

Increased loadings of lorries on bridges

Introducers

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The theme of the meeting related to the increased loading arising largely from the changing legislation brought about by EC initiatives, and the recently announced budgeted framework by the DTp through its *Transport Supplemented Grant (TSG) procedures 1991–92* which provides for funding the programme for assessment and strengthening, in accordance with the new loading standards consequent on this legislation.

The DTp expenditure plan is for some ten years, preparing for the arrival of the 40 t lorry in Britain in 1999. Every bridge and tunnel affected by the change is to be inspected, and strengthened where necessary to meet the new standards. The DTp itself estimates that the final bill will be about £800 million. Provision in the 1991–92 TSG is £90.7 million, split up as shown in Table 1.

The Transport Act of 1968 includes load bearing standards, referred to as BE4, which sets out the requirements for assessment of highway loaded structures. The recent regulations have been developed from the DTp new standard BD21/84, which relates to 38 t vehicles. Amendment 1 dated 1988 now raises the standard to 40 t. These regulations were the basis of the assessments discussed at the meeting. These are the key regulations which are part of a series of design criteria developed over a period of years.

The owners: British Rail

J. A. U. Woods of British Rail, Anglia Region, indicated how the present assessment offices were arranged, geographically, but based on pre-existing railway regions, centred at Glasgow, York, Birmingham, Swindon, Croydon and Norwich. Apart from undertaking assessment of rail-carrying structures in-house, this

was also the network of offices for responding to road hauliers' requests for movement of abnormal loads.

Initial transparencies projected showed heavy steam railway locomotives aboard low-loader road trailers and were intended to set the scene contrasting with present-day heavier road loads passing over railway bridges. The penultimate slide showed a collapsed road bridge, admittedly ill-suited to heavier traffic of the early 1900s but nevertheless a timely warning of something that all were dedicated to avoid.

Reference was made to the National Audit Office report of 1987 on *Regulation of heavy lorries*, wherein allocation of road track costs and various other factors of lorry design, effect on the environment, enforcement of weight limits, etc., had been considered. EC harmonization appeared as the penultimate item of the report.

The railway offices referred to earlier were now setting priorities for assessment of road bridges over the railway to BD21/84.

This action plan considered three categories of structure: cast iron; wrought iron; and those with current weight restrictions for one reason or another. Priorities agreed with local authorities were being assembled, and the consequential manpower and budgeting issues were evolving from this programming work, in order to discuss approximately 16 000 spans.

The time-scale of ten years was viewed by British Rail as a very tight schedule, and the awareness that the programme had been put in place by the DTp was one which required early attention, vying with all the everyday constraints of running, as far as possible, a cost-effective railway in safety.

The concluding remarks from Mr Woods drew attention to the key issue of axle loading. This became a point arising in the discussion as a feature of the research needed to assess the true conditions resulting from the intensity of increased vehicular weights. The view was expressed that the multiple axles of the heavier vehicles could, in fact, reduce the loading. Suggestion was made that research work might be beneficial to the final requirements of these new procedures. Finally, Woods asked if, to

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Table 1. Breakdown of TSG (1991–92) provision for bridge assessment and strengthening

Location	Cost: £million
Shire counties	48.6
Metropolitan districts	27.1
London boroughs	15.0
Total	90.7

give the whole study a 'handle', he might suggest the title: *Bridgeguard 3*.

The owners: London Underground

C. L. A. Ying of London Underground Limited (LUL) introduced the owner's position relating to the conurbation and the range of problems facing the Underground. The summary of the position as set out by Mr Ying is given in Table 2.

The issue of the DTp's own trunk road and motorway structures was isolated from the general range of structures to be assessed. As far as LUL was concerned, however, these structures were being assessed within the programme, where they crossed the tracks.

The Paper discussed the bridge types, and examples were given describing certain circumstances which had to be addressed, and the difficulties of access on account of the railway operations. A limit of some 3–4 hours only was available for these assessments, and special restrictions might occur where remedial work was necessary. Such remedial work was designed to avoid service restrictions wherever possible.

In this context there was some discussion about emphasis on the traffic measures that occurred during the interim period following a diagnosis of structural weakness. Examples described were restricted road traffic movement, which was an immediate if only temporary emergency solution. Such situations occurred at Earls Court Station, and a more notable example was the Blackfriars roof modifications required on the District and Circle Lines.

Unlike British Rail, LUL had established a programme commissioning consultants to carry out various elements of the assessment programme, drawing attention to the increased manning required for these new procedures.

The question of road traffic signing and restricting was viewed with some concern, since the ability to restrict traffic had caused some difficulty in certain situations. The only measures found effective were to narrow and 'stream' traffic over affected areas. Further evidence was given of the complexity of an old structure, and the development of property and adjacent structures, often impinging on spans, causing further difficulties. Examples were also given of the repairs that had been carried out as

a result of war damage, which had created some weaknesses only now exposed through the loading assessment.

The examples given by Mr Ying were illustrative of the difficulties in introducing remedial measures. Composite constructions developed over the years, using varying materials, were clearly a considerable aggravation to the formation of suitable solutions for modification, as well as to the effective assessment of strengthened capability.

The Paper gave some indication of the assessment procedures now in place, and explanation was given as to the content of the surveys required. Opportunities were being taken to establish new records for structures of considerable age. Throughout the afternoon meeting, the cost of each assessment was referred to from time to time. This was stated as varying in a band between £4000 to £16000 per structure.

In the case of London Underground, however, the costs were also affected by the difficulty of access for inspection from the tracks of the possessions needed. Consultants were instructed to proceed to the BE4 standard, followed by the BD21/84 review. Relevant local authorities were informed by letter of the reasons of failure, together with a permissible vehicular loading. The authority was also invited to liaise with the consultant regarding the scheme for strengthening the bridge.

Discussion

This liaison between local authorities and the bridge owner was also the subject of debate. There was clearly some concern about the ultimate responsibility for cost, a matter developed by A. D. Leadbeater during the presentation of his paper. LUL reported that, of 177 assessments so far completed, 74 failures had been recorded. Of these, 15 had failed the BE4 standard.

Discussion also developed regarding the enforcement of restrictions on suspect structures, and the point was made that some improvement in the road traffic signing would be necessary in the future as the programme developed. The co-operation of the DTp to redesign some legal signing was considered necessary.

Speakers from London Boroughs and County Authorities in Wales and Scotland raised questions relating to the apportionment of cost, and procedures and agreements to be established between the local authorities and the bridge owners. Mr Leadbeater drew attention to a recent draft circular on this topic, which was an important DTp Policy Review. The general concern for the programming of the work was summarized by the Chairman, B. H. North (Travers Morgan), in concluding the first part of the discussion, highlighting the programme

Table 2. *London Underground: structures to be assessed*

Structure	Number
Highway bridges	264
Sub-surface tunnels	114 (20 km)
Covered ways	63 (11 km)
Girderings	78

deadline for completion of ten years set by the Department of Transport.

Repairs and maintenance

K. A. L. Johnson presented his paper, emphasizing the practical sides of introducing remedial measures, and describing, as an introduction, an assessment of the critical loading effects on the various types of structure, focusing particularly on the small- to medium-span bridge. The problems existed principally in the 5–30 m span range, which formed the greater majority of this country's bridge stock. Special problems of long-span structures were a separate topic and had been illustrated by the recent strengthening works carried out on the Severn and Wye bridges. Illustrations indicated the bending moment and shear force for a traffic lane of loading which were relevant in various codes, showing the significant increases for the smaller span structures.

In older stock, the overloading of lorries and varying materials that were present, introduced additional problems of assessment. Attention was drawn to the robust nature of some of the older structures—particularly masonry structures—which had an inherent strength far greater than those obtained from the application of the current assessment methods, emphasizing again the need for research at this stage to evaluate the true strengths of various configurations. Mr Johnson drew attention to the need for this knowledge base to be developed.

To conclude the presentation, there were various illustrations showing the techniques available to carry out the remedial work. It was in this area that the speaker felt the contractor could contribute greatly. The question of economic cost benefit in methodology and material replacement through testing and studies was focused on. Ingenuity in removing and strengthening was clearly beneficial. The contribution of the practical approach in this particular field was emphasized strongly and was demonstrated by a series of illustrations of techniques.

In a concluding remark, the loading assumptions relating to practical difficulties and known abuse of vehicular management were emphasized. The 'impact loading', for example, was assessed as high as 80% in some cases. The load limit abuse of some vehicles was also highlighted. Lateral bunching on structures as a result of traffic congestions should never be underestimated.

The question of the development of conditions of contract was raised for serious consideration, which would allow the involvement of the practical contribution of a contractor. The research and investigation of material strengths and structural configurations was an

area which could benefit the ultimate outcome of any refurbishment work.

The local authority

A. D. Leadbeater's paper was presented through the eyes of the ultimate authority for implementation. Figures were given indicating the scale of the works to be covered in the ten year period. A breakdown of bridges to be assessed was given as 11 260, with a cost variation between £500 million and £1400 million. The paper reflected the concern repeated from the floor in the discussion periods, of the ultimate beneficiary of the work and the legality of responsibility for the upgrading. This issue dominated much of the discussion, and it concerns most of the local authority management when it addresses the assessment and strengthening programme.

To illustrate these concerns, Mr Leadbeater drew attention to the costing for the assessment programme, and the manpower required in organizing and managing this process. These were reduced to the following estimated figures

- (a) the average cost of assessment per year: £4.5 million [200 man years per year]
- (b) the average cost of traffic management in restrictions and temporary works: £7 million per year
- (c) the average cost of strengthening of bridges: £87 million per year (300 man years per year)
- (d) the staff resources required for the total programme: 500 man years per year

It was evident that this was an area of considerable concern, since the experience and ability within the profession to carry out this work on such a scale was doubted by many attending the meeting as well as by the speakers.

Mr Leadbeater's paper drew attention to the current policy of the DTp. The government was supportive through the TPP system, using TSG for the 1991–92 programme. Key features of the policy were as follows.

- (a) All expenditure by local authorities on structural maintenance of bridges was eligible for TSG.
- (b) All authorities were being given supplementary credit approval to cover that part not designed to be covered by TSG.
- (c) The allocation included expenditures incurred on other party's bridges, including those owned by such as British Rail.
- (d) Bridge expenditure on structural maintenance, including reconstruction and rechecking, amounted to just over £90 million, which compared favourably with the figures referred to earlier of £91 million per year. It is thought likely, however, that costs would rise as the programme got underway.

The speaker stated that the programme had begun and that the management of funds for the various local authorities from the DTp would be handled on a year-by-year basis. The initiative is on local authorities to implement the programme as a matter of urgency, to ensure that the funds available were spent objectively, and that the programme was maintained to meet the targets for the ten-year completion. It was vital that all local authorities set up a bridge maintenance management quickly. Furthermore, Mr Leadbeater emphasized that it was his view that management should be separated out from assessment and construction work by a proper split of internal consultants within the local authorities' engineering structure.

The local authorities' view was concluded in Mr Leadbeater's paper, describing the priorities in programming the works and assessment framework. Issue of route priority, risk factors associated with the condition of the bridge, and the variations in lorry traffic that might use particular routes were examples. A matter that was given considerable time was the responsibilities arising relating to private bridges, and the two-part costing that might arise through the strengthening programme relating to the liability of the private owner to strengthen to the 24 t level, and the cost arising for the strengthening required to achieve the 40 t level. It was felt that some agreement should be set out and established for the cost sharing to be implemented. It was envisaged that some dispute would inevitably occur, and the importance therefore of some strategy through the DTp, would be an important feature. A further very vital requirement was the continuing DTp support for local authority bridge strengthening over the whole of the ten-year period.

Discussion

Concluding the meeting, the discussion drew further comment from local authority representatives, reflecting their concern for implementing the programme. A county representative drew attention to the problems related to listed

structures, underlying the additional problems that arose through other interests. The restrictions and traffic management issues arising from the London Underground presentation, and the dangers of overloading occurring through traffic restriction measures, were discussed. A research programme being managed by the TRRL was referred to as being of practical help to those responsible, and a request was made for access to redundant structures for load testing to failure. This programme could be seen as a genuine step in exploring techniques for evaluating the inherent strength of materials and configurations in older structures.

The Chairman concluded the meeting by summarizing the main points that had arisen. He stated that it was gratifying to note that the DTp had made available sufficient funds to carry out the first year of the ten-year programme and that it was committed to the provision of funds for the remainder.

The estimate of over 500 man years required to complete the assessment programme gave cause for concern since there was an apparent shortage of engineers to carry out the task.

The possibility of disputes concerning ownership and cost-sharing with regard to authorities gave great cause for concern, and the Chairman expressed his view that since the funds for this work came from the taxpayer, it would be a pity if they were diverted into the time-consuming and expensive business of resolving disputes rather than getting on with the job. If the assessment programme is to proceed satisfactorily, the government should address this particular problem.

It would appear that the use of bridge weight restrictions was inevitable in the short term. Most of those present appeared to agree that they were largely a waste of time since they were seldom obeyed.

In order that the construction industry as a whole should be given sufficient chance to meet the heavy resourcing requirements to carry out the assessments, early programming was essential. Resources should be used from all quarters of the industry.