Consultation comments and responses

Document Title: Guidance on evaluating excessive dynamic effects in underline bridges

Document number: GEGN8616 issue one

Consultation closing date: 19th December 2023

1. Responders to consultation

No	Name	Company
1	David Gibson	Mott MacDonald
2	Sue Perry	Great Western Railway
3	Chris Talbot	Network Rail
4	Ben Wilkinson	Network Rail
5		

2. Summary of comments

Code	Description	Total
-	Consulted	
CE	Critical errors	
ED	Editorial errors	
TY	Typographical errors	
OB	Observations	
-	Total comments returned	

Classification codes for a way forward:

- DC – Document change
- NC – No change

3. Collated consultation comments and responses

No	Page	Clause	Comment	Suggestion	By	Way forward	Page	Clause	Response
1			My organisation has no comments or suggested amendments and supports the standards committee approval of the publication of this document		2	NC			Noted. Thank you for your support.
2	Various	Various	To assist with making the document easier to use, Network rail has identified: - duplicated text for deletion; - text on the background to clauses that could be moved to a new appendix; - text identifying the assumptions underpinning the document that could be moved to a new appendix; and - other detailed guidance text on the qualitative dynamic behaviour of bridges that could be moved to a new appendix.	See attached marked up pdf copy of document "Comments on GEGN8616 - issue one - draft 1.3.pdf" with suggested edits and the attached first Word document containing suggested updated contents list "V02 Preferred GEGN8616 Contents List Option_LG.docx" covering the new appendices and the attached second word document "V1.1 Suggested Additional Changes to GEGN8616 Draft 1a.docx" suggesting the contents of the new appendices.	3	DC			Agreed. Text changed. Noted that these changes are editorial related to moving existing text to make the document easier to use
3	Various	Various	There are some minor inconsistencies in the use of symbols in the equations which could be addressed by adding a list of symbols to the document.	See attached marked up pdf copy of document with suggested edits and the attached second Word document containing a list of suggested definitions for symbols used in the document.	3	DC			Agreed. List of definitions and symbols added to document. Text in document also checked for consistency and updated.
4	Various	Various	The proposed revisions to GERT8006 (Issue 4) include changes to the numbering of the figures etc. in GERT8006. These changes should be reflected in this document.	See attached marked up pdf copy of document with suggested edits.	3	DC			Agreed. References to GERT8006 updated to reflect GERT8006 Issue 4.
5	Various	Various	There are some minor technical inconsistencies in the document. For example, it would be better to use the term 'GB Mainline Network', inconsistent use of other terminology, references to NTSNs. etc.	See attached marked up pdf copy of document with suggested edits.	3	DC			Agreed. Text changed.

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6	Various	Various	Either the extracts from other RSSB standards should be checked against the latest published versions or these 'grey boxes' of text deleted.	See attached marked up pdf copy of document deleting the text in grey boxes and replacing deleted text with suggested cross references.	3	DC			Agreed. Grey boxes of text deleted. References added to call up appropriate section of referenced standards.
7	Various	Various	It is noted that a number of the equations in the document take account of GB/UIC practice for the dynamic increment of real train loading for shear load effects to be taken as 2/3 the value for bending load effects. The relevant equations should be checked for consistency, and for clarity it would be better to include a factor k in the equations where k = 1.0 when considering bending effects and k = 2/3 when considering shear load effects.	See attached marked up pdf copy of document with suggested edits and the attached second Word document containing a list of suggested definitions for symbols used in the document.	3	DC			Agreed. Text changed.
8	Various	Definitions	It would be useful to add definitions for the terms RA_{Bridge} and $RA_{TrainDynamicAnalysis}$ in the document as they have a specific meaning.	See attached second Word document.	3	DC			Agreed. Definitions added.
9	Various	References	A number of references are missing in the reference section.	See attached second Word document.	3	DC			Agreed identified references added, document rechecked and additional references added.
10	15	G1.2.9	Definition of **Risk 2 Excessive Vibration (deck acceleration)** specifically states that deck acceleration "downwards" is of concern. Should this be changed to "vertical"?	Consider change in text from “downwards” to “vertical”.	1	DC			Agreed. 'Vertical' added.

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11	88	G7.1.2	The benefit of **Risk Evaluation Technique 2: Absolute (comparative)** is not fully clear in the Guidance Note. Our interpretation is that: *If train A) has been cleared against acceptance criteria (using Risk Evaluation Technique 1), then train B) may be cleared against train A).* However, would it be more straightforward to compare train B) directly against acceptance criteria using Risk Evaluation Technique 1?		1	DC			Where an individual bridge dynamic analysis is being carried out, you are correct. This option is useful in dynamic parametric analyses and so has been retained with guidance on undertaking comparisons with trains that have been using a large part of the network for many years. Clauses G9.1.6, G9.1.7 and G9.1.8 added providing guidance on the use of reference trains.
12	127-128	Table 6 9.6.1	Table 6 and the associated Section 9.6.1 should be reviewed for consistency with Part 4.	See attached marked up pdf copy of document with suggested edits and the attached second Word document suggesting text for a revised section 9.6.1.	3	DC			Agreed. Review undertaken and text changed as necessary. Also, Table 6 now cross references G9.6.1 and G9.6.2 to avoid duplication of text.
13	Various	Various	Network Rail notes that a further internal RSSB review of the document has identified the potential need for further editorial changes.	These changes should be reviewed and appropriate updates to the document made.	3	Dc			Agreed. Editorial changes have been made to text.
14	Various	Various	Further to comments 2, 4 and 6 Network Rail advises that after addressing the above comments 1 to 10 it would be beneficial to recheck the document.	Network Rail will be pleased to assist RSSB with: - a specific check of the derivation of the equations used in the document; and - a general recheck of the document.	3	DC			Agreed. Document has been rechecked and updated. For details of further comments raised and RSSB response see below.
15	Various	Various	Network Rail has identified that a number of the cross references in the main text of the document and the figures need updating.	Network Rail will be pleased to assist RSSB with identifying these corrections. It is suggested that the best time to undertake these corrections is when the above comments have been addressed (the above comments will result in changes to clause numbers). Once checked, appropriate 'clickable links' for cross references should be added where not yet included.	3	DC			Agreed. Cross references have been checked and updated.
16	Various	G1.2.1 G3.1.4 G4.2.2.1.2 G4.4.2.1.3 Definitions Risk 2	It should be clarified that the 'vertical' deck acceleration is checked	....vertical deck acceleration...	4	DC	11	G1.2.1 G3.1.4 G4.2.2.1.2 G4.4.2.1.3 Definitions Risk 2	Agreed. Text changed.

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17	13	G1.2.10	References to Network Rail in the document are to Network Rail Infrastructure Ltd. [not to Network Rail (High Speed) Ltd.] The guidance in the document has been written to align with the NESA and Network Statement published by Network Rail Infrastructure Ltd. with advice for similar information provided by other IMs.	Change to Network Rail Infrastructure Ltd in this clause only.	4	DC	13	G1.2.10	Agreed. Text changed.
18	13	Last clause in G1.2	Users of GERT8006 and RIS-8706-INS will be very familiar with the new RA calculator tool as it is mentioned in the update to these standards. Whilst the RA calculator is very relevant to GERT8006 it is a static load tool and not relevant to this guidance note on excessive dynamic effects.	Delete clause.	4	DC	13	Last clause in G1.2	Agreed. Clause deleted.
19	19	G2.2.2 a)	In this clause it is not the allowances for dynamic loading that are relevant - it is the actual dynamic loading from trains that is relevant and used in the assessment (not design) of bridges. (Design of new bridges covered by new bridge standards)	a) limiting the dynamic loading from trains to not exceed the corresponding loading assumed for the assessment of bridges; and	4	DC	19	G2.2.2 a)	Agreed. Text changed.
20	19	G2.2.2 c)	Text on traction and braking not relevant to scope of document.	Delete c)	4	DC	19	G2.2.2 c)	Agreed. Bullet deleted.
21	23	G2.3.4 d) (ii)	Whole bridge bending modes are also relevant.	....whole bridge <u>bending and</u> torsional modes, ...	4	DC	23	G2.3.4 d) (ii)	Agreed. Text changed.
22	24	G2.3.4 e) (i)	It is not a simple addition of maximum dynamic load effects generated by each axle in the train, the effects of previous axles are diminished so to avoid gross conservatism over-estimating the dynamic effects of the train it is necessary to take time into account.	By the principle of superposition <u>and taking time into account</u> these load effects.....	4	DC	24	G2.3.4 e) (i)	Agreed. Text changed.

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23	24-25	G2.4.4	In this clause guidance is given for the very uncommon situation of where EN1991-2 requires a dynamic analysis for the design of a new bridge where the bridge is very stiff and there is a risk that the formula in EN1991-2 for estimating the dynamic effect of track irregularities is not sufficient. Accordingly the checks in this clause are generally for phi'' and not phi'. And because phi''dyn is determined from a dynamic analysis taking into account track quality according to speed it should not be divided by two (division by two is an approximate approach for the EN1991-2 formulae taking into account that track quality is better at higher speeds).	Check the correct use of symbols (e.g. phi''dyn and not phi'dyn), terminology and whether phi'' or phi''/2.	4	DC	24-25	G2.4.4	Agreed. Text reviewed and changed. Note: No change to phi' in bullet (ii) because that covers a situation where the dynamic analysis might need to check phi' as well.
24	28	G3.3.2	Tests also indicate excessive bridge deck vibrations reduce the lateral stiffness of track and hence resistance to track buckling.	Insert 'reduced lateral resistance to track buckling'	4	DC	28	G3.3.2	Agreed. Text changed.
25	35-46 162-174	G4.2.1 H3.2-H12	A number of equations in the GN compare the dynamic loading of a train determined from a dynamic analysis with the dynamic loading determined using formulae from Network Rail's assessment code.	The parts of the formulae based on Network Rail's assessment code should be checked for consistency with Network Rail's assessment code including the correct application of the 2/3 factor for the dynamic load effects due to shear.	4	DC	35-46 162-174	G4.2.1 H3.2-H12	Agreed. The equations and figures have been checked and updated in the main text and in the appendix detailing the background to the equations. The equations have also been updated to align with the new list of symbols in Part 1. Regarding the particular comment regarding shear load effects, this has been addressed by the using the symbol k_2 which is 1.0 for bending and deflection load effects and 2/3 for shear load effects.
26	38	End of G4.2.1.2	Clarify that when you calculate phi'dyn you calculate the dynamic and static deflections for the same point in the structure.	Insert new clause Generally phi'dyn is determined by taking into account the dynamic and static deflection of the same point in the bridge or a structural element.	4	DC	38	End of G4.2.1.2	Agreed. Text changed.
27	40-41	Equation E4.5	Clarify units used for static live load carrying capacity in the equation - static loading element of both LHS and RHS of equation should be in same units.	Add The static live load carrying capacity is expressed as the lesser number of units of the static load model set out in Figure 4 or Figure 5 of GERT8006 Issue 4 for the loaded length L of the member.	4	DC	40-41	Equation E4.5 In main text and Appendix H	Agreed. Text changed. Also Appendix H updated.

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28	44	Figure 5	Key note 3	Indicates the required minimum increase in static loading so that total loading matches A	4	DC	44	Figure 5	Agreed. Text changed.
29	45	G4.2.9.1.10	The list of items to take into account in deriving RATrainDynamicAnalysis includes reference to the tables in Part 9 for bridge parameters and dynamic analysis methodology but omits a reference to the table detailing the train parameters to be used for a consistent approach.	Add a corresponding bullet point for the train parameters in Table 5	4	DC	45 100 103 105	G4.2.9.1.10 Table 4 Table 5 Table 6	Agreed. Text changed. Also titles of table updated for consistency with this clause.
30	Various	Part 4 Part 9 etc.	Throughout the document it is assumed that speeds in the NESA and signed on the ground are for mph. Where a value of speed is stated [km/h (mph)], the value of mph should for example be 110mph (not 109mph) to align with the value of speed signed on the ground as this is the value that should be used in any calculation.	Review text and present speeds in appropriate mph values. These values then dictate the corresponding km/h values.	4	DC	Various	Part 4 Part 9 etc.	Agreed. Text checked and updated.
31	57	G5.3.4.2	The maximum speed of a train is limited by the maximum infrastructure permissible speed and the lowest maximum speed of a rail vehicle of in the formation.	Train formations are taken into account in a dynamic analysis with speeds up to the lesser of the maximum infrastructure permissible speed; or the lowest maximum speed of a rail vehicle of in the formation according to the design of the vehicles in the formation.	4	DC	57	G5.3.4.2	Agreed. Text changed
32	62	G6.1.3.1 b)	Track defects also occur near the ends of bridges.	Add: 'defects in the vicinity of the ends of bridges'.	4	DC	62	G6.1.3.1 b)	Agreed. Text changed.
33	68	G7.2.2.3	Review list of quoted standards that have been used historically for the design of bridges.	Check for standards: - covering rail bridge loading; and - covering the limit state calculation of the load carrying capacity of bridges.	4	DC	68	G7.2.2.3	Agreed. Text checked and updated.

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34	70	G7.2.5	With the other changes to the document detailing how to take into account the different speeds of the proposed train and existing comparator trains **this sub section is unnecessarily restrictive** in limiting the maximum speed of the proposed train to the speed of existing traffic and **unnecessarily precludes useful techniques for undertaking compatibility checks for increase in line speed**.	Rewrite clauses to take account of existing comparator trains and their associated speeds (taking account of differences in their speeds) over the same part of the route.	4	DC	Various	G7.2.5 G7.3.3.2.1 G8.5.3.1.3 G8.5.3.1.4 Table 5 E2.3.4 E2.5.8	Agreed. G7.2.5 rewritten to address comment. Also new clause added that explicitly states that Risk Evaluation Techniques 2 and 3 can be used for a proposed train operating at a lower, the same speed or a higher speed than existing comparator trains operating on the route so techniques can be used for line speed improvement projects. Corresponding changes made to Table 5 and G7.3.3.2.1, G8.5.3.1.3, G8.5.3.1.4 and E2.3.4. New clause E2.5.8 added. Original D3.2.8 deleted.
35	75	G7.3.2.1.1	A comparator train should be used with its speed profile along the route which is not necessarily the same as the speed of the proposed train.	....up to and including their maximum permissible speed profile along the route	4	DC	75	G7.3.2.1.1	Agreed. Text changed. Also see response to comment on G7.2.5.
36	79	Note to Figure 10	In nearly all situations lower bound damping values are to be used to avoid underestimating the dynamic load effects in bridges (unconservative).	Clarify that average damping values are only to be used for one of the two cases considered when using long term comparator trains.	4	DC	79	Note to Figure 10	Agreed. Text checked and updated.
37	81	G8.2.2 near end after Step 4	It would be useful to clarify why Step 1 utilising simple line beam analysis is not sufficient for bridges with more complex dynamic behaviour and why they need an individual bridge dynamic analysis. This will assist the user in determining which bridges require an individual dynamic analysis.	Add: 'because vibration modes other than the first bending mode of vibration make a significant contribution to the total dynamic response of a bridge or individual structural elements.'	4	DC	81	G8.2.2 near end after Step 4	Agreed. Text changed.

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38	95-96	G8.5.3.6.2 G8.5.3.6.3	Improve the guidance on the types of structural situations where a bridge is not adequately covered by the line beam dynamic parametric analysis study. Also to update existing bullet e) to reflect type of floor where dynamic issues were found on WCML project that required physical works or a lower train speed for train / bridge compatibility to be demonstrated (typical composite floors have not required physical works to achieve compatibility in previous studies).	Review findings of T1066 and WCML project and update document. a) Also to state: ..... is to be undertaken where vibration modes other than the first bending mode make a significant contribution to the total dynamic response at potentially critical locations in the structure. In the absence of studies confirming that additional vibration modes are insignificant examples of bridges not covered by simple line beam modelling include: b) ....revise existing bullets as necessary c) existing bullet (e) change 'a composite floor spanning between main girders' to 'with an all metallic floor with the floor plate supported by rail bearers and cross girders'. d) existing bullet g) bridges with significant reliability issues	4	DC	95-96	G8.5.3.6.2 G8.5.3.6.3	Agreed. Text reviewed and updated. Also the clauses in G8.5.3.6 when read together state that the findings of other studies (e.g. research or train / bridge compatibility studies) can be used to identify situations where the line beam dynamic parametric analysis adequately covers these bridges.
39	98	G9.1.1	For consistency with Part 8 etc. it should be noted that the defined parametric study does not cover all GB rail bridges.	....representing the majority of the GB national bridge population...	4	DC	98	G9.1.1	Agreed. Text changed.
40	100	G9.3	Clarify that an existing train used as a comparator train should be running on the same part of the route as the proposed train	Selection of existing trains running throughout same parts of the intended routes of operation that are...	4	DC	Various	G9.3 G1.2.4 Definitions	Agreed. Text changed in table Also G1.2.4 ...compared with trains previously checked on the route against..... Also for definition of Risk Evaluation Technique 2
41	110	G10.1.4.2	The formula in EN1991-2 covers resonance effects from the spacing of groups of axles but the resonance effects arising from other repeating loadings, e.g. from the spacing of axles in a bogie and between other pairs of axles also produce their own wavelengths of excitation.	some of the resonant speeds may be estimated...	4	DC	110	G10.1.4.2	Agreed. Text changed.
42	114	G10.1.11.1 .11	For some common bridge types a line beam dynamic analysis capturing the dominant first bending mode may be sufficient.	For some structural forms a 1D analysis may be sufficient	4	DC	114	G10.1.11.1.1 1	Agreed. Text changed.

No	Page	Clause	Comment	Suggestion	By	Way forward	Page	Clause	Response
43	118	G10.1.17.11 a)	The stated assumption that concrete is always uncracked is not always valid for the stress level described, whilst live load stresses could be small the concrete could be cracked due to differential settlement, deficiencies in curing, transport damage for precast units etc.	a) where the stress level does not exceed the tensile strength of concrete the concrete member may be assumed to be uncracked (unless a site examination has identified the concrete to be cracked) and the...	4	DC	118	G10.1.17.11 a)	Agreed. Text changed.
44	118	G10.1.17.11 d)	Clarify the direction in which the Clark method may be used for estimating the stiffness of cracked reinforced concrete.	....for estimating the stiffness of reinforced concrete floor slabs in the direction parallel to the main girders in half through bridges where.....	4	DC	118 178	G10.1.17.11 d) K.1.6	Agreed. Text changed. Also K.1.6 updated.
45	120	G10.1.20.2	The time histories provide useful information on the nature of the bridge response at a particular speed	nature of the dynamic response at a particular speed at the point of interest	4	DC	120	G10.1.20.2	Agreed. Text changed.
46	Various	Part 10 Figures	There are some typos - some of the figures are stated as being for acceleration when they are for deflection and vice versa.	Check figure titles.	4	DC	Various	Part 10 Figures	Agreed. Titles checked throughout document and changed. Titles also shortened.
47	127	G11.2 G11.3	Clarify which changes to train parameters do and do not require a reassessment of train / bridge compatibility - the 'and or and' style of text is confusing.	Check text.	4	DC	127	G11.2 G11.3	Agreed. Text checked and updated.
48	136	D.6	Contribution of other vibration modes should be further clarified.	Add near start of D6: Often significant local floor modes and torsional modes of vibration are induced which sometimes makes a significant contribution to the total dynamic response at critical locations in the bridge. Simply adding these dynamic effects to the main vertical bending mode response overestimates the total dynamic response of the structure. A dynamic analysis technique is required which allows for the contribution of each mode at each time step in the analysis.	4	DC	136	D.6.2 D.6.3	Agreed. Text incorporated in updated guidance.

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49	N/A	Previous last clause in E2.5 (Before Appendices renumbered)	With the changes that were incorporated in the consultation draft providing guidance on how to take into account speed for the two types of comparator trains in Part 9, the train / bridge compatibility checks are no longer limited to existing traffic speeds - they can be used for investigating train / bridge compatibility for projects increasing line speeds.	Delete clause.	4	DC	N/A	Previous last clause in E2.5 (Before Appendices renumbered)	Agreed. Clause deleted.
50	154-155	F.5	Further guidance should be provided on the background to the limits of validity of the dynamic parametric analysis described in Part 9 and when additional checks are required on individual bridges	Review and update text.	4	DC	154-155	F.5	Agreed. Background to G8.5.2.1 for Risk 1 and background to G8.5.3.6 for Risk 2 added to Appendix F
51	155	F.5.11	Add background to G8.5.3.5.6.	Insert new clause: G8.5.3.5.6 The combination of Table 4 and G8.5.3.2 covers the risk identified in the RSSB research report T1066 (2016) that some bridges have a calculated natural frequency outside the range of natural frequencies specified in Table 4 for the dynamic parametric studies.	4	DC	155	F.5.11	Agreed. New clause inserted.
52	157	F.9	Add background to Appendix D.	Insert new sub section: F.9 background to Appendix D Insert new clause: F.9.1 The guidance in Appendix D is based upon the findings of ERRI D214 Report 9 (2001).	4	DC	157	F.9	Agreed. New clause inserted.
53	179	Definitions	Common definitions with GERT8006 should be updated to align with latest draft of GERT8006.	Review definitions.	4	DC	179	Definitions	Agreed. Definitions for 'capacity', HSLM, $RealTrainLoading_{(L)}$ and RA_{Design} updated. 'assessed capacity' deleted as this is not found in the main text.
54	Various	Various	Some of the terminology used to support the formulae in the text is used more than once and appears to be a defined term.	Consider moving to 'definitions' and recheck terminology.	4	DC	179-183	Definitions and Various	Agreed. Relevant text identified and moved into Definitions. Also text reviewed and updated in main text to align with the new definitions.
55	Various	Various	The figures should be checked for consistency with the updated text.	Review and amend as necessary.	4	DC	Various	Various	Agreed. The figures have been checked. Changes have been made to take account of the list of symbols and cross references updated.

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56	Various	Various	A number of cross references are not 'clickable' and a number are not necessary.	Review and amend as necessary	4	DC	Various	Various	Agreed. Cross references reviewed, deleted and amended as appropriate.
57	Part titles Section titles	Part titles Section titles	A number of the Part Titles and Section titles identify which case the guidance applies to.	Check that all Part titles and Section titles identify the Cases which the Part / section applies to.	4	DC	Part titles Section titles	Part titles Section titles	Agreed. Titles checked and updated.
58	Various	Various	For a number of the bulleted lists in the document it is not clear whether all bullets are applicable or whether some are alternative guidance.	Review bulleted lists.	4	DC	Various	Various	Agreed. Text checked and updated with 'and' and 'or' to clarify the guidance.
59	184-187	References	The list of references at the end of the document should be updated for references in the main text that are missing from the list.	Please identify missing references.	4	DC	184-187	References	Agreed. Document reviewed and missing references added for: BS153, prEN1991-2:2021, CP110-1, BS5400, BS5400 Part 2, BD37/88, BR Tech Note 27, BR Tech Note 34, ERRI project D214, Network Statement, Sectional Appendix, UIC IRS70778-2, CEN DIBRST Studies, Ammann & Nussbaumer 1994, P Norris, T Wilkins and I Bucknall 2003.