



Fabrication of reinforcement

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Introduction



The fabrication of reinforcing steels, into shapes suitable for fixing into the concrete formwork, is normally performed 'off-site' in the UK, by specialist reinforcement fabricators, although it is recognised that this differs globally. Very little reinforcement is cut and bent on-site in the UK today. Although the cutting and bending of reinforcement appears relatively straightforward, the specialist reinforcement fabricator is well equipped to do so in a consistently accurate manner and, by working within a defined set of quality management criteria, as provided by the CARES Steel

for the Reinforcement of Concrete (SRC) Scheme. The maintenance of product traceability and the accuracy of cutting and bending operations is vital to ensure proper fit on site, and to maintain required lap lengths, anchorage lengths and concrete cover.

This Guide describes the cutting and bending operations, providing an understanding of the processes involved, as well as the role that the CARES scheme for fabricators plays in providing assurance of the quality of fabricated reinforcement.

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British Standards

Within the UK and elsewhere, BS 8666, Specification for scheduling, dimensioning, bending, and cutting of steel reinforcement for concrete, specifies requirements for scheduling, dimensioning, bending, and cutting of reinforcing steels. It is of vital importance that the standard being used, e.g. BS 8666:2020, is clearly stated on the cutting and bending schedule.

BS 8666 is the basis for the CARES SRC Scheme for reinforcement fabricators. Under CARES approval, all approved reinforcement fabricators are required to fully understand the requirements of their customers and to provide reinforcement to the specified standards and related bending schedule.

The scheduling standard defines the bar schedule used to transmit requirements for cut and bent shapes from the designer/detailer to the contractor and reinforcement

fabricator. Bending schedules have specified notations for calling up the different reinforcing materials available on the market, including the different grades of conventional carbon steels (BS 4449), stainless steels (BS 6744) and any other special steels. The Notations are given in Table 1.

It is important that the specific versions of the scheduling standard, BS 8666, and the product standard BS 4449 are agreed for each specific project.

Bent shapes are defined by means of standard shape codes (Table 2 of BS 8666:2020). When non-standard shapes are required, guidance is given as to how these should be referenced (as shape code 99's), and specified by an appropriate drawing. For each standard shape, the standard gives the overall length of bar used, as a function of the principle dimensions.

Table 1. Notation for reinforcing steels (from BS 8666:2020)

Type of steel reinforcement	Notation
For diameters $\leq 12\text{mm}$, Grade B500A, B500B or B500C conforming to BS 4449:2005. For diameters $> 12\text{mm}$, Grade B500B or Grade B500C conforming to BS 4449:2005	H
Grade B500A according to BS 4449:2005	A
Grade B500B or grade B500C according to BS 4449:2005	B
Grade B500C according to BS 4449:2005	C
Smooth plain round bar, straight shape code 00, for dowel bars only conforming to BS EN 13877-3	D
The specified grade(s) and steel designation number(s) of ribbed stainless steel conforming to BS 6744:2023 and BS EN 10088 shall be stated on each bending schedule	S
Reinforcement of a type not included in the above list having material properties that are defined in the design or contract specification.	X

Note 1. In the Grade description B500A, etc., "B" indicates reinforcing steel.

Note 2. Within the ranges given, the grade(s) supplied for notations H and B are at the supplier's discretion.

Note 3. A specific grade(s) and type(s) of ribbed stainless steel conforming to BS 6744 and BS EN 10080 should be stated on each relevant bending schedule.

BS 8666:2020, clause 5, specifies the format for the schedule in which the requirements for cut and bent reinforcement are to be specified. Schedules are often supplied to fabricators by means of commercially available software packages. This saves significant time for the fabricators, and improves the accuracy of information. In some cases, this electronic schedule information can be linked directly to the computer control system of the production equipment. There are also significant benefits for designers and contractors in terms of reduced errors, fewer queries, and easier change procedures.

BS 8666 specifies various restrictions on the bending of shapes as follows:

- 1) The minimum bend radius is specified for the different material grades (see Table 2).
- 2) The minimum dimension from a bend to the end of the bar (bob length) is specified as a function of bar diameter and grade.
- 3) The maximum limit for which a pre-formed radius is required.
- 4) The restrictions on dimensions of particular shapes.

The minimum scheduling radii, mandrel diameters and end projections are shown in Table 2 of BS 8666:2020.

Fabrication processes

The basic fabrication processes consist of cutting and bending the reinforcing steel. The actual processes employed in the bending and cutting of reinforcing steel depend principally on the form of material being processed, whether bar or coil.

Generally reinforcing bar is supplied to the fabricator from the mill in bundles of straight lengths. Stock lengths are normally 12m, 14m and 15m, and can be up to 18m. Non-standard lengths can also be supplied, usually subject to a minimum tonnage requirement. Bar is fabricated by cutting on shear lines, and subsequently by bending on power bending machines.

Reinforcing bar, in coil form, is supplied from the mill in a continuous length. This may be in a 'spooled' form - wound in a uniform presentation of coil. Coil is normally available in sizes 8, 10, 12 and 16mm, although larger diameters, 20mm, are available. Coil weights are typically two to three tonnes, so that for the smaller diameters, the coil can be several kilometres in length. Coil can be unwound and cut to length in a single operation, called either "decoiling" or "straightening". Coil can also be straightened, bent, and cut to most shapes, in continuously operating machines commonly referred to as Automatic Link Benders (or ALB's).

Cutting

Bars will normally be cut to the required length in machines called Shear Lines. These machines normally consist of an unscrambler, where bundles of steel are split and loaded into the shear line, a roller table which presents the bars to the cutting shears, a hydraulically activated set of shear blades, a run-out table to take the cut bars, and pockets into which the cut lengths of steel are deposited. In an automated line, the different cuts required from each mill length can be programmed into the machine, improving efficiency and accuracy, and decreasing wastage. The tolerance specified in BS 8666:2020 for cutting is $\pm 25\text{mm}$.

Bending

The bending of reinforcing steel requires significant training to develop the skill and competence required. The bending of ribbed reinforcing steel needs to take account of the following:

- a) The hot rolling process employed in the steel mill may produce some variation in dimensions along the length of bars/coils.
- b) The ribs on the bar surface may result in a cross section which is not exactly round. This means that resistance to bending depends on bar orientation.
- c) The hot finishing process may introduce a degree of twist along the length of the bar, thus exacerbating the problems of a) and b) above.
- d) The degree of spring-back when the bending load is released is a function of bar profile, steel type, and cast characteristics. Suitable allowance must be made for this.

Bar shape requirements, e.g. in terms of twist or straightness, which can affect consistent bending performance, are not covered by BS 4449. It is the responsibility of steel mills, to supply product that is fit for purpose in this respect. This is covered in the CARES SRC scheme, whereby the CARES assessments of such steel mills, which includes process control requirements, ensures that bar shape is being adequately controlled.

Decoiling

From the perspective of the reinforcement fabricator, processing coil instead of bar has many benefits, including increased productivity, less wastage, and increased flexibility. The use of coil in sizes up to 16 mm has increased markedly, particularly in the UK but also elsewhere, and many fabricators prefer to use coil exclusively on these sizes. The decoiling process must be properly controlled to ensure proper straightness of the product, and to minimise any damage to the ribs, or change of mechanical properties. The quality of the ingoing coil in terms of consistency of geometry and mechanical properties is important in enabling reinforcement fabricators to process steel efficiently.

Automatic Link Benders (ALB's).

The bending of reinforcing steel requires significant ALB's process coil directly to bent shapes. These machines incorporate a roller straightening system, a shear, and a bending table. ALB's increase efficiency of fabrication, compared to conventional cutting and bending.

- a) The hot rolling process employed in the steel mill may produce some variation in dimensions along the length of bars/coils.

The CARES Scheme for Fabricators

Appendix 2 of the CARES Scheme for Steel for the Reinforcement of Concrete covers “Quality and operations schedule for the processing and/or supply of steel products for the reinforcement of concrete.”

This provides for:

- Independently verified compliance with the specified standard (BS 8666:2020).
- Quality management system assessment to ISO 9001.
- Verification that raw material is only purchased from CARES approved manufacturers, thus ensuring approval for the whole process route, from steel making, rolling, processing, fabricating to delivery to site.
- Full traceability throughout the supply chain. All batches of fabricated reinforcement can be traced back to the original mill test data.
- Verification of the long-term quality level as defined in BS 8666:2020.
- Resolution of any complaints made to CARES approved suppliers.
- Removing the need for purchasers to have their own testing and inspection regime on site, saving considerable time and cost.

CARES approval is gained by a fabricator only after demonstrating that its quality management system meets the requirements of ISO 9001 and additional product-specific CARES requirements. This includes checking the fabricated shapes against the requirements of BS 8666:2020.

Once approval has been granted, it is maintained by twice-yearly surveillance audits conducted by CARES specialist auditors. The quality management system is audited, dimensional checks are made to ensure product is consistently complying with BS 8666:2020

and customer requirements, and traceability systems are examined.

It should be emphasised that the fabricator plays a vitally important role in the reinforcing steel supply chain. Some fabricators have claimed that they do not need themselves to be CARES approved, because they only purchase steel from CARES approved sources. This is not the case, since only CARES approved fabricators have independent verification of their quality management systems, bending capability, and product traceability systems.

The CARES Scheme- verified compliance

When using CARES approved fabricators, specifiers can be confident that all steel supplied will be from CARES approved manufacturers. The product can be used without the need for further product testing. Where CARES approved fabricators are not specified, the onus is on the purchaser to verify compliance, which may require inspection and testing involving both significant cost in both testing, and the associated site delays.

CARES list of approved fabricators

CARES maintains, in an updated form, a list of approved firms. This is published on the CARES website www.carescertification.com in an easily searchable. The list describes the firms' scope of approval and useful contact information. The scope of certification achieved by each CARES approved firm will include the product standards for which that fabricator is approved to cut, bend, and distribute. If there are any doubts about the scope of approval of a reinforcement fabricator, the CARES list of approved firms should be consulted, or alternatively, the CARES office can be contacted for advice.



Your guide to specifying Learn how to procure CARES certified steel products

To specify CARES certification that meets government and private sector quality assurance and responsible sourcing requirements use the text from the guide in your project specifications.

specification
guide



References

1) BRITISH STANDARDS INSTITUTION. BS 8666:2020
Scheduling, dimensioning, cutting and bending of steel
reinforcement for concrete — Specification

2) CARES Steel for the reinforcement of concrete (SRC)
scheme Appendix 2 “Quality and operations assessment
schedule for the processing and/or supply of steel products
for the reinforcement of concrete.

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