Appendix

The Department of Building and Housing have recently released a series of Practice Advisory notices regarding the use of Reinforcing Steel and Cold Worked Mesh.

This appendix contains reproductions of these Advisories as well as the datasheet for Reids™ new Ductile Reinforcing Mesh.

For more information regarding these Practice Advisory Notices go to www.dbh.govt.nz

Department of Building and Housing | Building Controls
Te Tari Kaupapa Whare

Practice Advisory 1

Bend the bar but not the rules

Bending of steel reinforcement must follow New Zealand Standard procedures

Issues of concern

Incorrect bending can severely affect the performance of steel reinforcement in service. Results can be premature fracture, which will affect the capacity of the building elements to carry design loads. Of particular concern is the practice of bending reinforcing steel to too small a diameter. Bending then straightening (rebending) the reinforcing on site is of even greater concern.

To avoid fracture or weakening, NZS 3109 requires that hooks and bends are formed in accordance with the bend requirements of Table 3.1, which is reproduced below with the permission of Standards New Zealand. The minimum diameter of bend is measured on the inside of the bar.

Grade f_y (Mpa)	**Bar type**	**Bar diameter, d_b** (mm)	**Minimum diameter of bend, d_i** (mm)	
			Plain bars	Deformed bars
300 or 500	Stirrups and ties	6–20 24	$2d_b$ $3d_b$	$4d_b$ $6d_b$
	All other bars	6–20 24–40	$5d_b$ $6d_b$	$5d_b$ $6d_b$

Note that the above table only gives part of the requirements for hooks and bends. For full details of standard hooks, bends, stirrups or ties, for mesh bend diameter requirements and for galvanised bar bend requirements, refer to Clause 3.3 of NZS 3109.

Rebending should only be carried out when unavoidable and identified at the design stage. NZS 3109 and NZS 3101 require that rebending is done in the specified manner and to the manufacturer's requirements. For guidance, refer to the Department of Building and Housing wall chart on reinforcing steel requirements.

Don't

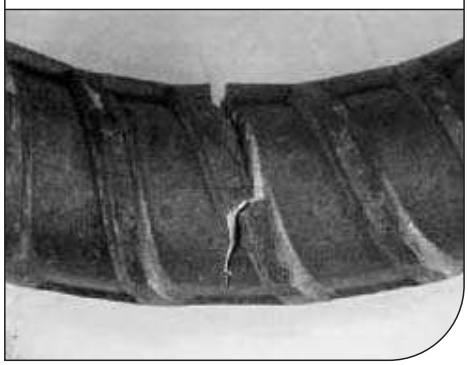
- x **Don't** bend steel on site unless absolutely necessary and then only with equipment fit for the purpose.
- x **Don't** rebend steel on site without using a purpose-built tool and proper preparation and preheating.

Do

- ✓ **Do** obtain a copy of the hooks and bends requirements in NZS 3109.
- ✓ **Do** bend any reinforcing steel using a purpose-built tool that will achieve the correct bend diameters.
- ✓ **Do** obtain bend-o-meter discs from the Department to help quickly ensure that reinforcement is bent to the correct diameters.
- ✓ **Do** report any failures of reinforcing steel to the manufacturer and the Department. Keep a sample of the failed bar.

Figure 1 A 12 mm bar bent to correct diameter of 60 mm.
Source: CCANZ IB79

Figure 2 Cracks in Grade 500 reinforcement caused by incorrect bending and rebending



Practice Advisory 1 cont.

Background

There have been formal and informal reports of bars breaking when handled on site. In many cases this was shown to be due to incorrect bending and handling of the bars.

The Department responded by investigating the concerns and issues behind the reports. Many of the reported failures could be linked to incorrect bending and rebending practices on site. These practices are more critical with Grade 500 steel as there is less tolerance for bending this reinforcement to tight diameters.

Further information: AS/NZS 4671, NZS 3101, NZS 3109, Department wallchart, CCANZ Bulletin IB 79

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Practice Advisory 7

Use with care
Grade 500E reinforcing steel in New Zealand

Recommended practice

Source of supply, method of manufacture and identification

Several steels marketed in New Zealand as Grade 500E are manufactured by the QT (quench and temper) process. This results in a bar with a hardened outer skin. As indicated below, QT steel is vulnerable to some fabrication processes. The identification markings on imported steels do not clearly identify the strength, grade or manufacturing process. This lack of information creates potential site difficulties.

Most Grade 500E reinforcing sold in New Zealand is locally manufactured by the microalloy process, conforms to AS/NZS 4671 and has clear identification markings.

Designers, building consent authorities and contractors are advised to satisfy themselves that any steel supplied as Grade 500E meets the requirements of AS/NZS 4671.

Bending Grade 500E reinforcing

A Department of Building and Housing investigation has established that many 'field failures' of Grade 500E reported were the result of bars being bent to smaller diameters than the minimums specified in NZS 3101 and NZS 3109. Grade 500E has less ductility than Grade 300E and therefore less tolerance of the permanent strains associated with tighter diameter bends.

It is imperative that all reinforcing bars are bent to diameters that conform to the requirements of NZS 3101 and NZS 3109. To emphasise the importance of this, Practice Advisory 1 'Bend the bar but not the rules' was issued by the Department in December 2004 and revised in June 2005.

Another useful guide was published by CCANZ in October 2004 as IB 79 'Recommended Industry Practice on Bending and Re-bending of Reinforcing Bars'.

Don't

- x **Don't** bend Grade 500E bars to diameters less than those permitted by NZS 3101 and NZS 3109.
- x **Don't** re-bend Grade 500E microalloy bars of 16 mm or less, unless the strict conditions of NZS 3109 can be met.
- x **Don't** re-bend Grade 500E microalloy bars more than 16 mm diameter.
- x **Don't** re-bend Grade 500E QT bars.
- x **Don't** weld or thread Grade 500E QT bars.
- x **Don't** weld Grade 500E microalloy bars if it can be avoided.

Do

- ✓ **Do** identify at the design stage how reinforcing steel will be used on site, so its appropriate manufacturing process can be specified.
- ✓ **Do** adopt design and detailing practices that avoid the need for re-bending reinforcing steel.

Practice Advisory 7 cont.

Re-bending Grade 500E

Re-bending is the action of reversing the bend in a bar. Normally it involves straightening an already-bent bar. The need for re-bending usually arises to allow other site activities to proceed, or the transport of precast units.

Amendment 2 of NZS 3109 permits re-bending of microalloy Grade 500E bars under conditions of controlled heating and cooling. These conditions are very difficult to reproduce on site, so re-bending of this steel is discouraged.

Re-bending of QT Grade 500E bars is not permitted by NZS 3109.

Welding Grade 500E

Welding QT Grade 500E steel reduces the strength of the hardened outer skin, so this steel must not be welded.

There are some reservations about all forms of welding of microalloy Grade 500E. Successful welding of microalloy Grade 500E depends on a highly competent welder following carefully controlled procedures that are very difficult to produce on site. The electrodes available for butt welding cannot be relied upon to provide sufficient overstrength. Lap welds are eccentric and dependent on workmanship so are considered unreliable. There is also evidence that tack welding can lead to premature failure of Grade 500E bars. It is therefore recommended that all forms of welding of this type of steel be avoided.

Background

Introduction of Grade 500E

The joint Standard AS/NZS 4671 was published in 2001 and introduced Grade 500E to replace Grade 430E.

Failures reported of Grade 500E

Failures of Grade 500E reinforcing were reported in University of Auckland tests in 2003.

Other 'field failures' were subsequently reported to the Department both formally and informally.

Investigation of Grade 500E by Department of Building and Housing

In response to the reports of these failures, the Department commissioned an investigation which culminated in the 'Report on Grade 500E Steel Reinforcement'. Hard copies are available on request. The Report concludes that Grade 500E is a viable material, but it is essential to be aware of and address the issues of concern: source of supply, method of manufacture, bending, re-bending and welding. Grade 500E is a high-strength ductile steel. The ductility, which is essential to its satisfactory performance in earthquakes, must not be compromised by unsatisfactory construction procedures.

References

1 Department of Building and Housing. July 2005. Report on Grade 500E Steel Reinforcement.

2 Building Industry Authority. July 2003. BIA Update No. 9, Grade 500E reinforcing steel: advisory note.

3 Department of Building and Housing. June 2005. Practice Advisory 1, Bend the bar but not the rules.

4 Cement and Concrete Association of New Zealand. October 2004. Information Bulletin IB79, Recommended Industry Practice on Bending and Re-Bending of Reinforcing Bars.

5 Standards New Zealand. AS/NZS 4671 Steel Reinforcing Materials.

6 Standards New Zealand. AS/NZS 1554.3 Welding of Reinforcing Steel.

7 Standards New Zealand. NZS 3101 Concrete Structures Standard.

8 Standards New Zealand. NZS 3109 Concrete Construction.

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Practice Advisory 3

Beware of limitations
Cold-worked wire mesh

Issues of concern

In some situations where ductility in an earthquake may be required, cold-worked wire mesh may seriously affect the performance and integrity of the structure.

As the commonly specified standard mesh has a very limited ductility, it may not be able to withstand the strains imposed as a result of the design actions (displacements, forces). This can cause the mesh to fracture and reduce the capacity of the structural element and the overall performance of the structure.

Designers must ensure they specify seismic-grade steel reinforcing bars in areas requiring ductile performance of the steel. Construction contractors must ensure the design requirements are correctly implemented on site and that care is taken when using mesh on site.

Background

Concerns have been expressed about the use of low ductility mesh in floor diaphragms that are expected to undergo large displacements requiring a high level of ductile performance from the steel.

Amendment 3 (March 2004) to the Concrete Structures Standard, NZS 3101: 1995, Clause 7.3.1.2, requires welded wire fabric to have a uniform elongation of at least 10% unless the yielding of the reinforcement will not occur at the ultimate limit state or the consequences of yielding or rupture will not affect the structural integrity of the structure.

Further information: AS/NZS 4671 Steel Reinforcing Materials, NZS 3101 Concrete Structures, NZS 3109 Concrete Construction.

Don't

- x **Don't** use cold-worked (ie, standard) wire mesh in seismic diaphragms or as primary flexural reinforcement in slabs where there is the potential for yielding of the reinforcement.
- x **Don't** use standard cold-worked mesh if high ductility mesh is specified.
- x **Don't** use Grade E (Earthquake) machine-welded wire mesh unless it has been shown that the mesh in its welded condition is suitable for use in ductile demand situations (in particular the elongation requirements).

Do

- ✓ **Do** use Grade E (Earthquake) 6, 10 or 12 mm diameter bars instead of mesh in areas of high ductility demand in floor slabs.
- ✓ **Do** obtain a copy of NZS 3109 Concrete Construction and AS/NZS 4671 Steel Reinforcing Materials.
- ✓ **Do** obtain a copy of Amendment 3 to NZS 3101 Concrete Structures.

Figure 1 Separation of floor slab putting high strains on topping reinforcement.
Source: University of Canterbury Civil Engineering Department, J Matthews