VOLUME 2 HIGHWAY STRUCTURES: DESIGN (SUBSTRUCTURES AND SPECIAL STRUCTURES)

SECTION 3 MATERIALS AND COMPONENTS

PART 7

BA 82/00

FORMATION OF CONTINUITY JOINTS IN BRIDGE DECKS

SUMMARY

This Advice Note gives guidance on the construction of continuity joints in trafficked concrete bridge decks. Only the potential effects of early-age vibration and relative deflection of the decks are addressed; design matters such as consideration of creep, shrinkage and settlement are not within the scope of this document.

INSTRUCTIONS FOR USE

1. Remove IM5, which is superseded by BA 82/00 and archive as appropriate.

2. Insert BA 82/00 into Volume 2, Section 3.

3. Archive this sheet as appropriate.

Note: A complete new index for DMRB is available from HMSO quarterly.

THE HIGHWAYS AGENCY

THE SCOTTISH EXECUTIVE DEVELOPMENT DEPARTMENT

THE NATIONAL ASSEMBLY FOR WALES
CYNULLIAD CENEDLAETHOL CYMRU

THE DEPARTMENT FOR REGIONAL DEVELOPMENT*

Formation of Continuity Joints in Bridge Decks

* A Government Department in Northern Ireland

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Contents

Chapter

1. INTRODUCTION

General

1.1 When a bridge deck is to be widened, built in stages or reconstructed in stages, the need to maintain traffic on the deck may necessitate longitudinal construction joints and the use of narrow, typically 0.5m - 1.0m wide, concrete in-fill strips. In certain circumstances, an extension may be cast directly against the deck carrying traffic without using an in-fill strip, if differential deflection between the existing concrete and the new deck is small.

1.2 Where construction joints are designed to enable the completed deck to act monolithically, it is essential to ensure that the completed structure is not adversely affected during the early life of the joint by traffic-induced vibration, deflections and stresses.

Scope

1.3 This Advice Note gives guidance on the construction of extensions to bridge decks and in-fill strips. However, only the potential design issues due to effects of vibration and relative deflection at the concrete setting stage of the decks are addressed here; detailed design requirements to counter effects of creep, shrinkage and possible differential settlement between old and new parts of the structure are not within the scope of this document.

Implementation

1.4 This Advice Note should be used forthwith for all relevant schemes currently in preparation, provided that in the opinion of the Overseeing Organisation this would not result in significant additional expense or delay. Design Organisations should confirm its application with the Overseeing Organisation.

2. DESIGN ISSUES

General

2.1 The designer should assess and consider the design constraints and structural implications that may affect the construction of a widened section of a bridge deck with or without in-fill strips. Important considerations are the volume, composition and speed of the traffic (discussed in chapter 4), consequent traffic induced vibration effects and differential deflection while fresh concrete is hardening. The designer must ensure that any constraints on construction are clearly stated in the contract documentation.

Detailed Design Issues

2.2 The designer in widening a concrete deck should consider differential deflection effects. This may directly affect the decision on whether to:

a. construct the new extension attached to the trafficked deck or

b. build a parallel deck and construct the in-fill strip as a second stage.

The second is generally preferable, but where the first method is unavoidable, the designer should ensure the differential deflection is limited to a maximum of 1mm.

2.3 In calculating the possible differential deflection, the development of the concrete strength and the elastic modulus and the sequence of removal of shuttering are associated aspects that need careful consideration. Early removal of shuttering will lead to a higher initial deflection in all forms of composite construction. Propping can be considered to limit differential deflection, but designers must carefully assess the structural implications.

2.4 Consideration should be given during the design process to carry out a dynamic analysis of the structure taking into account the early life properties of the concrete coupled with monitoring for deflections and vibrations. The peak particle velocity of the structure in particular has been found to give an indication of risk of damage to immature concrete. As a guide, for concrete less than 24 hours old, it has been suggested that vibrations during construction should be limited to a peak particle velocity of 5mm per second.

2.5 It should be noted that the theoretical calculation of peak particle velocity is not an easy process. Where possible and appropriate, vibrations should be measured on a trafficked deck, in advance or during construction. If this is to be undertaken during the construction process then the contract documents should clearly stipulate the requirement, and due provision should be made to consequent changes to design, construction, temporary propping and traffic restrictions that may ensue.

Formwork

2.6 When in-fill strips are to be adopted the formwork design should ensure that vibration due to traffic is not transmitted at the first stage of parallel strip construction. This can be achieved in most locations by keeping formwork independent of the trafficked deck.

2.7 In order to ensure resistance to vibrations and the forces exerted by differences in movements, the infill strip should not be concreted until the new deck has gained sufficient strength. Support to the infill strip may utilise the strength of the existing deck and the new deck in most circumstances with suitably placed transverse supports between beams.

2.8 In all forms of construction, where peak particle velocity at the construction joint is likely to exceed the ppv limit, temporary propping to the trafficked deck or traffic restrictions should be considered. Where propping is proposed the designer must re-assess the structural implications. Additional traffic restrictions should also be considered.

Concrete

2.9 Well proportioned concrete mixes are tolerant of low-amplitude, low-frequency vibrations during the period of setting and early strength development.

2.10 Laboratory research has shown that high slump concrete mixes are especially sensitive to segregation. Also if the slump is high, traffic induced vibrations result in lower bond and compressive strengths. Bleeding in freshly placed concrete also may be caused by intermittent vibration during the period of initial set. Mixes with high cement content and low water/cement ratio are less prone to bleeding. A reduction in bleeding

may be obtained by appropriate concrete mix design and the use of admixtures.

2.11 To avoid adverse effects from concrete mix segregation, reduction in bond and strength, the in-fill concrete should:

i) be at least Grade 40 or the grade applicable to the new works, whichever is greater;

ii) have a minimum cement content of 340 kg/m^3;

iii) have a maximum free water-cement ratio of 0.4;

iv) have a slump of between 25mm and 50mm;

v) have low bleed characteristics - concrete with bleed water less than 10%, when tested in accordance with ASTM C232-92 (Bleeding of Concrete) - Method B, may be considered to exhibit low bleed characteristics.

For special situations other mixes of high early strength and workability with appropriate reinforcement may be used.

Reinforcement Details

2.12 When the in-fill strip construction method is to be employed the reinforcement from the existing structure should not extend into the main body of the new work, but only into the connecting strip to lap with the new reinforcement.

2.13 It is preferable not to use hooked reinforcement as voids may develop between the bar and fresh concrete. The other alternative for congested locations, use of reinforcement couplers also should be considered. Advice on this subject is available on Specification for Highway Works, Clause 1716.

2.14 The connection of the reinforcement should be as rigid as possible with longitudinal bars fixed in both the top and bottom layers of the steel. The reinforcement should be securely tied at all bar intersections.

2.15 Existing concrete shall be removed to expose sufficient reinforcement to provide the necessary bond length, using suitable tools and minimum force to expose a sound, even surface to receive fresh concrete. The concrete interface shall be kept wetted for at least four hours, but surface water shall be removed within an hour before placing fresh concrete.

3. SAFETY

General

3.1 The problems associated with maintaining traffic during construction include the safety of the public and the construction workforce. It is preferable to do as much of the work as possible prior to the removal of existing kerbs and parapets. Details of minimum traffic control standards for construction and maintenance operations are given in Chapter 8 of the Traffic Signs Manual and Notes for Guidance on 'Safety at Roadworks'. These are minimum standards for normal situations and analysis should consider each stage of construction. When special complexities or hazards prevail, additional protective measures should be employed.

4. CONSTRUCTION REQUIREMENTS

General

4.1 Experience and research (see bibliography) has shown that satisfactory joints can be formed in trafficked decks provided that the following factors are taken into account.

Road Surface Condition

4.2 Because vibrations are primarily the result of vehicles passing over an irregularity in the bridge approach or deck surface, the most effective way to reduce the amplitude of traffic-induced vibrations is to maintain a smooth riding surface. Particular attention should be given to patching potholes and maintaining a smooth transition at expansion joints and temporary ramps.

4.3 Where flexible bearings are employed such as elastomeric type, consideration should be given to inserting temporary packings to limit vertical movement at the support. In such cases due regard should be given to their effect on the overall structure whilst in place.

Traffic Restrictions

4.4 Designers should establish the criteria for controlling vehicle speeds and limiting weight in the trafficked deck adjacent to the fresh and immature concrete on the basis of engineering judgement, using the guidelines identified in Chapter 2. Generally speed should not exceed 50 mph during the casting of in-fill strips or concrete adjacent to the joint and for a period of 24 hours thereafter. However in many sites the speed restriction may be more onerous due to safety requirements. Provided that attention has been paid to the adjacent road surface condition it is usually unnecessary to impose a vehicle weight restriction for concrete setting requirements but vibration can be minimised by timing of concreting operations to times of low HGV traffic.

4.5 Similarly safety considerations will dictate the minimum clearance of vehicles from the edge of the construction joint. However, in order to minimise vibrations the wheels of vehicles should be kept a minimum of 600mm from the construction joint. Other restrictions may also be necessary in this situation.

5. BIBLIOGRAPHY

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2. 'Traffic-Induced Vibrations and Bridge Deck Repairs' - Concrete International, May 1986, pp 36-42, Discussion, March 1987, pp 77 & 78.

3. 'Guide for Widening Highway Bridges' - ACI Structural Journal, July - August 1992, pp 451-466.

4. A survey of traffic induced vibrations AC Whiffin & DR Leonard, RRL Report LR 418:1971.

6. ENQUIRIES

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

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