TECHNICAL ADVICE NOTE

HANDLING OF BRIDGE BEAMS ON SITE

PCA

PRESTRESSED CONCRETE ASSOCIATION

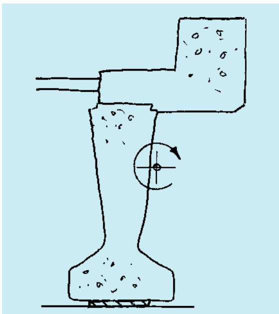
Additional advice may be obtained direct from PCA member companies, who will assist at the earliest stages of planning, or from the Prestressed Concrete Association.

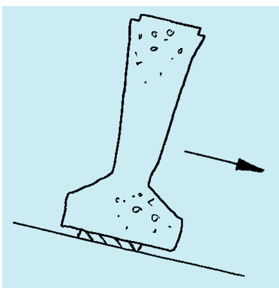
This note is written for the guidance of planning supervisors, design engineers and principal contractors on sites where precast concrete bridge beams are used. In many cases these beams are manufactured to the design of others and delivered by PCA manufacturing members. This note provides information which the designer and contractor may find useful in preparing risk assessments and safe working method statements when discharging their obligations under the CDM regulations. This information may not always be sufficient and in special cases, further advice may be sought from the Technical Department of the manufacturer.

Contents

• Stability of Beams

There are two forms of stability of beams:
- Global Stability
- Elastic Local Stability





Global Stability:- This is the most important consideration with bridge beams. If a beam is globally unstable it will rotate or slide. This may cause the beam to fall off its bearings, dislodge other beams and, if it rotates through 90°, it may then fail in bending in the span. All beams must be globally stable at all times.

Elastic Local Stability:- A slender beam, like a slender column, may become unstable and buckle because of deformation of the beam itself. Lateral, flexural and torsional buckling are all possible. This form of behaviour is unknown in concrete bridge beams but is common in steel beams. The most slender SY beams can approach a buckling condition and the means used to ensure a sufficient safety factor against buckling are described in this note.

• Preplanning

It is, in most cases, the responsibility of the manufacturer to deliver bridge beams to site. The handling of units on site, preparation of suitable access roads, cranage and further site operations will require planning by the contractor. The manufacturer will always advise in this planning phase if requested.

• Transportation

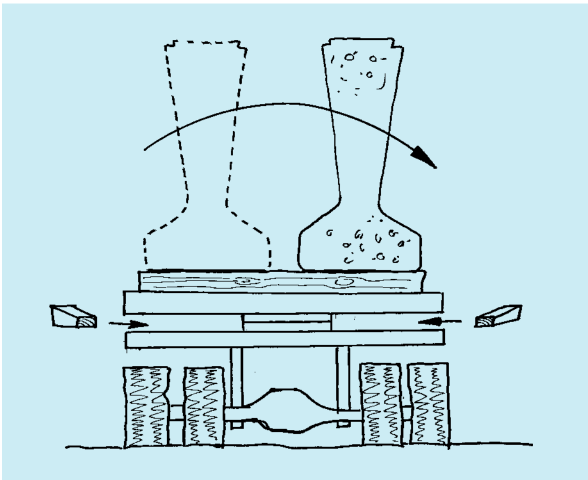
Beams are delivered to site on vehicles with the load supported and restrained appropriately. On site, the access road to the point of unloading must be appropriate for road vehicles. Roadways with crossfalls or corners with severe changes of level should be avoided as these may impose torsional stresses on the beams. The unloading area should be on level ground and appropriate space for turning should be available.

• Lifting

Lifting operations must be reviewed by a competent person. Cranes should be positioned such that the erection of the beams can take place safely, within the safe working load and radius of the crane. Beam weights for lifting are identified on drawings. The minimum sling angle will also be defined on the drawings. Bridge beam lifts are often critical with respect to road or rail closures, it is recommended therefore that the crane has some additional capacity. For Y, T, TY, M and U beams allow an additional 5% of weight, for box beams allow 10-15%. If necessary, beams can be weighed. Bridge beams will normally have lifting loops so that the crane supplier will require a cleat. The minimum shackle pin diameter will be specified. Standard PCA sign gantry beams and columns have different inserts. In this case liaison with the supplier is essential to ensure that correct lifter is used on site.

The site ground conditions should be investigated including ground adjacent to the access and working area. Outrigger loading should be established from the crane supplier. Crane stabilisers should be supported on ground with adequate bearing capacity. Hazards such as unconsolidated backfill, edges of embankments, river banks, trenches, manholes and underground services must be avoided.

If a beam has additional insitu concrete cast onto it before lifting, the weight including all the lifting gear must be checked. Additional lifting points may also be required to ensure that the beam hangs vertically.

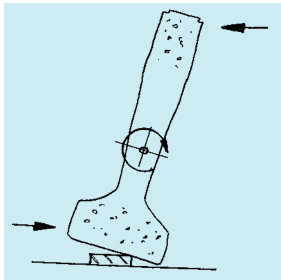


In some cases, beams are delivered side by side by tractor and rear bogie rig. It is important to chock the turntables of the loads before the first beam is lifted as otherwise the second beam would apply an eccentric load to the bogie and cause it to rotate.

Bridge beams should ideally be placed at their final location as soon as the are delivered but on occasions it may be required to store a number of beams until a closure allows them all to be placed at the same time. Storage areas should be cordoned off and beams should be supported on stout timber bearers on appropriate foundation strips. Tall beams should be stabilised with props and all beams should be supported only under the lifting points.

• Temporary Support

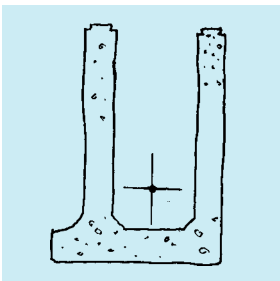
Beams are usually placed on bearings in their final location. Bearings may be simple rubber strips or fabrications allowing rocking, sliding, etc. In some cases, beams are supported at the bearing points by temporary packers until the final bearings are placed. Packers must be sufficiently large to provide a safe bearing even in the temporary situation. Support on the edge of a beam only could cause spalling, rotation and instability. Bearings are often narrower than the beams at the soffit and this can give a false sense of security.



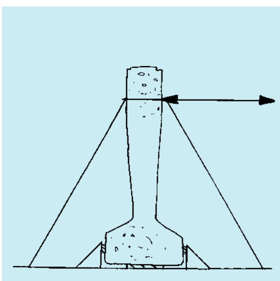
Any beam where the depth is greater than twice the support width should be propped.

The props should be left in place until the beams are connected together by the insitu diaphragm or deck concrete. Any temporary works/props must be designed by competent persons.

When beams are jacked up to fit bearings, the props may be loosened but should never be removed. Props at one end only are insufficient. If beams are lifted by hydraulic jacks, each jack should have its own pump unit and the jacked clearance should be filled with temporary packers as the jacking process takes place. Never connect two jacks to a single pump unit as there may be no control of fluid running from one jack to another thus causing displacement and overturning. Propping to prevent overturning must be at two points, usually towards the top of the beam and at the bottom. One prop is insufficient as the other edge of the beam must also be prevented from sliding. The manufacturer's literature gives the height of the centre of gravity of each beam section from its base and, in the case of unsymmetrical sections, the lateral position of the centre of gravity is given also.

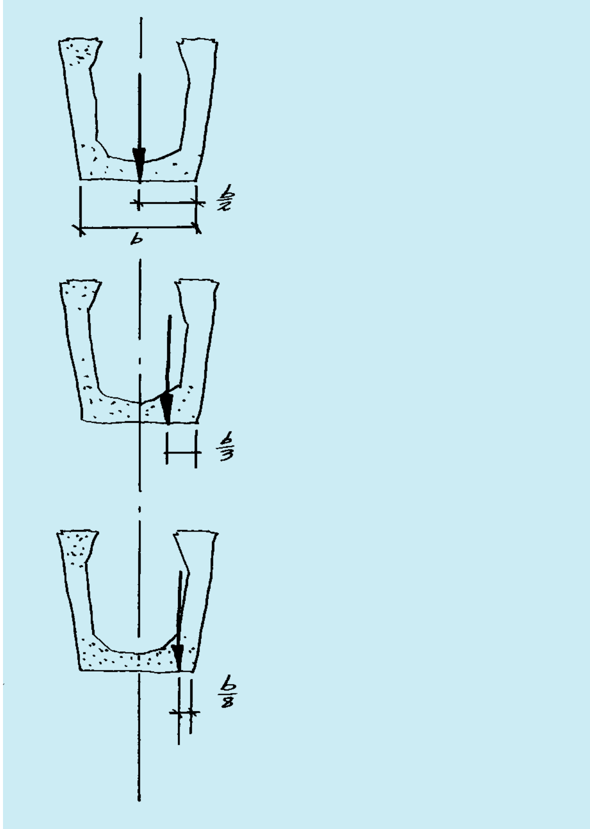


Bridge beams of more than 1.5m depth should be linked together as soon as they are erected so they can share any lateral load from wind or other causes. It is not necessary to fully prop all the beams in a deck, providing some beams are properly propped, the remaining beams may be connected to them at the top and soffit with connectors which can carry tension and compression. Beams on a crossfall should always be restrained from sliding at the base. The manufacturer will provide holes or sockets for the fixing of support ties and props if requested and if agreed by the engineer.



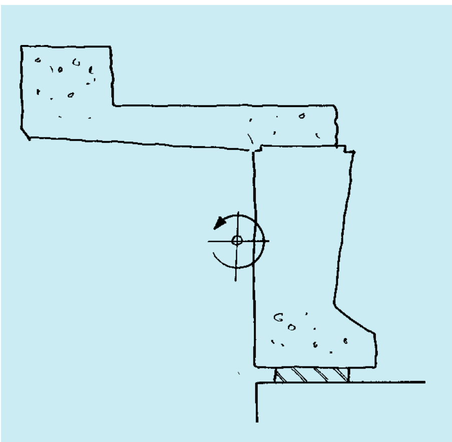
• Bearing Stresses

Bridge beams are usually are made of concrete stronger than their supporting structure so that the supports are usually critical in calculating bearing stresses. Eccentric support of beams does however increase bearing stresses considerably. Uniform support on the whole width gives uniform bearing. Support within the middle third gives higher stresses, up to twice the uniform value when the support is at the edge of the middle third. Support outside the middle third can give very high stresses and may cause local failure or spalling. The designer should be involved in checking supports and bearers. Particular care must be taken with skew beams as in these cases, bearing areas can be very close to the edge of abutments.



• Slender Beams

Slender beams can buckle, this failure mode is common in steel beams but almost unknown in concrete beams. The SY beam is, at its longest spans, at a range where the factor of safety against buckling is in the order of 1.5 to 2.0. In transportation there are dynamic effects and the manufacturers have designed a transportation frame which stiffens the top of the SY beam web (it has no top flange). This considerably improves the buckling safety. **In all jobs with SY beams, the designer and contractor should involve the manufacturer** who will provide drawings and method statements for the offloading of the beams and the sequencing of the dismantling of the stiffening frame. There are special requirements for moving SY beams on trailers on site of which the manufacturer will be able to advise.



•Edge Beams

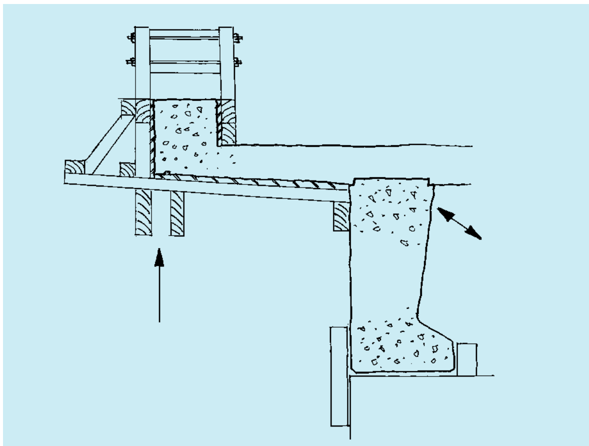
Edge beams, and in particular the YE and UM beams, are not symmetrical about their vertical centre lines. The eccentricity is given in the PCA and manufacturer's brochures. In some cases, edge beams have additional concrete cast onto them for the footpath and parapet, either at the factory or on the ground on site. Particular care should be taken in the support and restraint of these beams as the centre of gravity then moves outside the line of the soffit. Vertical support of the outstanding edge and horizontal restraint of the bottom flange are both required. In some cases the additional concrete does not continue to the ends of the beam. In these cases, restraint only at the end of the beam will induce torsional load. Projecting bars should be kept as short as possible.

• Parapet Units

Parapet units may be cast separately and connected to edge beams with insitu concrete. In this case, as with integral edge parapet beams, overall stability must be ensured at all construction stages.

• Shuttering

The placing of shuttering on decks, particularly at edges, applies an eccentric load. These loads and the loads of the wet concrete can cause beams to rotate if they are not restrained properly. The manufacturer will provide fixing sockets for shuttering if requested.



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• Removal

The CDM regulations require that removal and demolition is considered in the design process. Pretensioned precast concrete bridge beams do not present any special hazards in demolition compared with post tensioned and unbonded prestressed construction. Bridge beams may be cut free of each other by normal concrete cutting procedures with all of the pieces to be separated being supported and restrained as described in this note. Lifting will require lifting points to be fixed to the beams, preferably with through bolted fabrications.

On lifting free, the beams may be lowered onto soft ground and turned onto their sides at which point they may be broken up by conventional concrete breakers.

Bridge beams are made of high quality concrete which may be recycled when crushed. Bridge beams are very durable and re-use as a beam may also be possible.

• Useful References

In addition to the CDM regulations and other general material, the following references may be useful with respect to the handling of bridge beams.

Codes of Practice for the Safe Erection of Precast Concrete. British Precast Concrete Federation, 60 Charles Street, Leicester LE1 1FB.
Provides useful advice on the organisation of the erection of precast concrete components, particularly with respect to management, responsibilities, CDM, method statements, etc.

Stability Design of Long Precast Concrete Beams. Stratford, Burgoyne and Taylor: Proceedings, Institution of Civil Engineers, Structures and Buildings May 1999. Pages 159-168. Provides theory and practical advice for the designer. The cases of transportation, beams hanging from the crane and beams in their final supported position are considered. The theory is derived and a simplified design approach is given in accompanying papers.

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