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The Use of Foamed Concrete for Bridge Abutments

Traditional bridge abutments involve the use of compacted aggregates, usually sand. This causes excessive sideways pressure on the bridge walls, which need to be thick in order to withstand the lateral force imposed by the weight of the sand. In addition, it is necessary to have substantial foundations to support these thick walls. The main problem with this is the cost…thick walls and large foundations are expensive and time consuming to construct.

Further problems due to settlement are caused when constructing bridges with traditional materials. There are two main areas of concern: the settlement of the aggregates due to the weight of traffic, and the sinking of the entire bridge abutment into soft ground. The first case occurs even when the bridge is not built on soft ground, and results in cracking and subsidence of the road surface. These problems are exacerbated when building on soft ground.

The cost of the work can be greatly reduced by use of foamed concrete for the abutments.
Foamed concrete is a very versatile material, which can be tailored to fit the specific requirements of any given job. By choosing a suitable mix, it is possible to design the ideal abutment to fit the local conditions.

(i) First of all, well made foamed concrete does not settle in the way that loose aggregates do. Furthermore, by using foamed concrete of a suitable density, any overall sinking can be significantly reduced. The weight of the abutment can be adjusted to prevent this from happening in areas of soft ground.

(ii) With little or no settlement or sinking, subsidence of the road is not a problem, hence very little remedial work is required after the bridge is put into use.

(iii) Secondly, the excessive lateral pressure on the side walls is eliminated, so these can be made thinner, and the foundations less massive. Huge cost savings are possible because of this.

(iv) Furthermore, the load spreading characteristics of foamed concrete mean that the material in the lower part of the abutment can be made from a weaker mix than the top layer, thus saving on the cement content of the material. This further reduces the overall cost of the abutment.

There are many **other advantages** from the use of foamed concrete for bridge abutment:

(i) Foamed concrete, unlike the traditional aggregate materials, does not require any form of compaction.

(ii) It is very easy to place, since it can be both poured and pumped via an ordinary concrete pump, into the bridge area.

(iii) Being fluid, the foamed concrete is largely self-levelling, so no additional measures need to be taken to ensure a level surface.

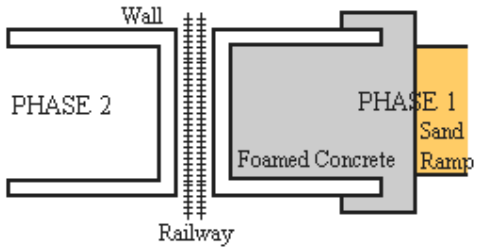
(iv) Tests have shown that foamed concrete is not significantly affected by a freeze-thaw cycle.

(v) Each successive load of foamed concrete is reproducible hence quality control is easier. This is not possible with aggregate fill materials, which can vary from load to load, due to variations in the water content or fines.

The use of foamed concrete for bridge abutment to date has not been extensive, however it has been used for several large projects both in the UK and in the USA. In the first job of this type in the UK, at Colchester, there was the additional problem of soft ground.

The bridge was seven metres high; the first six metres were designed to have a 7-day strength of 3 N/mm^2, and a dry density of about 1125 kg/m^3, and the top one metre was to have a 7-day strength of 4.5 N/mm^2, and a dry density of about 1300 kg/m^3. [This was in fact an over specification, since the engineers were originally going to use lightweight concrete using lightweight aggregates, rather than foamed concrete. They wanted a final strength of 4.5 N/mm^2, however, when they changed to foamed concrete they did not allow for the fact that foamed concrete gains its strength over a much longer period of time. Therefore a lower 7-day strength would have been sufficient.]

The foamed concrete was poured in stages, a half metre depth each day. This involved working about eight hours a day, during which time an average of about 240 m^3 material was poured.



The first phase of the bridge abutment at Colchester, UK.

The cement mortar slurry was delivered to the site by a fleet of five readymix trucks, which each made eight deliveries during the course of each day. Upon arrival at the site, foam was added to each truck, to make the foamed concrete. This was then discharged into the abutment area. (The area for each day's pour was shuttered off.)

In total, 4500 m^3 foamed concrete was placed for this job, and it was the second largest specified use of foamed concrete in the UK for a single contract. About 40 fewer piles were used than would have been needed had traditional aggregate materials been used, and the abutment wall thickness was reduced by 500 mm. The projected settlement of the structure was cut by 50%.

It was clear that the foamed concrete not only performed better as a fill material for bridge abutments, but was also more cost effective than traditional granular materials. If this success continues, then more and more bridges will be made with foamed concrete abutments.