20.4.7 *Welded yoke connection*

Where the yoke members are connected to the centre beam by welding, complete penetration butt welds shall be used. The nominal stress range at the weld shall be the sum of the longitudinal stress ranges resulting from horizontal and vertical bending of the centre beam. The effects of forces in the yoke need not be added. The stress range at the weld shall comply with Item 7 of Table 20.4.1.

20.4.8 *Welded plates for sliding surfaces*

The contact surfaces between the support bar and centre beam may require a special sliding arrangement. If the sliding device is welded to the edges of the centre beam by short lengths of longitudinal fillet welds, the flexural stress range in the centre beam at the weld location shall comply with Item 9 of Table 20.4.1. For continuous welds, the flexural range shall comply with Item 4 of Table 20.4.1.

20.4.9 *Spring buffer attachments*

Where equidistancing spring buffers are attached to the centre beam by welded cleats, the nominal stress range at the welded connection shall be the sum of the longitudinal stress ranges resulting from horizontal and vertical bending of the centre beam. The effects of forces in the equidistancing buffers due to thermal movements need not be added. The stress range at the weld shall comply with Item 10 of Table 20.4.1.

20.4.10 *Replaceable items*

Replaceable items shall be designed for fatigue as follows:

(a) Where a joint of similar type with the same replaceable components (materials, manufacture, design) has sustained 70 hours under the test regime described in NCHRP Report 467, no further design is required.

(b) For all other cases, the component shall be designed to resist the design number of stress cycles, calculated as follows:

$$n_{sc} = 500\,000(N_c + n_e)D_L \quad \ldots 20.4.10$$

where

n_{sc} = design number of stress cycles caused by the design load

N_c = number of centre beams supported on a support bar

n_e = number of effective cycles of vibration following excitation

D_L = design life of the component, in years

NOTE: n_e may be derived using the method given in Appendix F.

20.5 Ultimate limit state (ULS)

20.5.1 *General*

The strength shall be based on the nominal yield stress (f_y) and tensile strength (f_u). For materials supplied to Australian Standards, the values in AS/NZS 5100.6 shall be adopted. Where materials are supplied to other Standards (e.g. ASTM), the values of these Standards shall be adopted. The nominal values of f_y specified in Clause 20.3.4 shall be complied with.

For the member capacity of centre beams and support bars, the effective lengths of the members shall be as follows:

(a) For support bars, the length between centres of bearings at joint opening J_u.

(b) For overhanging portions of centre beams, twice the length of the cantilever.

(c) For internal spans of centre beams, 0.7 times the span for centre beams welded to support bars and 1.2 times the span for centre beams connected to support bars by yokes.

For shear and bending capacity, the requirements of AS/NZS 5100.6 shall apply.

For bolted, pin and welded connections, the requirements of AS/NZS 5100.6 shall apply.

The members and components of the modular joints shall be checked for ultimate strength as specified in Clauses 20.5.2 to 20.5.5.

20.5.2 *Centre beams*

If centre beams are subjected to significant axial force, which may arise if the joint is skewed or the transverse force is significant, their capacity for axial load with biaxial bending shall be checked in accordance with AS/NZS 5100.6.

20.5.3 *Edge beams*

Edge beams shall be adequately anchored into the concrete and the anchors shall be capable of resisting an ultimate horizontal force of 60 kN per metre length of the edge beam.

The section of the edge beam that spans across the openings of the support boxes shall be in accordance with Clause 20.5.5.

20.5.4 *Support boxes*

The top plate of each support box shall be designed to carry an ultimate load to satisfy the following:

$$P^* = \gamma_u \chi_o W = 230 \text{ kN} \quad \ldots 20.5.4$$

This load may be distributed over an area of $(L_w + t) \times (B_w + t)$, where t is the thickness of the overlying concrete and permanent surfacing layer. Composite action with the overlying structural concrete and the edge beam may be taken into consideration, provided all connections and shear studs are adequately designed for this.

On the three sides of each support box, adequate shear studs shall be provided to transfer the vertical load (P^*) and its horizontal components (ηP^* and τP^*) into the surrounding concrete, without assuming any support at the base of the box.

The bottom plate of the support box shall be designed to carry one-third of the maximum ultimate bearing reaction of the support bar, treated as a uniformly distributed load, by spanning between the three sides of the support box without any support from the underlying concrete.

20.5.5 *Connections*

All connections, whether by bolts, screws, pins or welds, shall be checked for the strength limit state in accordance with AS/NZS 5100.6.

For ULS, the forces Q^*_u, H^*_u and T^*_u shall be assumed to act concurrently. The stresses due to vertical and horizontal bending of the centre beam or support bar and the stresses at connections, such as welds of yokes or equidistancing buffer cleats, shall be calculated. The resultant stress calculated in accordance with Equations 20.4.1(4) and 20.4(5) shall be less than the design strength of the weld or parent material, whichever is lower.

20.6 Serviceability limit state (SLS)

20.6.1 *General*

The members and components of a MBEJ shall be checked at the SLS as follows:

(a) Friction grip bolts and screws in accordance with AS/NZS 5100.6.

(b) Vibration damping requirements in accordance with Clause 20.3.4.

(c) Noise in accordance with Clause 20.9.1.

(d) Elastomeric bearings in accordance with Clause 20.6.2.

(e) Other components normally designed on a SLS basis.

20.6.2 *Elastomeric bearings*

Elastomeric bearings shall be designed to resist serviceability loads and movements, in accordance with Section 12 of this Standard.

The stiffness of the bearings shall be either—

(a) derived by calculation in accordance with Method 1 of Clause 20.3.9 in analysis, or

(b) obtained by testing in accordance with Paragraph F2 of Appendix F when adopting Method 2 or Method 3 of Clause 20.3.9 in analysis.

20.7 Design features and fabrication details

20.7.1 *Anchorage of edge beams*

The anchorage of edge beams shall be designed in accordance with Clause 19.4.

20.7.2 *Weld detailing*

All welds in centre beams and support bars shall be full penetration butt welds, Category FP. All welds attaching anything to centre beams or support bars, within 10 mm of the top or bottom surface, shall be full penetration butt welds, Category FP.

NOTE: This requirement does not apply to the welding of stainless steel sliding surfaces.

All other welds, except stud welds, shall be Category SP.

20.7.3 *Corrosion protection*

Steel components other than stainless steel shall be coated on all surfaces with a coating system EHB6 [inorganic zinc primer/micaceous iron oxide (MIO) epoxy], or an alternative corrosion protection system with a durability of more than 25 years in a C3 corrosivity category.

Stainless steel shall comply with the material properties specified in ASTM A 240/A 240M Type 316L and the stainless steel sheet shall have 2B-mill surface finish.

NOTE: For guidance on steel coatings, refer to AS/NZS 2312.1.

20.7.4 *Seals*

Preformed elastomeric joint seals shall comply with the requirements of ASTM 5973.

Preformed elastomeric joint seals including those deemed to comply shall be tested in accordance with the seal push-out (SPO) test procedure of NCHRP Report 467, and shall successfully pass testing without failure.

The seals shall possess the necessary compression, extension and deformation properties to give the required range of movements specified by the bridge designer, whilst remaining watertight.

The preformed elastomeric joint seals shall resist penetration by material such as aggregate under traffic loading.

20.7.5 *Springs*

Elastomeric components used above and below support bars and between centre beams and support bars in the MBEJ shall be tested in accordance with the opening movement and vibration (OMV) procedure specified in NCHRP Report 467, and shall successfully pass 70 hours of continuous testing without failure.

20.8 Installation of MBEJ

20.8.1 *General*

A maintenance manual shall be available for the MBEJ.

After installation of the completed joint, the MBEJ shall be tested for watertightness.

20.8.2 *Maintenance manual and certification of the MBEJ*

The maintenance manual for the MBEJ shall include the following information:

(a) Certification and results from testing of fabricated components that the materials proposed for use in the MBEJ including steel, stainless steel, joint seals, PTFE and elastomeric springs meet the requirements of this Standard. The certification shall be by a laboratory accredited by signatories to the International Laboratory Accreditation Corporation (ILAC) through their Mutual Recognition Agreement (MRA).

NOTE: In Australia, an ILAC MRA signatory is the National Association of Testing Authorities (NATA).

(b) Documentary evidence of inspection and non-destructive examination (NDE) of every weld has been performed. As a minimum, the welding procedure documents shall comply with AS/NZS 1554.5.

(c) Details of the protective coating system.

(d) Recommended schedules of inspection and servicing of the MBEJ including detailed instructions for the repair or replacement of parts of the joint with a design life of less than 100 years.

20.9 Additional requirements

20.9.1 *Noise under traffic*

The MBEJ shall not generate excessive noise or vibration under traffic.

The MBEJ shall be accompanied with noise test data reports indicating its performance under traffic, including relevant site-specific information.

20.9.2 *Provisions for handling and erection*

The MBEJ shall include suitable handling attachments or lifting points, to assist in the handling and location of the joint.

20.9.3 *Provisions for maintenance*

The design of modular bridge expansion joints shall ensure that all performance criteria for the joint are met with minimum maintenance for the design life of the joint.

The design of the adjacent bridge elements shall allow for the ready access to the joints and shall provide sufficient space for inspection, maintenance and replacement of joint components.

MBEJs with 3 or less seals shall be detailed with support boxes with removable tops.

Design shall allow for ready access to the joints and provide sufficient space for inspection, maintenance and replacement of joint components as required.

APPENDIX A

TABLES OF STANDARD ELASTOMERIC BEARING PROPERTIES

(Informative)

Tables A1 to A20 provide performance data for laminated rectangular and circular elastomeric bearings of IRHD 50 rubber, as specified in Clause 12.

TABLE A1

LAMINATED ELASTOMERIC BEARING—PLAN SIZE 230 mm × 150 mm

Steel plate thickness = 5 mm Side cover thickness = 6 mm Top and bottom cover thickness = 4 mm

Number of internal rubber layers	Overall height	Compressive stiffness at zero shear	Mean shear stiffness	Rotational stiffness	Shear deflection capacity	Rated load at zero shear		Rated load at max. shear		Min. load	AS 5100.4 Part number
						Rotation 0.000 rads	Rotation 0.010 rads	Rotation 0.010 rads	Rotation 0.015 rads	Rotation 0.005 rads	
	mm	kN/mm	kN/mm	kNm/rad	mm	kN	kN	kN	kN	kN	
Internal rubber layer thickness—6 mm											
2	35	307	1.19	147	10.0	451	345	252	—	71	AS [50] 010602R
3	46	234	0.92	112	13.0	451	372	270	229	54	AS [50] 010603R
4	57	189	0.74	90	16.0	420	389	279	246	43	AS [50] 010604R
5	68	158	0.63	76	19.0	354	354	282	255	36	AS [50] 010605R
6	79	136	0.54	65	22.0	306	306	257	257	31	AS [50] 010606R
7	90	120	0.48	57	25.0	269	269	220	220	28	AS [50] 010607R
8	101	107	0.43	51	27.6	240	240	192	192	25	AS [50] 010608R
Internal rubber layer thickness—9 mm											
1	27	229	1.40	108	8.5	312	250	188	159	53	AS [50] 010901R
2	41	133	0.92	62	13.0	312	271	201	182	31	AS [50] 010902R
3	55	93	0.68	44	17.5	256	256	203	189	22	AS [50] 010903R
4	69	72	0.54	34	22.0	204	204	171	171	17	AS [50] 010904R
5	83	59	0.45	27	26.5	169	169	137	137	14	AS [50] 010905R
6	97	50	0.38	23	27.6	145	145	116	116	11	AS [50] 010906R

NOTE: Highlighted rated load values indicate capacity is limited by stability.

TABLE A2

LAMINATED ELASTOMERIC BEARING—PLAN SIZE 230 mm × 200 mm

Steel plate thickness = 5 mm Side cover thickness = 6 mm Top and bottom cover thickness = 4 mm

Number of internal rubber layers	Overall height	Compressive stiffness at zero shear	Mean shear stiffness	Rotational stiffness	Shear deflection capacity	Rated load at zero shear		Rated load at max. shear		Min. load	AS 5100.4 Part number
						Rotation 0.000 rads	Rotation 0.010 rads	Rotation 0.010 rads	Rotation 0.015 rads	Rotation 0.005 rads	
	mm	kN/mm	kN/mm	kNm/rad	mm	kN	kN	kN	kN	kN	
Internal rubber layer thickness—6 mm											
2	**35**	**580**	**1.59**	**605**	**10.0**	**615**	**397**	**—**	**—**	**182**	**AS [50] 020602R**
3	46	442	1.22	460	13.0	615	478	334	—	138	AS [50] 020603R
4	57	357	0.99	371	16.0	615	529	375	—	112	AS [50] 020604R
5	68	299	0.84	311	19.0	615	564	399	316	94	AS [50] 020605R
6	79	258	0.72	268	22.0	615	589	415	344	81	AS [50] 020606R
7	90	226	0.63	235	25.0	596	596	424	363	71	AS [50] 020607R
8	101	202	0.57	209	28.0	532	532	429	375	63	AS [50] 020608R
9	112	182	0.51	189	31.0	481	481	402	384	57	AS [50] 020609R
Internal rubber layer thickness—9 mm											
1	**27**	**440**	**1.87**	**441**	**8.5**	**504**	**318**	**—**	**—**	**138**	**AS [50] 020901R**
2	41	257	1.22	255	13.0	504	383	281	—	80	AS [50] 020902R
3	55	181	0.91	179	17.5	504	414	302	261	57	AS [50] 020903R
4	69	140	0.72	138	22.0	452	432	311	279	44	AS [50] 020904R
5	83	114	0.60	113	26.5	375	375	313	287	36	AS [50] 020905R
6	97	96	0.51	95	31.0	321	321	268	268	30	AS [50] 020906R
7	111	83	0.45	82	35.5	280	280	227	227	26	AS [50] 020907R

NOTES:

1 Bearings shown in bold have limited rotation capacity and should be used with caution.

2 Highlighted rated load values indicate capacity is limited by stability.

TABLE A3

LAMINATED ELASTOMERIC BEARING—PLAN SIZE 350 mm × 170 mm

Steel plate thickness = 5 mm Side cover thickness = 6 mm Top and bottom cover thickness = 4 mm

Number of internal rubber layers	Overall height	Compressive stiffness at zero shear	Mean shear stiffness	Rotational stiffness	Shear deflection capacity	Rated load at zero shear		Rated load at max. shear		Min. load	AS 5100.4 Part number
						Rotation 0.000 rads	Rotation 0.010 rads	Rotation 0.010 rads	Rotation 0.015 rads	Rotation 0.005 rads	
	mm	kN/mm	kN/mm	kNm/rad	mm	kN	kN	kN	kN	kN	
Internal rubber layer thickness—6 mm											
2	35	775	2.05	464	10.0	801	695	495	—	204	AS [50] 030602R
3	46	590	1.58	353	13.0	801	775	559	—	155	AS [50] 030603R
4	57	477	1.28	285	16.0	801	801	592	495	126	AS [50] 030604R
5	68	400	1.08	239	19.0	801	801	610	529	105	AS [50] 030605R
6	79	344	0.93	205	22.0	791	791	618	550	91	AS [50] 030606R
7	90	302	0.82	180	25.0	697	697	586	562	80	AS [50] 030607R
8	101	269	0.73	161	28.0	622	622	512	512	71	AS [50] 030608R
Internal rubber layer thickness—9 mm											
2	41	344	1.58	196	13.0	700	580	430	375	91	AS [50] 030902R
3	55	243	1.17	138	17.5	663	611	444	405	64	AS [50] 030903R
4	69	187	0.93	106	22.0	528	528	445	415	49	AS [50] 030904R
5	83	153	0.77	87	26.5	438	438	365	365	40	AS [50] 030905R
6	97	129	0.66	73	31.0	374	374	301	301	34	AS [50] 030906R

NOTE: Highlighted rated load values indicate capacity is limited by stability.

TABLE A4

LAMINATED ELASTOMERIC BEARING—PLAN SIZE 350 mm × 280 mm

Steel plate thickness = 5 mm Side cover thickness = 10 mm Top and bottom cover thickness = 6 mm

Number of internal rubber layers	Overall height	Compressive stiffness at zero shear	Mean shear stiffness	Rotational stiffness	Shear deflection capacity	Rated load at zero shear		Rated load at max. shear		Min. load	AS 5100.4 Part number
						Rotation 0.000 rads	Rotation 0.010 rads	Rotation 0.010 rads	Rotation 0.015 rads	Rotation 0.005 rads	
	mm	kN/mm	kN/mm	kNm/rad	mm	kN	kN	kN	kN	kN	
Internal rubber layer thickness—9 mm											
2	**45**	**755**	**2.25**	**1430**	**15.0**	**1287**	**905**	**—**	**—**	**327**	**AS [50] 040902R**
3	59	575	1.73	1087	19.5	1287	1044	743	—	249	AS [50] 040903R
4	73	464	1.41	877	24.0	1287	1131	808	637	201	AS [50] 040904R
5	87	389	1.19	735	28.5	1287	1191	846	705	169	AS [50] 040905R
6	101	335	1.02	633	33.0	1256	1234	867	748	145	AS [50] 040906R
7	115	294	0.90	555	37.5	1105	1105	878	775	127	AS [50] 040907R
8	129	262	0.81	495	42.0	987	987	828	792	114	AS [50] 040908R
9	143	236	0.73	446	46.5	891	891	732	732	102	AS [50] 040909R
10	157	215	0.66	406	51.0	813	813	653	653	93	AS [50] 040910R
Internal rubber layer thickness—12 mm											
2	51	433	1.88	794	18.0	1138	854	625	—	188	AS [50] 041202R
3	68	311	1.41	568	24.0	1138	925	674	578	135	AS [50] 041203R
4	85	243	1.13	442	30.0	1036	967	695	619	105	AS [50] 041204R
5	102	199	0.94	362	36.0	864	864	701	640	86	AS [50] 041205R
6	119	168	0.81	307	42.0	740	740	621	621	73	AS [50] 041206R
7	136	146	0.70	266	48.0	648	648	528	528	63	AS [50] 041207R
8	153	129	0.63	235	52.0	576	576	461	461	56	AS [50] 041208R

(*continued*)

TABLE A4 (*continued*)

Steel plate thickness = 5 mm | Side cover thickness = 10 mm | Top and bottom cover thickness = 6 mm

Number of internal rubber layers	Overall height	Compressive stiffness at zero shear	Mean shear stiffness	Rotational stiffness	Shear deflection capacity	Rated load at zero shear		Rated load at max. shear		Min. load	AS 5100.4 Part number
						Rotation 0.000 rads	Rotation 0.010 rads	Rotation 0.010 rads	Rotation 0.015 rads	Rotation 0.005 rads	
	mm	kN/mm	kN/mm	kNm/rad	mm	kN	kN	kN	kN	kN	
Internal rubber layer thickness—15 mm											
2	57	257	1.61	466	21.0	917	760	564	492	112	AS [50] 041502R
3	77	179	1.19	323	28.5	873	802	583	532	78	AS [50] 041503R
4	97	137	0.94	248	36.0	691	691	585	546	60	AS [50] 041504R
5	117	111	0.78	201	43.5	572	572	476	476	48	AS [50] 041505R
6	137	94	0.66	169	51.0	488	488	392	392	41	AS [50] 041506R

NOTES:

1 Bearings shown in bold have limited rotation capacity and should be used with caution.

2 Highlighted rated load values indicate capacity is limited by stability.