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TII Publications



Treatment of Existing Structures on Highway Widening Schemes

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For all documents that existed within the NRA DMRB or the NRA MCDRW prior to the launch of TII Publications, the NRA document reference used previously is listed above under 'historical reference'. The TII Publication Number also shown above now supersedes this historical reference. All historical references within this document are deemed to be replaced by the TII Publication Number. For the equivalent TII Publication Number for all other historical references contained within this document, please refer to the TII Publications website.

**Treatment of Existing Structures on
Road Widening Schemes**

December 2014

Summary:

This Standard sets out principles, processes and requirements in relation to existing structures affected by road widening schemes. Advice applicable to commonly encountered situations is also given.

1. INTRODUCTION

General

- 1.1 Making better use of existing roads, including by widening, is consistent with the National Roads Authority's mission statement which is to "improve the quality of life and national economic competitiveness by developing, maintaining and operating the national road network in a safe, cost effective and sustainable manner". The intention should be to reuse as much existing infrastructure as possible where economical to do so.
- 1.2 Widening gives rise to many issues affecting existing structures. The treatment of these issues can have a major influence on the design and cost of the widening scheme. This Standard has been produced to set out the principles to be applied and to promulgate advice and guidance relating to the treatment of structures affected by widening schemes.

Purpose

- 1.3 The objectives of this Standard are to:
- a) explain the principles and requirements applicable to the development of proposals for existing structures on road widening schemes;
 - b) describe the process that should be applied through preliminary and detailed design;
 - c) provide advice and ideas for solutions to commonly encountered situations.
- 1.4 A consistent approach is promoted to improve efficiency and avoid unnecessary design and construction work, with the overall aim of achieving better value for money on widening schemes.

Scope

- 1.5 This Standard applies to motorway and other national road widening schemes.
- 1.6 The principles and advice contained in this Standard may also be helpful to designers in relation to widening schemes on other roads.

Definitions

- 1.7 The following definitions apply throughout this Standard:

Technical Acceptance Report (TAR)	A document, which records the agreed basis and criteria for the detailed design or assessment of a Road Structure as defined within NRA BD 02.
Current Assessment Standards	Standards applicable to the assessment of road structures as implemented by Volume 3 of the NRA Design Manual for Roads and Bridges.
Current Design Standards	Standards applicable to the design of road structures as implemented by Volumes 1 and 2 of the NRA Design Manual for Roads and Bridges. The structural Eurocodes must be used for all design of new elements.

Maintenance Aspect of a Current Design Standard	Requirements in Current Design Standards where there are specific statements that they should be applied to existing structures or parts of structures.
Departure from Standards	Criterion, which departs from, or is an aspect not covered by the NRA DMRB or NRA MCDRW.
Latent Departure	A non-compliance with a Current Design Standard associated with an existing structure.
Maintaining Agent	The Maintaining Agent shall be defined as the organisation responsible for the maintenance of a structure, typically the Local Authority, the National Roads Authority or their appointed agent (e.g. MMarC).
Preliminary Design Report (PDR)	A report compiled from the various documents produced during the preliminary design stage as defined by NRA BD 02.
Review of Existing Assessment Form (REAF)	A form on which the decision to accept that an existing assessment is still valid is recorded.
Eirspan Bridge Management System	The National Roads Authority's electronic database of structure records.
Abnormal Vehicle	An abnormal vehicle in accordance with NRA BD 86.
Exceptional Abnormal Vehicle	An Exceptional Abnormal Vehicle in accordance with NRA BD 86.
Unaffected Structure	A structure which is not being modified and for which no strengthening or upgrading is proposed as part of the scheme. An Unaffected Structure may be subject to some change in geometry or load but the changes are not deemed significant such that an existing assessment is still valid (this is explained further in paragraphs 3.1-3.5).
Modified Structure	A structure at which the geometry of structural elements is being changed by a significant amount or a structure which is subject to a significant increase in load effect in order to accommodate a widened or re-aligned carriageway (this is explained further in paragraphs 3.1-3.5).
Strengthened or Upgraded Structure	A structure for which the geometry of structural elements is essentially appropriate for the scheme but strengthening/upgrading is proposed as part of the works.
Options Report (OR)	A report submitted to the Structures Inspector during the Preliminary Design phase of the road scheme, or before, describing the options considered for each structure or family of structures on the scheme. Details of the contents of an Options Report for Structures can be found in NRA BD 02.
Technical Acceptance of Structures	Documents, such as Options Reports, Preliminary Design.

Deliverables	Reports, Technical Acceptance Reports etc., for the detailed design or assessment of a road structures as agreed with the National Roads Authority and as defined within NRA BD 02.
Widening Scheme	A scheme involving widening of the existing cross-section of part of the road network.
Aesthetics Advisor	The Aesthetics Advisor shall have a proven track record in the field of aesthetics with a minimum of 10 years' experience working on bridge structures. The National Roads Authority shall adjudicate on decisions with regard to aesthetic matters.

2. PRINCIPLES TO BE ADOPTED IN THE DEVELOPMENT OF THE WIDENING SCHEME

Structure – Road Interface

- 2.1 The cost of widening schemes is heavily influenced by the treatment of existing structures. In particular, there is potential for substantial savings if the widened motorway or national road can be accommodated at existing structures without demolition/reconstruction or major alteration. It is therefore important to give careful consideration to the road geometry at structures (set-back, verge widths, lane widths etc.), taking advantage of reductions in standard requirements through a departure process where it is appropriate to do so. Reference should be made to NRA TD 27 ‘Cross-sections and Headrooms’.
- 2.2 The design team should develop a holistic solution for the widening scheme, taking into account the difficulty and cost in accommodating the desired cross-section but at the same time producing a road design which achieves the necessary standards for operation, safety and maintenance.
- 2.3 The Standards Section of the National Roads Authority should be consulted at the earliest opportunity to agree the likely acceptable standards for the scheme as a whole. Due to the number of variables, in particular accident statistics, each structure is then likely to require individual consideration to determine if the desired cross-section can be achieved. Variations in road cross-section may be the appropriate solution although the need for consistency along the route should not be overlooked. Ultimately Departures from Standard will be required where non-standard cross-sections are proposed.
- 2.4 Consultations with the National Roads Authority will also allow discussion on the latest innovations/developments in alignment design.
- 2.5 Temporary alignments and traffic management requirements must also be considered and consultation with the National Roads Authority is required to agree traffic management constraints and implications for congestion.
- 2.6 Reference to reductions in geometric standards, including Departures from Standard, should be made in the Technical Acceptance of Structures Deliverables.

Treatment of Existing Non-compliances

- 2.7 As a minimum, any known structures related non-compliance with a Current Assessment Standard or a Maintenance Aspect of a Current Design Standard must be considered and addressed as part of the scheme.
- 2.8 Similarly, any known structures related noncompliance with a Current Design Standard must be considered and addressed as part of the scheme if one or more of the following criteria apply.
 - a) The risks associated with the noncompliance are exacerbated by the widening scheme.
 - b) There is a national policy to upgrade particular elements during major schemes or Current Design Standards include a relevant mandatory requirement to be implemented on improvement schemes.
 - c) Retaining a non-compliance is considered to represent a significant safety risk.
 - d) Based on an assessment of whole life costs, there is a clear case for upgrading, maintenance or even replacement to be carried out as part of the widening scheme.

- e) Upgrading works at the structure that would address the non-compliance are required to be carried out in the short term.

Note: A non-compliance may be addressed by undertaking works to eliminate the non-compliance or by providing justification and obtaining approval from the National Roads Authority to retain the non-compliance, e.g. through the Departure from Standards procedure.

- 2.9 Consideration should be given to undertaking works to address other non-compliances with Current Design Standards if sufficient funds are available. For example, the National Roads Authority may wish to undertake works to address issues if there are benefits in terms of improving the reliability of journeys. A widening scheme will often present the opportunity to carry out maintenance, upgrading or strengthening works in a cost effective manner and with minimal further impact on network operation. Therefore, in circumstances where none of the mandatory criteria apply, it may still be appropriate to address other non-compliances as part of the widening scheme.
- 2.10 When considering existing non-compliances, the design organisation should liaise with the Maintaining Agent and seek the agreement of the National Roads Authority regarding:
- a) the scope of works including which non-compliances may be considered acceptable;
 - b) the responsibility for design and construction;
 - c) the funding for the work.

This should be agreed at preliminary design stage and included in tender documents and/or statements of intent for detailed design.

- 2.11 In many cases, the Maintaining Agent will already be aware and have records of non-compliances at existing structures. Additional non-compliances may become apparent from inspections and/or assessments undertaken as part of the scheme. However, irrespective of whether non-compliances were known about in advance, the principles to be applied for dealing with them remain the same.
- 2.12 Annex B.3 includes a list of common situations and possible solutions to issues encountered on widening schemes. Many of the examples in the list relate to the treatment of existing non-compliances.

Note that where there is any discrepancy between the above principles and the requirements of the contract, the requirements of the contract shall take precedence.

- 2.13 The agreed scope of any maintenance, upgrading or strengthening works should be recorded as described in Chapter 5.

Retention and Replication of Non-compliances

Retention of a Structures Related Non-compliance

- 2.14 Any non-compliance with a Current Assessment Standard or a Maintenance Aspect of a Current Design Standard requires a Departure from Standards.
- 2.15 A non-compliance with other aspects of a Current Design Standard does not require a Departure from Standards provided that none of the five criteria listed in paragraph 2.8 are applicable. However, if other works are being carried out at the structure then brief details of the retained non-compliance should be included in a list of Latent Departures.

Note: No Departure from Standards is necessary in relation to the assessed capacity of a structure for Abnormal Vehicles and Exceptional Abnormal Vehicles.

- 2.16 The action required for the retention of known non-compliances at existing structures is summarised in Table 2.1.

Note: In cases of doubt, the National Roads Authority should be consulted to confirm whether or not an issue is structures related.

- 2.17 Confirmation of requirements for 'Departures from Standards' on individual schemes must be sought from the National Roads Authority.

Replication of a Structures Related Non-compliance

- 2.18 Any proposal to deviate from Current Design Standards for new construction (extensions, strengthening or modifications) requires a Departure from Standards.

- 2.19 The action required for the replication of a known non-compliance when modifying existing structures is summarised in Table 2.2.

Note: In cases of doubt, the National Roads Authority should be consulted to confirm whether or not an issue is structures related.

- 2.20 Confirmation of requirements for 'Departures from Standards' on individual schemes must be sought from the National Roads Authority.

Out of Favour Forms of Construction

- 2.21 There are numerous structures on the road network which are in a serviceable condition but which utilise 'out of favour' forms of construction, e.g. half joint decks. Work on recent projects has indicated that there is no overriding justification to replace all such structures. Further, when it comes to widening these structures, replicating the 'out of favour' detail, taking care to mitigate known durability, maintenance and safety issues, may be the appropriate solution in circumstances where the existing structure can be managed in a cost-effective way. Replicating 'out of favour' forms of construction should only be considered when there are no practical alternatives and acceptance of the approach will require a Departure from Standards.

- 2.22 Further information is included in Annex B.2.

Modifying Strengthening or Upgrading an Existing Bridge

- 2.23 If a structure is to be modified or a noncompliance is to be addressed, then the modification, strengthening or upgrading must be designed in accordance with Current Design Standards.

- 2.24 In general, the existing elements of a Modified or Strengthened or Upgraded Structure need only comply with Current Assessment Standards. Further information is given in paragraphs 3.6-3.8.

- 2.25 The designer of a modified bridge shall certify the whole structure, although with the agreement of the National Roads Authority isolated strengthening or upgrade works can be dealt with by partial certification.

- 2.26 Further advice on the process for the design of extended/modified bridges is provided in paragraph 5.2.

- 2.27 If different requirements are applied to the new and existing parts of a bridge, there is potential for it to have varying capacity. In some cases the capacity of the whole bridge will be limited by the existing elements. In other cases, heavier loads can be permitted but may need to be restricted to particular lanes. These restrictions should be identified in the assessment report and certificate. The National Roads Authority should be consulted to agree how the capacity is to be recorded in order to ensure compatibility with any asset databases which may be in use.

Future Inspection and Maintenance

- 2.28 In developing a cost effective widening scheme, there will often be advantages in minimising clearances and other facilities which are utilised for inspection and maintenance. The effects on future maintenance and inspection shall be considered in the development of the proposals. This consideration shall be recorded in the Options Reports (ORs) for structures, see Annex A of NRA BD 2 and later in the Technical Acceptance of Structures Deliverables. It is also required for inclusion on relevant applications for Departures from Standards.
- 2.29 The Maintaining Agent shall be consulted at the earliest opportunity and invited to comment on proposals which affect future inspection and maintenance.

Health and Safety

- 2.30 Health and Safety shall be considered from the commencement of conceptual design and shall include a full review of potential risks and hazards associated with strengthening, upgrading and modification works. Current legislative requirements shall be observed.
- 2.31 Input to the project Health and Safety Plan shall be provided with key health and safety issues recorded in the ORs and Technical Acceptance of Structures Deliverables.

Aesthetics and Heritage Issues

- 2.32 The aesthetics of Modified Structures should be considered in the context of the existing infrastructure. Guidance on this topic is provided in NRA BA 41 'The Design and Appearance of Structures' and in the publication 'The Appearance of Bridges and Other Road Structures'. Where appropriate, advice should be sought from an Aesthetics Advisor.
- 2.33 In addition there may be heritage issues associated with the existing structures. Guidance on this subject is provided in NRA BD 89 'The Conservation of Road Structures'.

Adaptability of Modified Construction

- 2.34 In general, when modifying structures, designs that would be particularly difficult to further modify in the future, or which preclude future changes in use of the road (hard-shoulder running, active traffic management etc.), should be avoided. Where the provision of an adaptable design would have significant cost implications a less adaptable design may be appropriate. Overbridge designs with open spans are generally preferred to other alternatives as these offer greater scope for future changes in use of the carriageway.

Redundant Structures

- 2.35 In general, all abandoned or redundant existing structures within the new road boundary should be demolished, partially demolished, concrete filled or otherwise made safe in order to remove any maintenance liability and to eliminate any effect on the performance of the network.
- 2.36 Where responsibility for an existing structure may be transferred to another owner, they shall be consulted to agree the treatment of the structure.

- 2.37 The possible need to retain structures for their heritage value should be considered. In addition, structures fulfilling other functions, e.g. carrying services, may need to be retained.

Buildability

- 2.38 It is important to give careful consideration to buildability in the design of structural modifications. In particular, it is vital that the designs provide sufficient space to accommodate traffic management schemes that are required to achieve adequate traffic flows during the various stages of a widening scheme.

Circumstances applicable to the Structure	Non-compliance with respect to: Assessment Standards or Maintenance Aspect of a Current Design Standard (See Note 2) or Current Design Standards (See Note 4)	Are any of the five numbered criteria in paragraph 2.8 applicable? 1. The scheme exacerbates the risk(s). 2. There is a national policy to upgrade or Current Design Standards include mandatory requirements for improvement schemes. 3. Significant safety risk. 4. WLC supports addressing the issue as part of the scheme.	Proposed Action (See Note 1)	Comments
Structure within the length of the scheme but 'Unaffected'	Assessment Standards or Maintenance Aspect of a Current Design Standard	Yes or No	Departure from Standards submission required	Any non-compliance with an Assessment Standard must be a Departure from Standards. The principle of this Standard is that structures are assessed to Assessment Standards and deficiencies addressed accordingly.
	Current Design Standards	Yes	Departure from Standards submission required	Although a structure may be 'Unaffected', an element (e.g. parapet) may require upgrading on the basis of a national policy.
		No	None	If none of the criteria of paragraph 2.8 apply then this Latent Departure can be accepted without seeking approval.
Structure at which works are required to accommodate the scheme (e.g. width of deck to be increased) or other works, not directly related to widening, are required (e.g. deck strengthening) (See Note 3)	Assessment Standards or Maintenance Aspect of a Current Design Standard	Yes or No	Departure from Standards submission required	Any non-compliance with an Assessment Standard must be a Departure from Standards. The principle of this Standard is that structures are assessed to Assessment Standards and deficiencies addressed accordingly.
	Current Design Standards	Yes	Departure from Standards submission required	This may apply if, for example, WLC shows that addressing low cover is appropriate.
		No	Include in list of Latent Departures and submit to the National Roads Authority	Identifying the non-compliance in a list submitted to the National Roads Authority gives the National Roads Authority the opportunity to consider the issue and instruct works if appropriate. It is recommended that these Latent Departures are identified in Structure Options Reports.

Notes:

1. Where a Departure from Standards has previously been approved for a specific issue, a further Departure from Standards submission for that issue will only be required if any of the criteria of paragraph 2.8 apply (e.g. the risks at the time the previous Departure from Standards was approved are increased as a consequence of the scheme).
2. Maintenance requirements are specific stated requirements in design standards for a performance feature to be maintained during the service life of a structure, e.g. NRA TD 27 Maintained Headroom requirement.
3. Requirements under this section apply only to the retained part of the structure after modification. Departures from Standards for modifications are required in all cases where they do not comply with Current Design Standards.
4. In the context of this table, non-compliances with Current Design Standards are not relevant where there are Assessment Standards covering the same issue.

Table 2.1 Action Required for the Retention of Known Non-compliances at Existing Structures

Circumstances applicable to the Structure	Proposed Action	Comments
Structure at which works are required to accommodate the scheme (e.g. width of deck to be increased) or other works, not directly related to widening, are required (e.g. deck strengthening)	Departure from Standards submission required	When extending or modifying an existing structure there could often be good justification for replicating an existing non-compliance (e.g. providing joints to match existing over intermediate supports). However, this does not lower the status of the issue. Therefore, a formal Departure from Standards submission is required in every case.

Table 2.2 Action Required for the Replication of Known Non-compliance when Modifying Existing Structures

3. CLARIFYING REQUIREMENTS FOR ASSESSMENT OF EXISTING STRUCTURES

Structures to be Assessed

- 3.1 Structures should only be assessed if there is:
- a) no existing assessment or design valid for the proposed treatment of the structure; or
 - b) evidence of an assessment being carried out, but the results of the assessment cannot be clearly identified, or there is evidence to suggest the results are questionable (specific project requirements should be agreed with the National Roads Authority).
- 3.2 Where it has been decided that an existing assessment is, and will remain, valid, this must be recorded using the Review of Existing Assessment Form (REAF) in Annex A. It is not necessary to verify the accuracy of the existing assessment, however a clear reasoning as to why the structure can be deemed acceptable without further assessment must be recorded.
- 3.3 In determining whether an existing assessment is (and will remain) valid, the following advice may be used:

Assessment Valid

- a) Generally, a marginal increase in design load effect can be accepted without treating the structure as modified and, therefore, invalidating any existing assessment.
- b) Similarly, a marginal increase in design load effect on foundations can generally be accepted. However, the site specific ground conditions need to be considered as in some circumstances small changes can have significant effects. The effect of the widening scheme on the ground water levels may be an important consideration.

Assessment Invalid

- a) Structures which are being modified in a way which affects their structural behaviour will always require some assessment (see the note below regarding local assessment of affected elements).
- b) Where a structure has previously been assessed and found to have a reduced capacity, any increase in loading may invalidate the assessment.
- c) Although there is no time limit on the validity of assessments, there may be changes in standards or applied loading which have taken place since an assessment was carried out. These may invalidate the assessment.
- d) Deterioration in condition since the assessment was carried out may invalidate an assessment if the deterioration results in a lower condition factor than that used in an earlier assessment. In this case however, advice from the Maintaining Agent should be sought to clarify whether there is any planned maintenance.
- e) A reduction in headroom such that collision loads on superstructure requirements are invoked may invalidate an assessment.

- 3.4 These principles and the need for assessments should be agreed with the National Roads Authority on a project by project basis.

Note: What constitutes a ‘marginal increase in design load effect’ will need to be agreed with the National Roads Authority for individual cases. If the changes are not considered significant such that the existing assessment is still valid, then the structure is considered as ‘unaffected’.

- 3.5 In some circumstances only a partial assessment may be required. A particular example is an assessment for vehicle impact (see paragraphs 3.11-3.14). Certification relating to a partial assessment should identify the elements covered and should record the extent to which the previous assessment remains valid. It may not be necessary to rectify deficiencies in local failures provided that these would not jeopardise the global performance of the bridge. This, however, must be agreed with the National Roads Authority.

Assessment Standards

- 3.6 As a minimum existing structures or existing elements of Modified Structures shall be assessed to Current Assessment Standards.
- 3.7 In addition to the assessment live loading described in NRA BD 21, there may be a requirement to assess for Abnormal Vehicles in accordance with NRA BD 86. This must be agreed with the National Roads Authority and may involve consultation with the Maintaining Agent.
- 3.8 If an existing element complies with Current Design Standards (as implemented by the National Roads Authority), a check to assessment standards is not required. Paragraphs 5.32-5.33 describe a scenario where this approach may be simpler.

Achieving Minimum Required Capacity

- 3.9 Where a structure is found not to be capable of carrying the specified assessment loading there are generally three options:
- a) Carry out further assessment (more accurate field measurements, materials testing or more detailed analysis techniques can be employed). Advice on levels of assessment is included in NRA BD 79 ‘The Management of Sub-standard Road Structures’. Refer also to NRA BD 304.
 - b) Obtain a Departure from Standards.
 - c) Carry out strengthening or replacement.
- 3.10 It is not possible to globally set thresholds for when each of these options should be adopted and the proposals should be agreed with the National Roads Authority once the first pass of assessments are complete.

Assessment for Substructure Impact and Parapet Impact

- 3.11 If the proposed works increase the likelihood or consequences of vehicle/substructure impact (e.g. traffic will be in closer proximity to existing piers in the completed scheme) then, unless a valid assessment for substructure impact already exists, this particular assessment shall be carried out. Where the substructure fails an assessment the non-compliance should be addressed as part of the scheme.

Note: The non-compliance may be addressed by undertaking strengthening/protection works or by obtaining approval from the National Roads Authority to retain the non-compliance.

- 3.12 Vehicle restraint system provision on a widening scheme should be determined in accordance with NRA TD 19 and NRA BD 52.
- 3.13 The decision on whether to upgrade or replace parapets shall be determined in consultation with the National Roads Authority. In this evaluation the capacity of the supporting structure should also be considered.
- 3.14 Where a new vehicle restraint system (e.g. parapet) is being installed an assessment is required to verify that the load effects acting on the structure can be accommodated. However, no further assessment is required if an existing assessment is valid for the load effects associated with the new parapet.

Road Surface Condition

- 3.15 For the purpose of undertaking structural assessments and in the absence of any contradictory evidence, 'good surfacing' condition can be assumed for roads forming part of the motorway network.
- 3.16 Other roads should be categorised in accordance with NRA BD 21.

Unknown Foundation Details

- 3.17 Where foundations require assessment (see paragraphs 3.1-3.5) difficulty can be encountered where there is insufficient as constructed information available to determine their capacity. Unless exhaustive detailed surveys are carried out, some assumptions may need to be made regarding the foundations.
- 3.18 Geotechnical Specialists should be consulted prior to formal geotechnical procedures in order to seek advice on whether the risks associated with making an assumption are justified compared to the risks and costs associated with undertaking surveys.
- 3.19 In developing a pragmatic solution, the following suggestions should be considered.
- 3.20 Trial holes and boreholes can be used to determine foundation and backfill soil parameters as well as providing access to record structural details. For deeper foundations or where access is particularly difficult, other surveying techniques may prove useful. There is wide range of techniques available that could be considered.
- 3.21 The most efficient way to deal with the problem could be to avoid adding further load to the foundations such that analytical assessment is not necessary. Techniques which may be utilised to this end include:
- a) providing protection from impact by means of an independent structure;
 - b) adjusting the alignment to minimise the risk of vehicle impact (reasonable mitigation of risk may be achieved such that a Departure from Standards could be granted);
 - c) reducing surfacing thickness;
 - d) providing independent foundations for widened or extended structures.
- 3.22 Without a detailed knowledge of the structural foundations, some consideration should be given to any reserve capacity that may be available. For example:
- a) a granular founding material will often have more bearing capacity than required for the foundations;

- b) the strength of cohesive soils under load usually increases with time;
- c) older design codes may be more conservative than current standards;
- d) a more conservative analysis may have been utilised in the original design. For example, passive resistance from the fill to the side of a pad foundation may have been ignored but can reasonably be included for a short term condition such as pier impact.

3.23 An understanding of the past behaviour of the ground under the current configuration is important when considering adding load to existing foundations. The Maintaining Agent should be consulted to identify any available records or knowledge.

3.24 The OR for Structures, Technical Acceptance of Structures Deliverables and the Geotechnical Design Report should record any assumptions or unusual techniques.

Load Sharing Between New and Existing Foundations

3.25 Where new foundations are provided for an extension to an existing structure difficulties arise due to the differential settlement between the new and existing foundations. Frequently the solution to this problem is to provide piled foundations even where piles were not required for the existing structure. Alternatives to this solution should be considered which include:

- a) configure the road over such that a longitudinal joint can be provided, e.g. through the central reserve, allowing a structurally independent extension to be provided;
- b) construct the extension and backfill then allow a settlement period with a monitoring regime before stitching the structures together.

3.26 It should be remembered that induced settlements and stresses in existing structures may need to be considered and analyses performed.

Assessment Criteria and Residual Life

3.27 The structural assessment of existing structures should be based on normal assessment criteria using an appropriate condition factor.

3.28 If a structure includes fatigue sensitive details then it may be necessary to assess the residual life of these elements.

4. LIABILITY ISSUES

- 4.1 Liability issues are a source of protracted debate on widening schemes. The guidance below sets out principles to be considered when preparing contracts. This section is not mandatory as contracts take precedence.

Existing Assessments

- 4.2 Where a valid certified assessment for a structure is available, expending resources re-assessing the structure or undertaking a detailed check on the assessment is not usually justified. Therefore, where the Designer or Contractor is using, has the option to use, or is required to use an existing structure without modification and the structure has an existing assessed capacity, the Designer or Contractor should assess whether the existing assessment is valid using the Review of Existing Assessment Form (REAF see Annex A). The Designer or Contractor does not need to verify and should not be responsible for the accuracy of the assessment.

Note: The principles of paragraph 4.2 are equally applicable to certified designs (see paragraphs 3.1-3.5).

Hand-Over Condition of Structures

- 4.3 The Contractor is usually responsible for maintaining the structures while they have possession of the site.
- 4.4 If existing structures are being used without restriction prior to hand-over to the Contractor and there are no interim measures (including monitoring) in place, it should be assumed that the structure is in an acceptable condition for its current use and in its current configuration.
- 4.5 If particular maintenance or strengthening works are included in the widening scheme, these should be clearly identified at the preliminary design stage.

Retained Parts of Existing Structures

- 4.6 The Designer should generally certify the capacity of an extended/Modified Structure as a whole. Subject to the agreement of the National Roads Authority, however, isolated strengthening or upgrade works, e.g. parapet upgrade, can be dealt with by partial certification, with the designer only taking responsibility for the particular element. In these circumstances it must be demonstrated that the work does not affect other elements or the overall performance of the structure.
- 4.7 Works to rectify non-compliances not covered by the mandatory requirements of paragraphs 2.7-2.9 may be specified in the Contract, e.g. in order to avoid further route disruption in the future. However, in many cases non-compliances with respect to Current Design Standards will not require rectification (see paragraphs 2.7-2.28 and Annex B). Some deficiencies, e.g. defective waterproofing on a concrete deck, may be identified during construction. In such cases the National Roads Authority and Maintaining Agent should be consulted to discuss whether the opportunity to carry out rectification should be utilised.

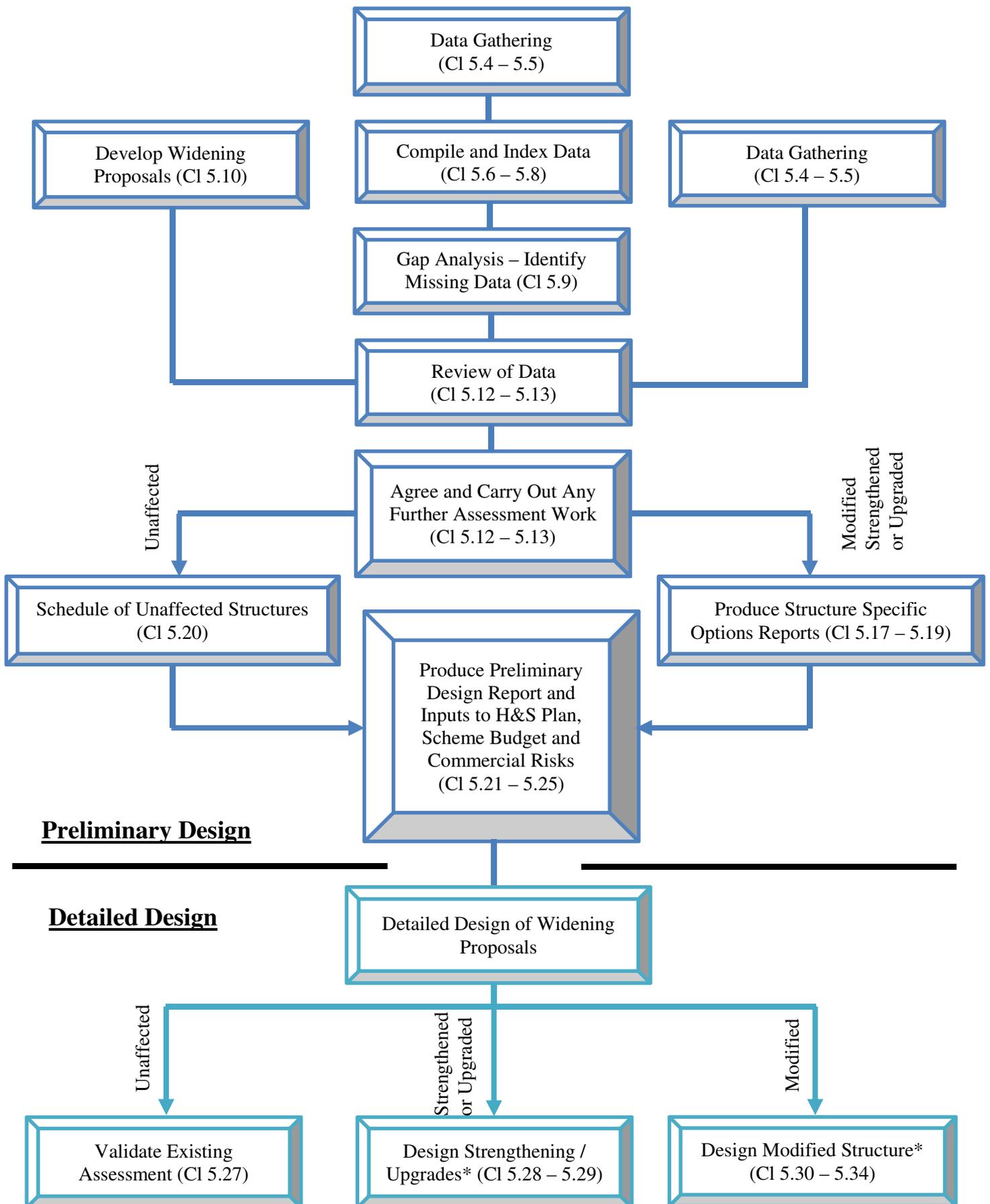
5. THE PROCEDURES FOR DEALING WITH EXISTING STRUCTURES

Introduction

- 5.1 The process for dealing with existing structures is, to some extent, dependent on the contract form and scheme specifics. However the following guidance is likely to be applicable in most cases.

Process Flow Chart

- 5.2 The flow chart below illustrates the typical process required at both the preliminary and detailed design stages. Commentary on each of these activities is included later in this section.



*Where an existing assessment is used in part it should be validated in the same manner as for unaffected structures.

The Preliminary Design Process

- 5.3 The Preliminary phase occurs within Phases 1 to 4 of a scheme as defined within the National Roads Authority's Project Management Guidelines. Refer also to Table 2/1 of NRA BD 02.

Data Gathering

- 5.4 A full search for data relating to all of the structures on the widening scheme should be undertaken. Although not all of the data may be required at this early stage it is often more efficient to carry out one complete retrieval exercise.
- 5.5 There are various sources of information available which may include:
- a) National Roads Authority or their Agents records (including the Eirspan database);
 - b) Maintaining Agent or Contractors records;
 - c) Local Authority records;
 - d) Design Consultants (original assessor or designer);
 - e) Libraries retain numerous papers and articles regarding bridges;
 - f) Geological Survey of Ireland.

Compile and Index Data

- 5.6 All data collected should be compiled and indexed. All data shall be converted into an electronic format.
- 5.7 The Eirspan Database should be updated if inaccuracies or supplementary information is found. The advice of the National Roads Authority should be sought on what action needs to be taken.

Gap Analysis

- 5.8 A gap analysis should be undertaken to identify missing data.

Proposals for Structures to Accommodate the Widening

- 5.9 At the same time as the data collection and verification, initial proposals for how the structures will be modified to accommodate the widening should be developed.

Consultation with Maintenance Agents

- 5.10 Consultation with Maintaining Agents should be undertaken in order to consider any upgrade or refurbishment work that could be carried out as part of the widening scheme. Paragraphs 2.7-2.10 describes the decision making process to be employed.

Review of Data

- 5.11 Data should be reviewed to identify any discrepancies. This process does not require detailed study of assessment calculations or preparation of further calculations. A review of the results should highlight for example:
- a) inconsistency in assessed capacity between similar structures;
 - b) changes in current condition that may invalidate an assessment;
 - c) changes in standard that may invalidate an assessment;
 - d) changes in loading that may invalidate an assessment.

- 5.12 Note that formal validation of existing assessments using the Review of Existing Assessment Form (REAF) is carried out at detailed design stage (see paragraphs 5.25-5.32).

Agree and Carry Out Further Assessment Work

- 5.13 In certain circumstances, it may be appropriate to carry out further assessment work at the preliminary design stage. The purpose may be to address:
- a) missing assessments or certificates;
 - b) assessments where the results are questionable;
 - c) old assessments where significant deterioration of the structure may have occurred, or where the standards used in the assessment are out of date;
 - d) for a Modified Structure, in order to more accurately determine whether the modification proposed is feasible.
- 5.14 The benefit of carrying out assessment work at this stage is that the risk transferred to the next stage is reduced. This allows a more robust estimate of cost and reduced allowance for contingency. The National Roads Authority should be consulted to agree the need for any assessment work.
- 5.15 In addition, in some circumstances it may be appropriate to verify some key dimensions or depths of overlays, for example. Again the National Roads Authority should be consulted if field survey/ investigation work is recommended.

Options Reports for Structures (ORs)

- 5.16 The Options Reports for Structures (ORs) are brief preliminary proposal documents covering many of the issues addressed in the Technical Acceptance of Structures Deliverables (produced at a later stage).
- 5.17 ORs should be prepared for all Modified or Strengthened or Upgraded Structures. The required information for the ORs for Structures is included in Annex A of NRA BD 02.
- 5.18 The preparation of information at the preliminary design stage should be detailed enough to allow a robust estimate of cost to be carried out and to permit a reduced allowance for contingency.

Schedule of Unaffected Structures

- 5.19 The Unaffected Structures should be described in a schedule. It is important that the assumptions which classify the structure as unaffected, such as permissible changes in surfacing levels, are recorded.

Health and Safety

- 5.20 Requirements for input to the Health and Safety Plan are included in paragraphs 2.37-2.38.

Budget and Evaluation of Risks

- 5.21 Input into the scheme budget and risk assessment process for the project should be carried out at this stage.

The Preliminary Design Report

- 5.22 The separate reports, tables and submissions described above should be combined to form the Preliminary Design Report (PDR).
- 5.23 The Preliminary Design Report is therefore a compilation of documents prepared previously during the preliminary design process.
- 5.24 An outline for the PDR is included in Annex B of NRA BD 02.

Detailed Design

- 5.25 In some forms of procurement, the detailed design may be carried out by a separate organisation. In others the same organisation may carry out both stages of the design. The latter form more readily permits the option of carrying out some of the detailed design activities during the Preliminary Phase. Any proposals of this nature should be agreed with the National Roads Authority.

Unaffected Structures

- 5.26 For structures where the existing assessment is still valid, the detailed design organisation is required to certify the validation process. The criteria for validating assessments and the process to be adopted are described in paragraphs 3.1-3.5.

Strengthened or Upgraded Structures

- 5.27 Design of strengthening or upgrade works should be developed as new design in the usual manner.
- 5.28 Where existing assessments are relied upon to conclude that some part of the structure is adequate for the proposed configuration, they should be validated using the process described in paragraphs 3.1-3.5.

Modified Structures

- 5.29 The requirements in terms of structure category and Technical Acceptance of Structures Deliverables are described in NRA BD 02, or specific contract requirements.
- 5.30 Where existing assessments are relied upon to conclude that some part of the structure is adequate, they should be validated using the process described in paragraphs 3.1-3.5.
- 5.31 The technical process for the assessment/design of a Modified Structure may be simplified with the agreement of the National Roads Authority. The approach will depend on the type of structure and the modification proposed.
- 5.32 To illustrate the types of approach which may be acceptable, two scenarios are described below:

A bridge being widened by a significant amount (e.g. the addition of several beams)

- a) A single TAR, covering both the assessment of the existing elements and design of the new elements is utilised.
- b) Using an appropriate load distribution analysis model, design loading is initially applied to the whole deck.

- c) If the existing deck has insufficient capacity (evaluated to Current Design Standards) for the full design loading, then assessment loading is applied in consultation with the Structures Section of the NRA. This would be considered a departure. Only the particular elements/load effects for which failure was determined under design loading need to be re-examined with capacity evaluated to Current Assessment Standards. The assessed capacity of the existing deck is then reported.
- d) The assessment report is produced and agreement reached, with regard to any further assessment or applications for Departure from Standards.
- e) Design drawings are prepared and certified.

A bridge requiring only a small amount of widening

- a) In this situation it may be more appropriate to first carry out the assessment of the unmodified deck in accordance with Current Assessment Standards.
- b) The new elements are then designed, including the connection to the existing structure using Current Design Standards.
- c) The effects on the existing elements need to be considered in accordance with Current Assessment Standards and included in the assessment report.
- d) The documentation would essentially be the same as the first scenario.

6. REFERENCES

6.1 The following is a list of documents in the NRA Design Manual for Roads and Bridges to which reference is made in this Standard:

- a) **NRA BD 89** The Conservation of Road Structures.
- b) **NRA BD 21** The Assessment of Road Bridges and Structures
- c) **NRA BD 86** The Assessment of Road Bridges and Structures For The Effects of Abnormal Vehicles and Exceptional Abnormal Vehicles
- d) **NRA BD 02** Technical Approval of Road Structures
- e) **NRA BA 41** The Design and Appearance of Structures
- f) **NRA TD 19** Requirements for Road Restraint Systems
- g) **NRA BD 79** The Management of Sub-standard Road Structures
- h) **NRA BD 52** The Design of Road Bridge Parapets

7. ENQUIRIES

- 7.1 All technical enquiries or comments on this document or any of the documents listed as forming part of the NRA DMRB should be sent by e-mail to infoDMRB@nra.ie, addressed to the following:

“Head of Network Management, Engineering Standards & Research
National Roads Authority
St Martin’s House
Waterloo Road
Dublin 4”



.....
Pat Maher
Head of Network Management,
Engineering Standards & Research

APPENDIX A: REVIEW OF EXISTING ASSESSMENT FORM (REAF)

A.1. Review of Existing Assessment Form (REAF)

1	Structure Details			
	Structure Name	<Structure Name>		
	Eirspan Structure Number	<e.g. KY-N86-021.00>		
	Northing : Easting			
	Date Commissioned	<Date that the structure came into service>		
	Bridge Spans	<Name of road, railway, river etc.>		
	Minimum Headroom	<Minimum headroom>		
	Bridge Carries	<Name of road, railway etc>		
	Brief Description of Structure			
	<i>Give a brief description of the structure including structural type (deck, substructure and foundations). Identify any unusual features or modifications since first constructed.</i>			
2	Existing Assessment Details			
	Inspection for Assessment Date	<Date>	Recorded Condition	<Condition Factor>
	Assessment Date	<Date>	Report Number	<Report Number>
	Assessing Engineer		Company	
	Current Assessed Capacity			
	HA	<eg 40te>	HB	<eg 30HB>
	Parapet	<eg N2 with mesh infill assessed as satisfactory>		
	Pier Impact	<eg Passes to NRA BD 48>		
	Certification	<Record if certificates exist>		
	Calculations	<Record if calculations exist>		
	As built drawings	<Record if as built drawings exist>		
	Comments on Assessment			
	<A brief summary of the assessment method and findings.>			

3	<p>Evaluation for Proposed Use</p> <p>Inspection Date <Date of inspection being used to assess current condition.></p> <p>Change In Condition <Identify any significant changes in condition since the original assessment/inspection. Field surveys and investigations may be required to identify depths of existing overlays etc.></p> <p>Change In Assessment Standards <Identify any significant changes to standards since the assessment></p> <p>Change In Use/Loading <Identify the key changes that are proposed such as a requirement to carry heavier vehicles or the addition of more lanes. Cross refer and attach drawings if necessary.></p> <p>Superstructure <Unless there is absolutely no change, justify the validation of the existing assessment for the proposed use. This may involve demonstrating that the additional load effects are marginal.></p>						
4	<p>Confirmation that Existing Assessment is Valid</p> <p>We confirm that for the proposed use described above the existing assessment is still valid</p> <table border="1" data-bbox="209 936 1477 1115"> <tr> <td data-bbox="209 936 863 1003">Signed</td> <td data-bbox="863 936 1477 1003">Name</td> </tr> <tr> <td data-bbox="209 1003 863 1059">Position</td> <td data-bbox="863 1003 1477 1059">Company</td> </tr> <tr> <td colspan="2" data-bbox="209 1059 1477 1115">Date</td> </tr> </table>	Signed	Name	Position	Company	Date	
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5	<p>Acceptance of Review Details by NRA</p> <table border="1" data-bbox="209 1223 1477 1312"> <tr> <td data-bbox="209 1223 863 1279">Signed</td> <td data-bbox="863 1223 1477 1279">Name</td> </tr> <tr> <td colspan="2" data-bbox="209 1279 1477 1312">Date</td> </tr> </table>	Signed	Name	Date			
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APPENDIX B: COMMON SITUATIONS AND SUGGESTED SOLUTIONS

B.1. Latent Departures in Modified or Strengthened or Upgraded Structures

Introduction

Paragraph 2.30 explains that existing elements of Modified or Strengthened or Upgraded Structures need only be assessed to Current Assessment Standards. This definition is straightforward to apply where assessment standards exist (e.g. loading and capacity checks). However, the position is less clear in terms of the application of other NRA DMRB standards to existing structures. Furthermore, the application of all NRA DMRB standards to new elements of Modified Structures may be impractical and Departures from Standards are likely to be appropriate.

What follows is a rationale developed from experience gained on widening schemes. It provides guidance on standard requirements that, subject to National Roads Authority agreement, are not mandatory for existing elements of Modified or Strengthened or Upgraded Structures. Specifically, when Current Design Standard requirements are not complied with for existing structures and none of the five criteria in paragraph 2.8 apply, a formal Departure from Standards is not necessary. In these circumstances it is only necessary that these Latent Departures are identified in the Options Reports for Structures and the Technical Acceptance of Structures Deliverables. Guidance is also given on Departures from Standard that may be justified in relation to new elements of existing structures.

The approach to be adopted on a scheme should be agreed in advance with the National Roads Authority, so as to avoid unnecessary delay in the approval process.

The Rationale

Many of the NRA DMRBs new or replacement standards have been introduced as a result of the poor performance in service of some of the older bridges or as a measure to improve safety. In many cases, meeting the new requirements in full would only be possible on existing bridges by complete reconstruction. Clearly this would not provide an economic solution in many cases.

For Modified or Strengthened or Upgraded Structures, new elements of the structure should, where reasonably practical, comply with Current Design Standards. Any proposal to deviate from Current Design Standards for new construction (extensions, modifications, strengthening or upgrading) requires a Departure from Standards which may or may not be acceptable.

Table B.1 is a typical list of current design standard requirements that may not be met by existing structures. As noted in paragraphs 2.17-2.22, provided that none of the five criteria in paragraph 2.8 apply, a formal Departure from Standards is not required in relation to these requirements for existing construction. In addition, the table gives a preliminary indication of Current Design Standard requirements that may be waived for new construction (e.g. extensions to existing structures) with a formal Departure from Standards.

The list is not exhaustive. It is expected that other items where current standard requirements could be amended for similar reasons, e.g. maintenance or durability would be added to project specific lists.

These issues should be considered and proposals included in the ORs for Structures. At detailed design stage the particular items relevant to a structure should be included in the Technical Acceptance of Structures Deliverables. This document will subsequently be included with the structure records and will assist future maintenance planning.

Standard	Title	Standard Requirement	Comments	Departure from Standards likely to be supported for new elements of Structure
NRA BD 29	Design Criteria for Footbridges	Minimum section thickness	Impractical to apply to existing structures. New extension to be designed in accordance with the relevant Eurocodes and the associated Irish National Annexes.	
NRA BD 33	Expansion Joints for Use in Road Bridge Decks	Vertical movements either side of joint	Impractical to apply to existing structure. New extension to be designed in accordance with the relevant Eurocodes and the associated Irish National Annexes.	
NRA BD 47	Waterproofing and Surfacing of Concrete Bridge Decks	Permitted system	Impractical to apply to existing structure unless deck is resurfaced. Requirement to be adopted for new extension	

Table B.1. Typical Current Design Standard Requirements Not Met by Existing Structures

Standard	Title	Standard Requirement	Comments	Departure from Standards likely to be supported for new elements of Structure
NRA BD 57	Design for Durability	Provision of facilities for jacking to inspect/ replace bearings.	Impractical to apply to existing structure. Should be considered for new extension.	
		Multi-span structures to be continuous over intermediate supports.	Impractical to apply to existing structure or to new extension. Note: Where widening is accommodated on a separate deck(s) this should be continuous over supports.	✓
		Half joints not permitted.	Impractical to apply to existing structure. Requirement to be adopted for new extension in most cases.	Depends on particular circumstances.
		Bridges less than 60m long or 30° skew to be integral (unless large differential settlements can occur) – see NRA BA 42.	Impractical to apply to existing structure or to new extension.	✓
		Reduce or limit the use of corrodible reinforcement.	Impractical to apply to existing structure. Requirement to be adopted for new extension.	
		Provision of abutment galleries.	Impractical to apply to existing structure. Should be considered for new extension where practical.	Depends on particular circumstances.
		Concrete mix characteristics to control sulphate attack.	Impractical to apply to existing structure. Requirement to be adopted for new extension.	
		Facilities for inspection of post tensioned tendons.	Impractical to apply to existing structure. Requirement to be adopted for new extension.	
		Drainage to be a closed system and roddable. Down pipes cast into piers not permitted.	Impractical to apply to existing structure. Requirement to be adopted for new extension.	

Table B.1. Typical Current Design Standard Requirements Not Met by Existing Structures (continued)

B.2. Out of Favour Forms of Construction

For extensions to structures, it is often appropriate to replicate the existing articulation/form of construction in order to avert or reduce the problems associated with differential movements under applied loading. However, this gives rise to the question of whether to adopt this approach for existing structures where the form of construction is no longer favoured (e.g. hinge decks, half-joints etc.). These situations require consideration on a structure-by-structure basis. When faced with this issue, one of the options is to consider changing the articulation of the existing structure. However, where this does not offer value for money, or introduces longitudinal joints that increase future maintenance, there may be ways of replicating the original form of construction without inheriting the original maintenance problems. For example, the hinge extension could utilise stainless steel for the reinforcement most susceptible to corrosion. This may overcome the potential durability concerns. Any proposal to replicate these out of favour forms of construction should be considered only after exploring all other options and after giving careful consideration to ongoing maintenance and operational issues. For example, will half-joints be more difficult to access after widening. Any proposal to replicate these out of favour forms of construction would be inconsistent with the requirements of NRA BD 57 and a Departure from Standards would be required (see paragraph 2.27).

The treatment of existing hinge and half joint structures is detailed in guidance documents produced by National Roads Authority. Initially, the capacity of existing hinges or half joints should be assessed, to ensure that their capacity is adequate. A qualitative risk assessment of the half joint or hinge should also be carried out, using the methodology outlined in the National Roads Authority guidance documents to establish the cost effectiveness of retention. Savings can be made by grouping structures into families and carrying out assessments to represent a group of structures. This assessment will confirm whether the detail can be retained in the Modified Structure. The capacity of all parts of existing structures still needs to be checked individually as part of the detailed design of the Modified Structure.

If widening the existing structure can be demonstrated to be cost effective, Table B.2 summarises the appropriate process and suggests treatment for widening.

Deck Form	Existing Deck Checks	Proposed Action for Widened Section
Half joints	Check half joint capacity in 'as-built' and 'deteriorated' state. If adequate widening with similar construction can be considered	Consider improving durability of extension half joint by using stainless steel for vulnerable reinforcement. Consider including instrumentation or facilities to allow examination/ monitoring
Hinges	Check hinge capacity in 'as-built' and 'deteriorated' state. If adequate widening with similar construction can be considered	Consider improving durability of extension hinge by using stainless steel for vulnerable reinforcement. Consider including instrumentation or facilities to allow examination/ monitoring
Short span deck on bearings	Confirm existing capacity	Provide compatible bearings and replicate existing beams. Galleries on extension may not be essential. Final bridge form may not need to be integral (see Annex B.1)

Table B.2. Suggested Strategy for Dealing with Out of Favour Forms of Construction

B.3. Other Common Situations and Possible Solutions

A list of potential widening situations and possible solutions is included in the table below.

The list is not exhaustive.

Situation	Implications of Scheme Proposals	Possible Action
Over bridge with weak pier supports and minimum headroom between the 'maintained' and 'new construction' requirements	Traffic will be moved closer to the piers but the minimum headroom will not be reduced	Protect/strengthen the piers or seek a Departure from Standards to retain piers without strengthening. No action with respect to headroom
Over bridge with weak cantilevers protected by a partially effective barrier	Carriageway widened beneath the bridge	No action to address weak cantilevers as the arrangement complies with Current Assessment Standards (NRA BD 21 Annex I DMRB Volume 3.4.1)
Over bridge with inclined verge supports	Carriageway moves towards support reducing headroom below 'Maintained Headroom' in 'Structure Free Zone'	Vehicle restraint system complying with Current Design Standards provided such that Maintained Headroom is provided at the traffic face of the barrier. In addition 3.0m of headroom to be provided over the working width appropriate to the vehicle restraint system. Note: This requires agreement as a Departure from Standards
Under bridge with substandard deck capacity for Abnormal vehicles	Increase in <u>load</u> on bridge	Liaise with Maintaining Agent to establish capacity requirements. Consider an operation regime where heavy vehicles utilise a particular lane. Alternatively, strengthen to the required capacity using Current Design Standards

Situation	Implications of Scheme Proposals	Possible Action
Under bridge with low cover to reinforcement. However, chloride contamination is not significant (e.g. < 0.3% by weight of cement) and the depth of carbonation is minimal	The bridge is being widened	No action with respect to low cover. Include details of non-conformance in a list of Latent Departures
Under bridge with low cover to reinforcement, significant chloride contamination (e.g. 0.3% by weight of cement) and concrete spalling taking place	The bridge is being widened and whole life costing indicates a clear case for undertaking maintenance as part of the widening scheme	Address low cover
Symmetrically widened under bridge with substandard edge (e.g. pre-cast service bay with limited load capacity)	Bridge will be widened	Consider removing more of existing deck than is necessary to remove the deficient elements
Traffic face of abutment is clad or has a feature with a deep relief	Carriageway edge is closer to the abutment with insufficient space for a safety fence	Fill cavity behind cladding to a minimum height of 1.5m. A rough finish may need to be removed and replaced with a concrete infill to a height of 1.5m

Table B.3. Common Situations and Possible Solutions



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