Conclusions

CONCLUSIONS

Schlußfolgerungen

Conclusions

W. HENDERSON
Great Britain

Interest in Theme II has centered round the grid decks, both open and filled, described by Mr W. J. Wilkes, the "Robinson" deck described by M. D. Sfintesco and F.J. Fauchart and the use of industrially manufactured tiles (in particular polyvinyl chloride), as a surface discussed in a paper by Mr K. H. Best and a contribution By Mr R. E. West. That is to say the theme has crystallised into two diverse subjects; one, the development of lightweight decks other than the simple steel plate of the orthotropic deck, and the other, the development of industrially pre-manufactured tiles cemented to the steel plate by adhesives.

The grid deck continues to be used in U.S.A. after forty years of application. In its open form it clearly is of considerable value on suspension bridges in providing wind-slots to combat aerodynamic instability on an area of deck which can still be used by traffic. The open form has, however, disadvantages as a running surface; these have been referred to in the preliminary report. To overcome loss of adhesion Mr Wilkes has mentioned the practice of welding steel studs or serrated bars to the top surface of the grid and the question of the extent to which these might damage the tyres of vehicles was raised. Whatever the efficacy of these devices may be, there can be little doubt that viewed solely as a riding surface for vehicles, the open grid deck is inferior to other types of construction, although these shortcomings may well be more than offset by other considerations such as the provision of wind-slots, for example. It is also feasible that the use of this expedient could be used to convert a wholly open wind-slot into a useful "pull off" area for broken-down and damaged vehicles, where its shortcomings as a running surface would not be significant and might indeed be turned to advantage.

The grid deck filled with lightweight concrete clearly provides a robust and sound road surface which can, if desired, be paved with one or other of the orthodox road materials without concern for the flexural problems associated with orthotropic steel plate. The concrete over and around the steel fabric of the grid should offer considerable protection against corrosion and as the grid with its infill can be used compositely with the supporting stringer, the adoption of this type of construction seems to depend solely on economics. Mr Wilkes has given a useful table of comparative weights of various types of deck which shows the filled grid to be about twice the weight of an orthotropic plate and about half that of a reinforced concrete deck. Comparisons of cost are not possible without consideration of the effect of varying load on the supporting structure, but it is extremely doubtful if the filled grid would be economically competitive except where it is available as a standardised factory-made product, and even then it appears likely to be costly.

The "Robinson" deck has now been used extensively in France over a period of up to 18 years and has given excellent service. The presence of a layer of $2\frac{1}{2}$" (6 cm.) to 4" (10 cm.) of concrete over the supporting steel plate and acting compositely with it provides an excellent and stiff foundation for surfacing materials. Since these bond well to concrete and the concrete is shear connected to the steel, adhesion problems appear to have been overcome. The facility with which a concrete surface can be regulated, given proper care and supervision is also of considerable advantage in providing good riding quality on the road. This type of construction appears to have considerable potential and to be well worthy of cost studies in countries other than France where it is said to have been trouble free in use. The question of the effects of cracks in tension zones on corrosion problems was raised in discussion but it was indicated by the author that he knew of no difficulties in this respect.

Twenty years is probably an insufficient period for corrosion damage to become obvious; nevertheless it seems quite possible that this is not likely to become serious even over a very much longer period. Shear connection should prevent "fretting" as a consequence of one surface moving over another, the oxygen content of any water which penetrates through cracks may become minimal and the cracks may become sealed with the first products of corrosion. This aspect is worthy of further investigation. It is perhaps relevant to note that on many old bridges where dished or buckle plates covered in concrete were used, corrosion, where it has taken place, has often done so much more slowly than might be expected. There is also evidence of quite considerable shear connection through friction alone without the aid of shear connectors.

It was also suggested that welding shear connectors to the steel plate could introduce "stress-raisers" and the risk of fatigue cracking or, alternatively, raise the cost unduly by designing at suitably reduced steel stresses. It appears that no adjustment of working stress on account of fatigue is made in France and that no damage has been observed. It seems likely that the adverse effect of steel shear connectors in this respect has been considerably exaggerated in some quarters; however, 20 years is again probably too short a period from which to draw conclusions from performance on site and some research in this field may be desirable.

The use of factory-made tiles of asphaltic material was tried some thirty years ago and gave satisfactory results over a long period on one bridge. Subsequently, it seems, the product did not come up to the same standard of quality and the use of this material seems to have been abandoned. That a factory-made product should not maintain a standard of quality is deplorable.

At the present time the only material of this sort which seems to have been used to any extent is the polyvinyl chloride tile described by Messrs Best and West. They appear to be tough, durable and to offer a considerable co-efficient of friction. They also appear to be reasonably easily stuck to the steel plate and to offer good protection against corrosion. Their use so far has been confined to structures where the traffic is heavy in terms of weight, but slow moving. It remains to be established whether these tiles would be satisfactory on bridges carrying dense, fast traffic. An important consideration in this respect (and for other thin surfaces) is the specified tolerance on irregularity of the surface which can be limited to, e.g., $\frac{1}{8}$" on a 10' chord length. This degree of flatness would be very expensive to achieve on fabricated large plates, but tiles, being of uniform thickness, will follow the contours of the plate. It seems unlikely that regulation could be achieved in the adhesive layer, but this requires investigation. Perhaps more important; is such a degree of flatness really necessary when associated with great cost? Could greater tolerance be allowed without inconvenience or danger to traffic, possibly with the qualification that the "high" spots do not occur at regular intervals likely to coincide with vehicle spring frequencies at prevailing traffic speeds?

These P.V.C. tiles must be laid with a small gap between them to allow for plastic flow under the effects of traffic. The gaps are filled with adhesive and this seems likely to introduce a region of vulnerability, both in respect of corrosion and of damage to the tiles. Is it possible that this need might be obviated by pre-treatment and that the tiles could be butted in construction?

The general impression is that there is a great potential in the application of this sort of synthetic material, but that much more research and study of the properties required and the conditions to be met is necessary. This calls for close collaboration between chemist and engineer and it is to be hoped that further efforts will be made in this field.