

Concrete Step Barrier Design Guidance

Concrete Mix and Supply

DRAWINGS CSB/002

Guidance Notes

The Britpave specification for concrete for CSB and the associated foundations is given on drawing CSB/002.

The principal requirements for concrete supply to a slipformed barrier operation are that sufficient quantities of consistent material must be delivered at a constant rate. Failing to meet these criteria will have a seriously detrimental effect on the finished product.

The relationship between slipform contractor and concrete supplier is critical in achieving a quality product at best cost and within programme.

Type of Aggregate & Mix Design

The choice of aggregate, proportions, shape and grading are critically important and should be monitored throughout the period of concrete supply and batch weights adjusted accordingly. (Figures 1 & 2). Due to the mechanics of the slipform process, concrete should be designed rheologically. Mix designs need to have tightly controlled yield points, i.e. the point at which the concrete starts to flow, and this is dependent on the force per unit area, which in this case is the vibration being applied by the machine. The stress required to attain the yield point is known as the yield stress and must be high enough not to allow the concrete to “deform or collapse” under the influence of gravity and the residual forces applied on exiting the mould.



Quality control of concrete



Finished surface

The mix should have high cohesion to ensure that it holds together. This is a function of the plastic viscosity, which is controlled by the raw material selection, water content and plasticiser dose. Aggregate interlock and internal angle of friction are important in vertical applications and the coarse aggregate should be at least partially crushed.

The quantity and grading of the fine aggregate should be selected to ensure there are sufficient fines to enable effective slip-form and closure of the face, without reducing the internal angle of friction. Too much fine aggregate tends to lead to a sticky mix prone to collapse, rather than a cohesive and elastic mix. Upon removal of the vibration the concrete needs to return to the elastic part of the viscosity profile, because there needs to be some elastic rebound from the concrete as it leaves the mould edge. This closes and polishes the face of the concrete surface. Mix designs should be designed to target combined grading envelopes with consideration to the material particle shape.

Cement replacements are suitable for slip form applications but the particle shape must be taken into consideration. With slag replacement the angular particle shape demands a greater number of molecules of water to provide particle liquidity. The opposite is true for fly ash. Therefore the mix using ggbs tends to have a reduced fine sand quantity (and hence reduced water demand component from the sand) to compensate for the higher water demand from the ggbs. High replacement levels of ggbs are not recommended because it reduces the concrete thixotropy.

To maximise mix robustness, plasticisers are often used to control the yield point. This makes the design less water sensitive and allows satisfactory paving with concrete which may appear to be too dry.

Polypropylene Fibres

Polypropylene fibres 6-7denier 12mm long reduce plastic shrinkage and improve spall resistance under both mechanical and fire conditions. Addition of fibres permits paving over a wider consistence or water tolerance range. Testing for surface mounted CSB to BS EN 1371 was undertaken using a fibre mix.

Mixer systems and Batching Sequences

With traditional static batching plants the type of equipment and procedures are critical to ensuring a reliable consistent supply of concrete. Concrete can be batched wet or dry, but ideally concrete should be batched in a wet batch mixer facility conforming to DIN459-2. The use of forced action mixers which meet this standard ensure that the concrete is fully homogeneous and allow large truck mixers to be used to transport the concrete to site.

If dry batch facilities are used, then the batching sequence should be designed for the consistence required for slipform concrete. Often this means batching in two or more batches. However, it is important to ensure that the correct amount of water is added at each stage to avoid wet or dry areas occurring through the load.

As moisture control and water addition are so critical to the consistence of slipform concrete, the batching facility should use moisture probes and batch dynamically (using the moistures of the materials as they pass the probes and continually recalculating the required wet weight).

The most reliable batching for consistence control utilises fully computerised batching as this permits multiple function addition sequences. Dry batch plants with specific slipform batch instructions can make excellent slipform concrete, with the water added in numerous increments to ensure consistence through the load. Admixture addition location and dose need to be carefully considered with regard to the batching method.

Dedicated plant

To minimise haul distances, the plant will ideally be located within the middle third of the length of the contract. Alternatively, for long lengths of road, it may be appropriate for the batching plant to be relocated during the course of the works to restrict haul distances to reasonable levels (Figure 3).

Mobile batching plants

There are a number of lorry-mounted batching systems now available. Such a plant typically has a capacity of up to 8 cubic metres and is capable of producing air-entrained concrete to high standards of quality and consistency. However, the plant needs to be constantly refilled and will benefit from strategically located depots that minimise haul distance.

The consistence of the concrete can be adjusted very quickly, eliminating waiting time that occurs whilst concrete is thoroughly mixed in truck mixers.

The use of mobile mixing plants has not been tested to any great extent in the slipforming/extrusion industry, but the flexibility and low set-up cost offered by this option makes it worthy of consideration.

Delivery Wagons

Concrete to slipform barrier or drainage operation is supplied in 6, 8 or 10m³ agitator or mixer wagons (Figure 4).

As slipform concrete is supplied at a relatively low consistence, the condition of the delivery wagon barrel and discharge chutes is important with only well maintained and clean equipment able to successfully mix and discharge the concrete quickly and effectively.

Re-tempering of Concrete

Despite rigorous compliance with the best planned quality procedures the extreme demands of the slipform process dictate that some re-tempering of the concrete is to be expected.

The Britpave specification allows for controlled water addition to concrete prior and during discharge and providing a compliant system is incorporated within the quality procedures concrete supplied will conform to the required specification.

Testing of Concrete

The Britpave specifications provide guidance for the frequency and manner of required concrete testing procedures. These should be incorporated into any quality plan with clear direction given where a failure occurs.



Dedicated concrete plant



Delivery wagons in operation