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Stress-laminated arches: a stronger case for timber bridges

G. Freedman and A. Kermani

Proceedings of the Institution of Civil Engineers—Civil Engineering, **157**, No. 4, November, 172–178

Timber bridges have been around for a long time but are still viewed with suspicion by design engineers and the public alike. Though not as durable or strong as steel and concrete, timber is nevertheless a sustainable material in plentiful supply and can be combined with other materials to make up for its structural shortcomings. 'Stress-laminated construction', where short planks of low-grade timber are simply bolted together to make large flat slabs, is now a primary design option for secondary road applications in the US. This paper reports on pioneering UK research which has shown such bridges can be even stronger when built with arched rather than flat decks.

Concrete bridges in sustainable development

A. Martin

Proceedings of the Institution of Civil Engineers—Engineering Sustainability, **157**, No. 4, December, 219–230

Concrete bridges form significant links in most infrastructure schemes, but as a constructional material concrete faces major challenges concerning its sustainability performance. The paper seeks to identify and discuss significant themes in sustainability as they affect concrete bridges and to give a briefing on the subject to bridge owners, designers, constructors, maintainers and users. After introducing the challenge of sustainability to the concrete industry, a structured means of addressing sustainability issues is presented and the role of concrete in bridge construction is described. The four major aspects of sustainable thinking (natural resources, environment, societal issues and economics) are discussed in the context of concrete bridges. Examples of how sustainable principles have been applied to practical situations involving concrete bridges are then

presented and discussed. In conclusion, the need for further research to provide practical sustainability assessment tools is identified together with the importance of increased awareness and involvement of all through education and training.

Settlement of a bridge embankment on soft soils

U. F. A. Karim, H. van Meekeren and R. Feenstra

Proceedings of the Institution of Civil Engineers—Geotechnical Engineering, **157**, No. 1, January, 9–12

This paper presents a method of analysis of monitored settlements of a bridge embankment in Franeker, the Netherlands. Consolidation coefficients (c_v), final settlement and duration are calculated from the monitored time–settlement data using a simple linear approach. Reanalysis is made to overcome uncertainties in settlement predictions arising mainly from the presence of soft soil layers, pre-construction drainage and the soil volume affected by net drainage quantities.

Testing a composite box-girder bridge with precast decks

H. K. Ryu, C.-S. Shim and S.-P. Chang

Proceedings of the Institution of Civil Engineers—Structures and Buildings, **157**, No. 4, August, 243–250

In order to design continuous composite bridges with full-depth precast decks, several factors should be considered, and confirmed through experiments: details of connections, serviceability of cracking and inelastic behaviour. After reviewing previous experiments, an experiment was executed with a steel box-girder bridge model having two spans of 10 m each. Because there is no reinforcement at the transverse joints except prestressing tendons, a design criterion for the prevention of cracking at the joints is not to allow tension at the joints under service loadings. In this paper, a major interest is in the behaviour of a composite section in a negative moment region. Therefore the elastic and inelastic behaviour of the model was carefully observed to provide proper design bases. In particular, cracking load, crack width and moment curvature of composite sections were investigated. The validity of the stiffness of the concrete slab in the negative moment region is discussed in terms of serviceability and ultimate limit states. After cracking at the joints, the flexural behaviour of a beam was observed carefully to estimate tension stiffening effects of the tendon and moment redistribution. Test results showed that uncracked section analysis for the concrete slab in a negative moment region could

be used for serviceability, and a cracked section for ultimate limit states.

Calculating stress of external prestressing tendons

A. Ghallab and A. W. Beeby

Proceedings of the Institution of Civil Engineers—Structures and Buildings, **157**, No. 4, August, 263–278

This paper presents a simple method to calculate the increase in stress of the external prestressing tendons used to strengthen the concrete beams at any loading. First, the previous equations used to calculate stress of unbonded or external prestressing tendons are briefly reviewed, and then a new design method is proposed by considering deformation of the member. The steps of this method are simple and can be used for any loading. Experimental results obtained from several sources are compared with those calculated using the proposed method and the Harajli, Naaman et al., ACI-318 and BS 8110 code equations. The proposed equation showed good agreement and better accuracy.

Clear water scour at abutments

S. Dey and A. K. Barbhuiya

Proceedings of the Institution of Civil Engineers—Water Management, **157**, No. 2, June, 77–97

Laboratory experimental results on local scour at short abutments (abutment length: flow depth ratio ≤ 1), namely vertical-wall, 45° wing-wall and semicircular, in uniform and non-uniform sediments under a clear water scour condition are presented. The equilibrium scour depth is related to the sediment size and approaching flow depth relative to the abutment length. The equilibrium scour depth increases with decrease in abutment length and increase in sediment size and flow depth. The scour depth is independent of flow depth at higher flow depths. The effect of sediment gradation on scour depth is pronounced for non-uniform sediments, which reduces scour depth significantly due to the formation of an armour layer in the scour hole. The time variation of scour depth for uniform sediments shows a family of parallel lines for different abutment lengths and sediment sizes. For non-uniform sediments, the time variation of scour depth reduces with increase in non-uniformity of the particle size distribution of sediments. The characteristic

parameters affecting the maximum equilibrium non-dimensional scour depth (scour depth: abutment length ratio), identified based on the physical reasoning and dimensional analysis, are excess abutment Froude number, flow depth: abutment length ratio, and abutment length: sediment diameter ratio. The experimental data in clear water scour condition under limiting stability of upstream bed sediments are used to determine the equations of maximum equilibrium scour depth through regression analysis. The estimated scour depths are in agreement with the experimental data.

An experimental investigation of a horseshoe vortex induced by a bridge pier

M. Muzzammil, T. Gangadharaiah and A. K. Gupta

Proceedings of the Institution of Civil Engineers—Water Management, **157**, No. 2, June, 109–119

The horseshoe vortex induced at a bridge pier is considered to be one of the principal causes of local scour at the pier. Knowledge of the location, size, shape and rotational velocity of the vortex is of paramount importance in modelling scouring processes and designing a suitable scour protection system. An experimental investigation was carried out to study the dominant features of the horseshoe vortex during the scouring processes with the help of a specially devised vortex probe and a simple method of vortex visualisation. It has been found that the shape of the primary horseshoe vortex is dependent on the pier Reynolds number (R_{eD}). The vortex is of circular shape only at lower Reynolds numbers ($R_{eD} \leq 5000$), but it becomes more and more elliptical as R_{eD} increases. The horizontal dimension of the vortex along the mean flow direction has been found to be a function of the pier geometry whereas its vertical dimension is mainly governed by the parameters related to the upstream velocity profile such as the boundary layer thickness. The size of the vortex increases with the development of the scour hole whereas its elliptical shape remains fairly invariant during the scouring process. The mean velocity of the vortex is approximately 50% of the mean approach flow velocity on the rigid bed for $10^4 \leq R_{eD} \leq 1.4 \times 10^5$. Its variation with the development of the scour hole indicates an increasing trend in the initial stages of scouring whereas a decreasing trend has been found in the later scouring stages.