Concrete Step Barrier Design Guidance
CSB: Concrete Mix and Supply

DRAWINGS CSB/002

Guidance Notes

The Britpave specification for CSB concrete 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 be designed to have high cohesion. 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 replacement materials can enhance the fresh concrete mix properties. However percentage levels of replacement need careful monitoring as the early concrete properties can be affected.

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 6-7 denier 12 mm 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 the surface mounted CSB to BS EN 1317[1] was undertaken using a fibre mix.

[1] BS EN 1317-2: Road Restraint Systems. Performance classes, impact test acceptance criteria and test methods for safety barriers
[2] DIN 459-2 Mixers for concrete and mortar

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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[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 though 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.

Delivery Vehicles

Concrete to slipform barrier or drainage operations is supplied in 6, 8 or 10 m^3 agitator or mixer wagons (Figure 4).

As slipform concrete is supplied at a relatively low workability, the condition of the delivery wagon barrel mixer unit blades 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.

Figure 3

Dedicated concrete plant

Figure 4

Delivery wagons in operation

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