
**VOLUME 1 HIGHWAY STRUCTURES:
APPROVAL PROCEDURES
& GENERAL DESIGN**

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PART 1

BD 36/92

**EVALUATION OF MAINTENANCE
COSTS IN COMPARING ALTERNATIVE
DESIGNS FOR HIGHWAY STRUCTURES**

INTRODUCTION

This Standard sets out the basis of the evaluation of commuted maintenance costs in comparing alternative designs for highway structures and alterations to existing structures.

INSTRUCTIONS FOR USE

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THE HIGHWAYS AGENCY

BD 36/92



THE SCOTTISH OFFICE DEVELOPMENT DEPARTMENT



THE WELSH OFFICE
Y SWYDDFA GYMREIG



THE DEPARTMENT OF
THE ENVIRONMENT FOR NORTHERN IRELAND

Evaluation of Maintenance Costs in Comparing Alternative Designs for Highway Structures

Summary: This Standard sets out the basis of the evaluation of commuted maintenance costs in comparing alternative designs for highway structures and alterations to existing structures.

REGISTRATION OF AMENDMENTS

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PART 1

BD 36/92

**EVALUATION OF MAINTENANCE
COSTS IN COMPARING
ALTERNATIVE DESIGNS FOR
HIGHWAY STRUCTURES**

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1. INTRODUCTION

1.1 This Standard supersedes Clause 5 and Appendix 1 of Technical Memorandum (Bridges) No. BE 5/76 (DMRB 1.2) with respect to the evaluation of the maintenance costs of alternative designs.

1.2 BD 36/88 is hereby superseded.

1.3 BD 36/92 (DMRB 1.2.1) is consistent with the current version of the QUADRO Manual.

Scope

1.4 This Standard sets out the basis for the evaluation of commuted maintenance costs when comparing alternative designs of highway structures either at design or tendering stage. It also covers alterations to existing structures. Major or unusual structures, e.g. suspension, cable-stayed and moving bridges, steel deck bridges and aluminium or timber construction are not covered in detail. Guidance, background information and examples are given in Advice Note BA 28/92, (DMRB 1.2.2).

Implementation

1.5 This Standard should be used forthwith for all schemes currently being prepared provided that, in the opinion of the Overseeing Department, this would not result in significant additional expense or delay progress. Design Organisations should confirm its application to particular schemes with the Overseeing Department.

2. CONSIDERATION OF ALTERNATIVE DESIGNS

2.1 The economic evaluation of alternative designs at preliminary or tendering stage shall include an allowance for future inspection, maintenance and road user delay costs. In this evaluation the cost of inspecting and maintaining common items may be ignored. This usually applies to joints, parapets, bearings, deck slabs and substructures where these do not differ significantly between alternatives. Similarly, the cost of principal inspections may be assumed to be the same for alternative designs unless significant differences are known. Thus the comparison can often be confined to the main superstructure members. However, all significant differences must be taken into account. For example, a viaduct of simply supported spans would require more bearings and joints than a continuous structure.

2.2 Access to superstructure and substructure will be required both for regular inspections and for maintenance work. It will also be necessary to take account of costs of additional land and/or wayleaves required for access. The initial cost of various alternative types of full or partial permanent access provision, e.g. gantries and gangways, shall be compared with the cost of temporary scaffolding or mobile access plant hired as required. The evaluation shall reflect any significant difference between designs in their permanent provisions for access for inspection or maintenance. Consideration shall be given to the effect on the costs of inspection, maintenance and access of providing an enclosure to a superstructure with steel main members.

3. ASSESSMENT OF MAINTENANCE COSTS

Basis of Cost Comparison

3.1 Costs shall be compared on the basis of their present value (PV). Future costs shall be estimated without any allowance for inflation and compared on the basis of their present value when discounted at the Test Discount Rate, currently 8% to the year of construction. The costs given in this Standard are all commuted values at 1988 prices and therefore do not require discounting. The rates take account of the composite cost of cyclical repairs at the appropriate maintenance intervals. Updated figures will be issued when necessary. The appropriate costs should be selected from Tables 3/1, 3/2 or 3/3, then multiplied by the plan area of deck or surface area of paintwork. However, specific estimates, agreed as Departures from Standard in accordance with Technical Approval procedures may also be used, present values of which shall be calculated using the maintenance cycles given in Table 3/5. Traffic management costs shall be separately estimated in each case.

Concrete Bridge Decks

3.2 In the absence of specific estimates agreed as Departures from Standard the PV of the engineering costs of all future inspection and maintenance including access shall be those values given in Table 3/1.

Steel and Steel/Concrete Composite Bridge Decks

3.3 In the absence of specific estimates agreed as Departures from Standard the PV of the engineering costs of all future inspection and maintenance of the steel work (other than weather-resisting steel) or steel/concrete composite bridge decks, shall be those values given in Table 3/2.

Substructures

3.4 Where there is a choice between steel and concrete, in the absence of specific estimates agreed as Departures from Standard, the PV for all future maintenance shall be the values given in Table 3/3.

Hybrid Schemes and Night-time Painting

3.5 In making an assessment of the commuted maintenance costs of a structure, full account shall be taken of the likely maintenance strategy for the particular structure and the associated length of highway. Where the structure is one of a series in reasonably close proximity, it is likely that a single closure or restriction of the carriageway will allow all the bridges in the group to be maintained at the same time. In this case the traffic delay cost shall be shared between all the structures in the group. Similarly where the bridge is located in such a position that any future maintenance is likely to take place during periods of highway maintenance (hybrid maintenance schemes), only a portion of the traffic delay cost shall be allocated to the structure. The proportion will depend upon the circumstances and could be as low as 10% of the total delay costs in the case of a single structure situated in a relatively long length of road. In the case of a complicated interchange, it may be more reasonable to apportion a higher percentage of the total delay costs to the structure. In the case of heavily used routes account shall be taken of the possibility that some maintenance, including painting, will be carried out at night when traffic flows are low. However it is possible that even though the work is carried out at night, it may still be necessary to maintain some carriageway restriction during the daytime.

Table 3/1 - Concrete Bridge Decks

| BRIDGE DECK TYPE | Commuted Rate/m ² plan area of deck in 1988 prices |
|---|---|
| a. Post-tensioned slab bridges and post-tensioned main members | £2.8 |
| b. Reinforced concrete main members | £0.4 |
| c. Reinforced concrete slab bridges | £1.2 |
| d. Deck slabs supported by main members (in addition to a or b) | £0.8 |

Table 3/2 - Steel and Steel/Concrete Composite Bridge Decks

| ITEM | Commuted Rate/m ² in 1988 prices |
|--|---|
| a. Exterior paintwork - painted area | £2.53 |
| b. Interior (box-girder) paintwork or steelwork otherwise enclosed - painted area | £1.0 |
| c. Associated access provisions for painting at 15 year intervals where no permanent provision * is made: Where headroom does not exceed 7.5m - plan area of deck Where headroom exceeds 7.5m (in addition to a and/or b) * Enclosure of steelwork may be considered as providing permanent access | £1.84 Specific estimate |
| d. Deck slab including access for inspection and maintenance - plan area of deck | £0.8 |

Table 3/3 - Substructures

| ITEM | Commuted Rate/m ² in 1988 prices |
|--|---|
| a. Steelwork - exterior paintwork - painted area | £2.53 |
| b. Concrete within 5 m or less from carriageway - surface area | £1.2 |
| c. Concrete more than 5m from carriageway - surface area | £0.4 |

Assessment of Traffic Delay Costs

Traffic Delay

3.6 Road user costs shall be evaluated using the program QUADRO. These costs may be kept to a minimum by arranging for maintenance to be carried out at night or weekends. However, for night work the normal engineering costs (e.g. those in 3.2, 3.3 and 3.4) should be increased by 50 percent to include additional labour costs, repeated access provision for staged work, lighting, heating, protection, etc.

3.7 High traffic and economic growth assumptions shall be used throughout the QUADRO evaluation.

3.8 For concrete repairs, the user delay and traffic management costs shall be multiplied by 0.02.

Use of QUADRO

- 3.9 (i) In urban areas and areas involving junctions, there are limitations to the use of QUADRO and advice should be sought from the Bridges Division of the Overseeing Department.
- (ii) The current version of the QUADRO program will not evaluate delay costs arising after the year 2025. For maintenance after this date, delay costs

shall be calculated for the year 2025 and assumed to be the same in the maintenance year. They must then be discounted from the maintenance year to the year of construction.

(iii) Data which shall be used in QUADRO relating to maintenance intervals and works durations are given in Table 3/5.

(iv) The revised National Road Traffic Forecasts (1989) and the revised value for "Proportion of Cars in Work Mode" (which incorporates a number of economic parameter updates) shall be used in all QUADRO evaluations.

3.10 The results, in undiscounted 1979 prices taken from the QUADRO 2 printout, shall be converted to undiscounted 1988 prices using the adjustment factors given in Table 3/4. The final combining of works costs and QUADRO user costs shall be carried out in accordance with the examples shown in Appendix B of BA 28/92.

Maintenance Intervals and Works Duration

3.11 The maintenance intervals and works durations shall be the values given in Table 3/5.

Table 3/4 - QUADRO - User Cost Adjustment Factors

To convert undiscounted costs in 1979 prices (taken from Phase 9 of QUADRO 2 output) to undiscounted costs in 1988 prices.

| Year | Adjustment Factor (High Growth) | Year | Adjustment Factor (High Growth) |
|------|------------------------------------|------|------------------------------------|
| 1988 | 1.88 | 2009 | 2.32 |
| 1989 | 1.90 | 2010 | 2.34 |
| 1990 | 1.91 | 2011 | 2.35 |
| 1991 | 1.93 | 2012 | 2.41 |
| 1992 | 1.95 | 2013 | 2.40 |
| 1993 | 1.96 | 2014 | 2.44 |
| 1994 | 1.98 | 2015 | 2.48 |
| 1995 | 2.00 | 2016 | 2.50 |
| 1996 | 2.02 | 2017 | 2.52 |
| 1997 | 2.04 | 2018 | 2.52 |
| 1998 | 2.05 | 2019 | 2.61 |
| 1999 | 2.08 | 2020 | 2.58 |
| 2000 | 2.09 | 2021 | 2.66 |
| 2001 | 2.12 | 2022 | 2.74 |
| 2002 | 2.14 | 2023 | 2.66 |
| 2003 | 2.16 | 2024 | 2.71 |
| 2004 | 2.19 | 2025 | 2.76 |
| 2005 | 2.22 | | |
| 2006 | 2.24 | | |
| 2007 | 2.24 | | |
| 2008 | 2.28 | | |

Table 3/5 - Maintenance Intervals and Works Durations

| BRIDGE ELEMENT | OPERATION | INTERVAL | WORKS DURATION |
|---|-------------------------|----------|--------------------------------------|
| Reinforced Concrete Deck. Reinforced Concrete Substructures. | Concrete Maintenance | 20 years | 8 weeks |
| Steel or Steel/Reinforced Concrete Composite. Steel Substructures | Re-paint Steelwork | 15 years | as determined for particular case |

4. REFERENCES

4.1 QUADRO 2 Manual, April 1982, plus advice issued to all holders of the QUADRO manual in 1989.

4.2 Design Manual for Roads and Bridges

Volume 1: Section 2 Other Procedural Documents

BE 5/76: Evaluation of Highway Structures (DMRB 1.2) (Clause 5 and Appendix 1 are superseded by BD 36/92).

BA 28/92: Evaluation of Maintenance Costs in Comparing Alternative Designs for Highway Structures (DMRB 1.2.2)

5. ENQUIRIES

All technical enquiries or comments on this Standard should be sent in writing as appropriate to:-

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