Appendix D Lightly trafficked rural bridges and other structures

In this section

D1 General

Use of the criteria in this appendix will be subject to approval of the road controlling authority.

a. Note that this appendix provides minimum design standards.

   These criteria apply to one-lane bridges and other structures (eg culverts, stock underpasses and subways) carrying a one lane carriageway on lightly trafficked roads. The criteria shall only be used where all the following criteria are met:

   i. the traffic count is less than 100 vehicles per day (vpd)

   ii. the road cannot become a through route

   iii. the alignment is such that speeds are generally below 70km/h

   iv. use of the route by logging trucks is unlikely, and

   v. no significant overloads are expected to occur or the structure can be bypassed.

b. Following each clause title below, is the number of the clause in the main body of this document which is modified by this appendix. Where no modification is detailed below, the original clauses shall apply in full.

D2 Specific requirements

D2.1 Basis of design (2.1.3)

Not used.

D2.2 Geometric requirements (2.2)

The specific requirements of appendix A may be waived but the following width limits apply:

a. Bridges and other applicable structures without handrails or traffic barriers: 3.0m minimum, 3.7m maximum between kerbs or wheel guards.

b. Bridges and other applicable structures with pedestrian barriers: 3.0m minimum, 3.7m maximum between kerbs or wheel guards, 3.7m minimum between pedestrian barriers.

c. Bridges and other applicable structures with traffic barriers: 3.7m minimum, 4.3m maximum between guardrails.

Traffic barriers may be omitted as detailed in B3.1.6 and pedestrian barriers may be omitted where pedestrians are not likely to frequent the structure, noting the requirements of B2.9 for the occasional presence of people.

Since agricultural vehicles up to 3.7m width may use a public road without permit, the choice of type and height of side protection should be made after consideration of the actual vehicles using the road, and the clearance to any overhanging portions of the vehicles.

D2.3 Traffic loads - gravity effects (3.2)

a. For design of both main members and decks, the HN design load may be replaced by 0.85 HN. The dimensions of the loaded areas remain the same as for full HN load. HO load need not be considered.

b. Areas of deck where wheels cannot normally travel, due to dimensional limitations or physical barriers need not be designed for the wheel loads of (a) above, but shall be designed for one 15kN wheel load, using the same contact area as an HN wheel, placed anywhere on the deck.

D2.3 continued

c. Note that the uniformly distributed part of the reduced HN load is expected to be adequate to cover the effect of all routine stock load.

D2.4 Combination of load effects (3.5)

Tables 3.2 and 3.3 shall be replaced by tables D1 and D2 respectively.

Table D1: Load combinations and load factors for the serviceability limit state

Dead	Self-weight	DL	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	Not applicable	See table 3.7
	Superimposed	SD	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Other permanent	Bearing friction	BF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
	Creep/shrinkage	SG	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
	Prestressing	PS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
	Earth pressure	EP	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
	Settlement	ST	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
	Groundwater pressure (ordinary)	GW_O	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
	Ordinary water flow and buoyancy[d]	OW	1.00	1.00	1.00	1.00	-	1.00	1.00	1.00	-	-	-	-	1.00	1.00		
Traffic	Normal vehicle	LLxl	-	1.35	1.35	1.35	1.35	1.00	1.00	1.00	1.00	-	-	-	-	-		
	Horizontal effects	HE	-	1.00	1.00	1.00	1.00	0.70	0.70	0.70	0.70	-	-	-	-	-		
Environment	Groundwater pressure (extreme)[a]	GW_E	-	-	-	-	0.70[c]	-	-	-	1.00	1.00	0.70[c]	-	-	-		
	Floodwater flow and buoyancy, with scour[a]	FW	-	-	-	-	0.70[b]	-	-	-	1.00	1.00	0.70[b]	-	-	-		
	Water ponding[a]	PW	-	-	-	0.70	0.70	-	-	-	1.00	1.00	0.70	-	-	-		
	Wind[a]	WD	-	-	0.70	-	-	-	1.00	-	-	0.70	1.00	0.70	0.70	1.00		
	Uniform temperature	TP	0.50	0.70	-	-	-	1.00	-	-	-	-	-	1.00	1.00	0.70		
	Differential temperature	DT	0.50	0.70	-	-	-	1.00	-	-	-	-	-	1.00	-	0.70		
Combination			0	1A	1B	1C	2A	2B	2C	3A1	3A2	3B1	3B2	4	C-			
Load symbol			Permanent effects only	Primary vehicular traffic with environmental	Traffic with temperature	Traffic with wind	Traffic with flood	Environmental with vehicular traffic	Temperature with traffic	Wind with traffic	Flood with traffic	Environmental combinations	Flood with wind	Wind with flood	Temperature with wind	Wind with temperature	Special vehicles (permitted overload)	Construction load combinations

Notes for table D1:

See page D–5.

Table D2: Load combinations and load factors for the ultimate limit state[a]

Load symbol	Combination	Dead[d]		Other permanent[d]									Traffic		Environment							Extreme		
		Self-weight	Superimposed	Bearing friction	Creep/shrinkage	Prestressing	Earth pressure	Settlement	Groundwater pressure (ordinary)	Ordinary water flow and buoyancy[c]	Normal vehicle	Horizontal effects	Groundwater pressure (elevated)	Floodwater flow and buoyancy, with scour	Water ponding	Wind	Uniform temperature	Differential temperature	Earthquake	Tsunami	Collision loads
		DL	SD	BF	SG	PS	EP	ST	GW_O	OW	LLxl	HE	GW_E	FW	PW	WD	TP	DT	EQ	TS	CO
Permanent effects only	0	1.20	1.20	1.20	1.20	1.00	1.20	1.20	1.00	1.20	-	-	-	-	-	-	0.50	0.50	-	-	-
Primary vehicular traffic with temperature	1A	1.20	1.20	1.20	1.20	1.00	1.35	1.20	1.00	1.20	1.84	1.84	-	-	-	-	1.00	1.00	-	-	-
Vehicular traffic with wind and temperature	1B	1.20	1.20	1.20	1.20	1.00	1.35	1.20	1.00	1.20	1.50	1.50	-	-	-	1.00[b]	0.75	0.75	-	-	-
Environmental with vehicular traffic — Temperature with traffic	2A	1.20	1.20	1.20	1.20	1.00	1.35	1.20	1.00	1.20	1.20	-	-	-	-	-	1.40	1.00	-	-	-
Environmental with vehicular traffic — Flood with traffic	2C	1.20	1.20	1.20	1.20	1.00	1.35	1.20	-	-	1.20	-	1.00	1.30	1.00	-	-	-	-	-	-
Environmental combinations — Primary wind with flood and temperature	3A	1.20	1.20	1.20	1.20	1.00	1.35	1.20	-	-	-	-	1.00	1.00	1.00	1.00	1.00	1.00	-	-	-
Special vehicles (permitted overload)	4	Not applicable																			
Extreme — Seismic	5A	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-	-	-	-	-	-	0.50	0.50	1.00	-	-
Extreme — Tsunami	5B	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-	-	-	-	-	-	-	0.50	0.50	-	1.00	-
Extreme — Collision with traffic	5C	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.20	-	-	-	-	-	0.50	0.50	-	-	1.00
Construction load combinations	C-	See table 3.7																			

Notes for table D2:

See page D–5.

Notes for table D1: (above)

a. Load factor applied to serviceability limit state level flood groundwater and wind actions.
b. If 0.70xFW results in a lower load than 1.00xOW, it shall be replaced by 1.00xOW.
c. If 0.70xGW_E results in a lower load than 1.00xGW_O, it shall be replaced by 1.00xGW_O.
d. Ordinary water flow and buoyancy to be taken as due to the flow with an AEP of 1 (ie 1 year event).

Notes for table D.2: (above)

a. Also load combinations and load factors for damage control limit state (DCLS) and collapse avoidance limit state (CALS) in accordance with sections 5 and 6.
b. See 3.4.5(b) for wind speed to be considered in conjunction with traffic loading.
c. Ordinary water flow and buoyancy to be taken as due to the flow with an AEP of 1 (ie 1 year event) other than for extreme load combination 5A (seismic) and 5C (collision) where it shall be taken as due to mean daily flow conditions.
d. Where the effect of a possible reduction in any permanent load is critical at ultimate limit state, use of a 1.00 factor shall be used for that load. See also 3.5.1(a).

D2.5 Reinforced concrete and prestressed concrete - General (4.2.1)

Design shall be in accordance with NZS 3101.1&2 *Concrete structures standard*(1), as amended by 4.2.1, with the following further provisos:

a. Crack widths (clause 2.4.4.2)

   Assessment of crack widths is required unless concrete tensile stresses do not exceed 0.0MPa at construction joints and $0.4\sqrt{f'_c}$ at other locations under all serviceability limit state load combinations. Crack widths shall not exceed the limits stated in table D3. Crack widths shall be assessed following the requirements of NZS 3101(1) clauses 2.4.4.6 and 19.3.3.5.3(c).

   For prestressed concrete, concrete tension shall be avoided under permanent effects (to be taken as the serviceability limit state permanent effects load combination 0 in table D1 without a temperature contribution).

Table D3: Crack width limits

	Crack width limit for exposure classification	
	A2, B1, B2	C
Reinforced concrete – SLS permanent effects load combination 0	0.30mm	0.20mm
Reinforced concrete – all other SLS load combinations	0.50mm	0.40mm
Prestressed concrete – SLS load combinations excluding permanent effects combination 0	0.40mm	0.30mm

   Care should be exercised when designing deep beams using the strut and tie method as cracks can become large when this method is used.

   Deck reinforcement design shall be exempt from a check of crack widths when the empirical design method specified by NZS 3101(1) section 12.8 is used.

b. Permissible service load stress ranges in prestressed reinforcement (clause 19.3.3.6.2(a) and (b))

   The stress range due to infrequent live loading by clause 19.3.3.6.2(b) shall be taken as that applicable to live loading acting on lightly trafficked rural bridges and other structures to which this appendix applies.

D3 References

(1) Standards New Zealand NZS 3101.1&2:2006 *Concrete structures standard*. (Incorporating Amendment No. 3: 2017)