REPORT ON THE CONDITION OF THE TRACK CONSTRUCTED IN PRINCES STREET

Executive Overview

Following discussions with Andrew Fitchie, Partner in DLA Piper, Solicitors acting for **tie** Limited, I have consulted with Ian Baker, CSc, CChem, MRSC who is a colleague of mine and recognised expert in road pavement materials with over 40 years experience in the design, manufacture and construction of road pavements. He visited the site and provided the photographs; series DSC. Blair Anderson MICE has also inspected the site and provided the photographs: series IMG he also has similar experience to rely on as well as rail experience.

I have prepared this report with them. I also have over 40 years experience in the design, manufacture and construction of road pavements and have been involved in Underground and Mass Transit projects here and in Hong Kong. Both Ian and I have given expert technical advice and evidence for use in the Courts. Both of us have served on various technical panels such as BS and joint Government/Industry Working Parties for pavement materials. As a measure of our experience we have been involved in Scotland in manufacturing and laying many millions of tonnes of material such as those used on Princes Street to form the wearing surface.

We have de facto addressed whether Infraco have complied with their obligations under the Infraco Contract especially pursuant to Clause 7.2 -- *"exercise a reasonable level of professional skill, care and diligence to be expected of a properly qualified and competent professional contractor experienced in carrying out works and services of a similar nature to the Infraco works in connection with a project of a similar scope and complexity."* Consequently we do not believe they have followed Good Industry Practice.

Our conclusion is that the Infraco have failed to comply with this obligation. In summary we are of the opinion that there are significant faults in the works which are a hazard, are capable of creating further hazards and will severely reduce the life of the pavement. We note that some of the failings are also seen in those areas which are constructed of granite setts.

On the basis of the inspections carried out, we further conclude that poor workmanship; ill advised choice of materials; inappropriate design and lack of supervision will have all contributed to the defects we refer to.

We have no doubts that the wearing surface in Princes Street should be removed and replaced and I recommend that the work is not paid for until it is. Moreover, I also believe that the Infraco should be asked to inform **tie** of what steps they intend to take to improve their supervision to prevent this happening in the future. On the basis of the obvious sensitivity of this part of the Infraco Works it is reasonable to question the quality of other work carried out by them.

We understand that the approval of the design will be subject of a formal application to Overseeing Organisation (The City of Edinburgh Council). Moreover, the formal application must include all construction details and all design calculations together with any empirical evidence that the applicant needs to submit to support his application. On the evidence we refer to below we cannot foresee such approval being given.

Evidence referred to

The attached photographs graphically show that the overall appearance of the hot rolled asphalt ("HRA") surfacing is typical of such a material manufactured in Scotland with a 50pen bitumen.

At a considerable number of locations the HRA has cracked and broken apparently from a lack of support. Without intrusive testing we cannot say why, but we surmise that it may, at least in part, be due to poor compaction in and around the rail flange. We point out that the base-course which underlies the HRA is some 170mm thick and that the HRA has "sunk" in some places by up to 50mm - thus defying any idea that the defects may be caused by poor compaction of the base course.

There are many locations where there is a significant step down from the top of the rail and the wearing surface, causing a hazard.

The regularity and application of the joint sealant is unsatisfactory. Intrusive investigation may show that its application was attempting to cover-up defects in the wearing course.

We would also draw attention to the granite setts – again we consider the workmanship to be of an inadequate standard, but we do not criticise the design or choice of materials.

Comment on design and choice of materials.

We understand that the design is based on German Standards and therefore German material and design standards. There are fundamental differences between asphalts used in Germany and those used in Scotland and the manner in which they are laid.

As referred to above, the HRA appears to be standard 50pen HRA manufactured and laid to DMRB specifications. From the photographs it can be seen that the material may have been what is referred to as being "fatty" – that is with a bitumen content at the high end of what is permitted. There is evidence from one photograph that the material may have been laid at a material temperature lower than permitted – but we do not think that this is a cause of the defects we refer to above.

Level control of HRA is achieved by surcharging and then compacting down to the required level. This is best achieved by "machine laying". I understand that both machine and hand laying techniques were used.

We cannot comment on the efficiency of the design method used in Germany, but we would observe that asphalts in Germany are markedly different to those used in UK, as are laying techniques and material control.

We also draw attention to the importance of achieving adhesion between layers in a pavement. The best performance is obtained by layers bonding together to form a monolithic structure. In the case of Princes Street we question whether sufficient attention would have been given to this. There is good reason to require polymer bond coats between scrupulously clean surfaces. "Cold" materials (that is below optimum for compaction purposes) when laid will also add to the lack of bond between layers which will be almost only frictional bond and would not therefore prevent (rapid) degradation of the pavement under traffic and with the ingress of water through cracks and the inadequate joint against the rails. Without there being some provision to rapidly drain the "concrete trough" in which the wearing and base courses sit, any water ingress will be retained and in winter subject to the ravages of "freeze/thawing". As is evidenced on site, this pavement has only a life measured in months before maintenance is required.

Ian Baker suggests that a solution in Scotland may be to use a "textured micro-silica concrete". I have no experience of this material, but I would agree that concrete infill would give a better design solution.

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Anthony Rush
16 June 2010.