

- GUIDANCE NOTE - THE DESIGN FOR SPLICING AND LIFTING OF PRE-FABRICATED AND SITE FABRICATED REINFORCEMENT CAGES FOR PILING AND WALLING WORKS

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Introduction:

This guidance note was originally prepared by members of the Federation of Piling Specialists (FPS) and the British Association of Reinforcement (BAR). It outlines current best practice in relation to the design and lifting of pre-fabricated reinforcement cages and site fabricated reinforcement cages for piling and walling works.

This latest revision also gives guidance on splicing the cage together and guidance on relatively light cages.

Definitions:

The following definitions shall apply:

- *Contractor* - Piling Contractor.
- *Supplier* - Reinforcement Supplier.
- *Designer* - competent person appointed to specify the *Cage Design Information*.

This person may be an employee of the *Contractor*, the *Supplier* or a third party.

- *Cage Design Information* – information required by the *Supplier* to construct the reinforcement cage in such a way that the *Contractor* can lift it safely.

Cage Design Information:

The *Contractor* shall provide the following information to the *Designer*:

- Grade of reinforcement to be used.
- Main bar design – quantity, diameter, spacing and length.
- Shear link or helical design – type, diameter and spacing.
- Details of how cages are to be coupled or spliced, if applicable.
- Lifting capabilities available on site.
- Details of pre-slinging requirements, including details of sling type (i.e. single or multi-use), length and safe working load.

The *Designer* shall provide the following information:

- Individual cage weights.
- Specification of lifting points including details of type (bands, bar or helical), steel grade, size and connections details (tying wire or welding).
- Position of lifting points for horizontal lifts, vertical lifts, lifting from horizontal to the vertical and for moving cages (note: these may be the same).
- Method of identifying lifting point. For example, coloured spray or tags.
- Details of how cage is to be lifted (i.e. single cage or multi-cage lifts).
- Details of pre-slinging requirements, including details of sling type (i.e. single or multi-use), length and safe working load.
- Details of the cage splicing coupling (minimum req.)

The designer shall consider the bending moments and shear forces induced as the cage is moved from the horizontal to the vertical, the dynamic loading effects and where applicable, the loads and deflections induced by the cage trapping either onto the casing or guide-wall.

The *Designer* must hold adequate Professional Indemnity Insurance and maintain this for a suitable period after the design is carried out.

It is recommended that the *Cage Design Information* be summarised on a drawing prepared by the *Designer*.

In many instances where the cage is a single length and relatively light (1 to 2 tonnes), the cage lifting bands have a high factor of safety. In these instances it is possible to group various cages together and justify their design as a group.

Purchase Orders:

The information required on a purchase order between the *Contractor* and the *Supplier* will vary depending on which organisation is acting as the *Designer*.

Four different scenarios are possible:

- A. The *Contractor* acts as the *Designer*.
- B. The *Supplier* acts as the *Designer*.
- C. A third party acts as the *Designer* on behalf of the *Supplier* or the *Contractor*.
- D. The Engineer acts as the *Designer*.

A. The Contractor acts as the Designer:

- 1. Confirmation that the *Contractor* shall act as the *Designer* and that they hold adequate Professional Indemnity Insurance to do so.
- 2. The *Cage Design Information*, normally on a drawing.
- 3. Requirements for an enhanced inspection regime if applicable.

B. The Supplier acts as the Designer:

- 1. Confirmation that the *Supplier* shall act as the *Designer* and that they hold adequate Professional Indemnity Insurance to do so.
- 2. Sufficient information to be able to prepare the *Cage Design Information*.
- 3. Requirements for an enhanced inspection regime if applicable.

C. A third party acts as the Designer:

- 1. Identification of who shall act as the *Designer* and confirmation of the contractual relationship (i.e. appointed by the *Contractor* or by the *Supplier*).
- 2. Confirmation that the *Designer* holds adequate Professional Indemnity Insurance to prepare the *Cage Design Information*.
- 3. a) Where the *Contractor* appoints the *Designer* - the *Cage Design Information*.
- b) Where the *Supplier* appoints the *Designer* - sufficient information to be able to prepare the *Cage Design Information*.
- 4. Requirements for an enhanced inspection regime if applicable.

D. The Engineer acts as the Designer:

In this case the *Contractor* should organise a suitable review of the proposals as a duty of care to their own staff and their suppliers.

The purchase order will also clearly detail the *Cage Design Information* as outlined above

Where loose reinforcement bar is delivered for site fabrication works the purchase order shall clearly detail, as a minimum, the following specific requirements; maximum bundle weights, maximum weight of pre-bagged cut & bent reinforcement bar and prebagged accessories, pre-slinging requirements.

Delivery & Lifting on Site:

All persons planning and supervising lifting operations shall be competent to do so and shall hold suitable qualifications to demonstrate their competency.

A lift plan should be prepared and this should incorporate the relevant *Cage Design Information and specific purchase order requirements*

Cage weights must be clearly identified on the cage label, the delivery ticket or on both. It must be possible for the *Contractor* to identify the cage weight without climbing onto the delivery vehicle.

Loose reinforcement bar weights must be clearly identified on the delivery items, the delivery ticket or on both. It must be possible for the *Contractor* to identify the weights without climbing onto the delivery vehicle.

Delivery:

The *Supplier* is responsible for planning and supervising all lifting operations onto the delivery vehicle.

When requested, the *Supplier* shall pre-sling the cage to allow the *Contractor* to unload the cage without climbing onto the delivery vehicle. All slings used shall be in accordance with the latest standard EN 1492-1 or EN 1492-2 and their safe working load should be clearly identified.

Confinement frames are only to be used to confine the cages during transport. They are not to be used to lift the cages from the delivery vehicle. The *Supplier* must ensure confinement cages are clearly marked with "DO NOT LIFT", or equivalent.

Stillages may be used to confine the cages during transport and to lift the cages from the delivery vehicle in accordance with the LOLER regulations.

Where cages are delivered on a hiab vehicle, the vehicle owner shall be responsible for providing information about the crane capacity and lifting radius to the *Contractor*

Delivery of loose reinforcement bar for site fabrication works will also be supplied in accordance with the above requirements and as detailed by the conditions of the purchase order; clearly identified and securely loaded

Lifting on Site:

The *Contractor* is responsible for planning and supervising all lifting operations on site. This includes unloading from the delivery vehicle, moving cages between site fabrication areas and stock areas, lifting from horizontal to vertical and placing cages in-situ. Lifting by hand is not encouraged!

Cage Quality:

It is the responsibility of the *Supplier* to implement adequate quality assurance / quality control procedures to ensure the cages are constructed in accordance with the *Cage Design Information* provided by the *Designer*.

The *Contractor* may request copies of the inspection regime for their records and may specify an enhanced inspection regime on the purchase order.

Upon delivery the *Contractor* must inspect the cages in accordance with their quality assurance / quality control procedures and inform the *Supplier* immediately if any cages do not satisfy the requirements of the *Cage Design Information*. The *Contractor* must ensure those undertaking any inspections are competent to do so.

Cage Splicing

Where pile or diaphragm wall cages need to be joined together on site they are typically connected vertically over the pile/wall bore as the cage is lowered in. It is important that the cage joining system is designed for the permanent and temporary conditions. There are a number of proprietary cage splicing systems available on the market. These are designed to make the cage joining process as safe and quick as possible.

The key safety issue is to avoid placing hands into the cage. This avoids any potential accidents if the cage moves during the splicing operation (either by the cage trapped over the pile bore moving or the cage supported by the crane). Preferred systems should be an integral part of the cages or, if separate, connect from outside the cage only without the need to insert fasteners or tools inside the cage.

Splices need to provide adequate laps to the bars for the permanent design case. They also need to be able to support the weight of the cage below the splice. The *Contractor* must specify how the cage will be constructed. The design must confirm the Temporary and permanent design of the splice connection. Particular care should be taken when constructing piles with a low level cut-off and a sacrificial cage and main cage needs to be able to support the weight of the cage below.

Manufacturer's guidance for cage splicing needs to be followed carefully. Particularly with respect to how any separate fixings are installed and tightened, the minimum number for the load and the minimum number for spacing.

Disclaimer

Although every effort has been made to check the accuracy of the information and validity of the guidance given in this document, neither the FPS nor its members accept any responsibility for omissions, mis-statements contained herein or misunderstanding arising herefrom.

Appendix

Safety and technical issues related to the use of Bulldogs

1. Bulldogs are not certified for any load capacity. The torque for tightening is unspecified. Torque wrenches are unlikely to be used.
2. Bulldogs rely on friction. Available friction depends on the orientation of the bar, i.e. whether the ribs are being mobilised or not.
3. Bulldogs come in different sizes and are provided by different suppliers.
4. Bulldogs are to be avoided where possible as the primary system for connecting cages together; instead, use couplers or proprietary systems instead.
5. It is encouraged not to use bulldogs whenever possible as they require hands to go inside the cage.
6. Bulldogs are acceptable, if necessary, as a secondary system for connecting the cages together.
7. If the piling contractor wants to rely on bulldogs then they should implement a testing and certification regime.
8. The cast iron saddles of bulldogs are designed to work with soft wire rope. When used on rigid rebar, the saddles, being brittle, can rupture during the cage lift.