulations (England and Wales)

Structure, Approved Document A

Arminox 1.4362 duplex stainless steel, when used in BS 8110 based designs using the data contained within this technical approval, satisfy 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 Arminox 1.4362 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 Arminox 1.4362 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 Arminox 1.4362 duplex stainless steel complies with the material requirements of BS8110 by virtue of *Clause B2.1*

Part C, Structure

Arminox 1.4362 duplex stainless steel when used in BS8110 based designs using the data contained within this technical approval, satisfy the requirements of *The Building Standards (Scotland) Regulations 1990, Part C, C2.1 clause b. construction,ii.*



9 References

- BS 6744: 2001: Stainless steel bars for the reinforcement of and use in concrete – Requirements and test methods.
- BS8110: Part 1: 1997 (Revised 2005): Structural Use of Concrete, Code of Practice for Design and Construction.
- BS EN ISO 9001: 2000: Quality management systems - Requirements.
- CARES Appendix TA10: Quality and Operations Schedule for the Technical Approval of Ribbed duplex (1.4362) stainless steel reinforcing bar
- Bureau Veritas Test Certificates: 33843
- Bodycote Testing Ltd. Certificates: D7212, D7213 and D7214
- CAPCIS Test Certificate: GE6287 Rev 1 January 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 Arminox 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 5019. Confirmation that this technical approval is current can be obtained from UK CARES.





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