

DEPARTMENT ORDER)
NO. 122)))
Series of 2023	,

SUBJECT: Revised DPWH Standard Specification for Item 417 – Bearing Devices

In line with the continuing efforts of the Department to update existing guidelines and standard specifications, the attached revised **DPWH Standard Specification for Item 417 – Bearing Devices**, is hereby prescribed for adoption in Government infrastructure projects.

The revised Pay Items are now included in the Project and Contract Management Application (PCMA) and shall form part of the DPWH Standard Specifications for Highways, Bridges and Airports, Volume II.

This Order supersedes the following issuances and shall take effect immediately:

- 1. Memo 097.7_062019_Revised Pay Item Subscripts Item 412 Elastomeric Bearing Pads;
- 2. Department Order No. 149, Series of 2015, DPWH Standard Specification for Item 417 -Bearing Devices; and,
- 3. Item 412 Elastomeric Bearing Pads of DPWH Standard Specifications for Highways, Bridges and Airports, Volume II, 2012 Edition.

MANUEL M. BONOAN Secretary

14.1.2 MLL/JDV/RPF

Department of Public Works and Highways Office of the Secretary

⊕ Website: https://www.dpwh.gov.ph
 № Tel. No(s).: 5304-3000 / (02) 165-02



Revised DPWH Standard Specification for ITEM 417 – BEARING DEVICES

417.1 Description

This Item shall consist of furnishing and installing bearing devices {elastomeric, pot bearing (fixed and sliding), disc bearing (fixed and sliding), spherical, rocker, roller, seismic isolation bearings [High Damping Rubber Bearing (HDRB), High Damping Rubber Bearing (HDRB) with Lead Plug, Lead Rubber Bearing]} on bridges in accordance with this Specification and as indicated on the Plans.

Elastomeric bearings as herein defined shall include unreinforced pads (consisting of elastomer only) and reinforced bearings with steel or fabric laminates, but not seismic isolation bearings.

Pot Bearings carry vertical load by compression of an elastomeric disc confined in a steel cylinder and accommodates rotation by deformation of the disc. They may be fixed bearings or sliding bearings. Sliding bearings accommodate movement by sliding of a stainless steel plate on a sliding material, such as Polytetrafluoroethylene (PTFE).

Disc Bearings carry vertical load and accommodate rotation by deformation of a single elastomeric disc molded from a urethane compound. They may be fixed bearings or sliding bearings. Sliding bearings accommodate movement by sliding of a stainless steel plate on a sliding material, such as PTFE.

Spherical bridge bearings consist of two metal parts matching curved surfaces and a lowfriction sliding interface made of high-strength brass that slides on a stainless steel mating surface.

Metal Rocker and Roller Bearings carry the vertical load by direct contact between two metal surfaces and accommodate movement by rocking or rolling of one surface with respect to the other.

Seismic isolation bearings transfer vertical loads, accommodate deck rotations and horizontal movements, and extend the structure's period and dissipate seismic energy to reduce seismic damage. They are composed of steel laminated vulcanized natural rubber with top and bottom connection plates and anchorages for bridge attachment. These bearings dissipate energy through lead plug deformation (Lead Rubber Bearings), rubber deformation (High Damping Rubber Bearing), or a combination of both (High Damping Rubber Bearing with Lead Plug).

417.2 Material Requirements

All bearing devices shall be designed in accordance with AASHTO LRFD Bridge Design Manual, AASHTO LRFD Bridge Construction Specifications, DPWH Design Guidelines, Criteria and Standards (DGCS) Volume 5 - Bridge Design, or the Japanese Handbook of Bridge Bearings.

417.2.1 Steel Components

1. Rolled Steel

Tensile properties of the rolled steel shall conform to AASHTO M 270M (ASTM A709M), Standard Specification for Structural Steel for Bridges, JIS G3101 – Rolled Steels for General

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Structure, JIS G3106 – Rolled Steel for Welded Structure, or equivalent. It shall be tested in accordance with ISO 6892-1 (JIS Z2241) – Metallic Materials – Tensile Testing – Part 1: Method of Test at Room Temperature or AASHTO T 244 (ASTM A370), Standard Method of Test for Mechanical Testing of Steel Products.

2. Steel Laminates

Steel laminates shall have a minimum nominal thickness of 1.52 mm. Tensile properties of the steel laminates shall conform to the requirements of ASTM A36, Standard Specification for Carbon Structural Steel, ASTM A1011, Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength, JIS G3101 – Rolled Steels for General Structure, JIS G3106 – Rolled Steels for Welded Structure, or equivalent. It shall be tested in accordance with ISO 6892-1 (JIS Z2241) – Metallic Materials – Tensile Testing – Part 1: Method of Test at Room Temperature.

3. Cast Steel

Cast steel shall conform to ASTM A802/A802M, Steel Castings, Surface Acceptance Standards, Visual Examination or JIS G5102, Steel Castings for Welded Structure and shall be free of all blowholes and impurities larger than 3.2 mm. It shall be tested in conformance with ISO 148-1 (JIS Z 2242) - Metallic materials — Charpy Pendulum Impact test — Part 1: Test method or JIS Z 2242, Method for Charpy Pendulum Impact Test of Metallic Materials.

4. Forged Steel

Forged steel shall conform to the requirements of ASTM A788, Standard Specification for Steel Forgings, General Requirements.

5. Stainless Steel

Mechanical Properties of stainless steel shall conform to the requirements of ASTM A240, Type 304 with a minimum thickness of 20 gage (0.91 mm), or JIS G 4304 – Hot-Rolled Stainless Steel Plate, Sheet, and Strip, JIS G 4305 – Cold-Rolled Stainless Steel Plate, Sheet, and Strip, JIS G 4303 - Stainless Steel bars, or equivalent. It shall be tested in accordance with ISO 6892-1 (JIS Z2241) – Metallic Materials – Tensile Testing – Part 1: Method of Test at Room Temperature or AASHTO T 244 (ASTM A370), Standard Method of Test for Mechanical Testing of Steel Products.

417.2.2 Rubber Material

417.2.2.1 Rubber Material for Elastomeric Bridge Bearings

Elastomeric Bearings as herein defined shall include unreinforced pads (consisting of elastomer only) and reinforced bearings with steel or fabric laminates. The Rubber Material shall meet the requirements of AASHTO M 251 or Tables 3.2.1, 3.2.2, 3.2.3, 3.2.4, 3.2.9, and 3.2.10 of the Handbook for Highway Bridge Bearings, that describe the physical and chemical properties summarized in Table 417.1 and Table 417.2, respectively.

	Ite	em	Unit	Natu Rubbe	Chloroprene Rubber (CR)			Test method	
Sta	tic shea	r modulus G	MPa	0.8 1	1.2	0.8	1	1.2	
stics	Elon	gation at break	%	≥ 550	≥ 500		≥ 450		Tensile test
Basic Characteri	Те	nsile strength	MPa			≥ 15			JIS K 6251
	g test	25% Stress Change Rate at 70°C for 72 h	%		-10	to +100			Air heat aging test JIS K 6257
	Agin	Elongation Change Rate at 70°C for 72 h	%	≥ -50					
rability	Compre	ession set at 70°C for 72 h	%		:	≤ 35			Compression set test JIS K 6262
ig and Du	Ozo at 40°C 20	one resistance for 96 hr,50 pphm,)% extension	-	Visua	l check a	nd free	from c	rack	Static ozone deterioration test JIS K 6259
Agin	Wa	iter resistance			:	≤ 10			Immersion test
	(Weig	ght change rate)	0/0						JIS K 6258-4
	(Tempe water at	rature of distilled 55°C for 72 hr)	70						
	Co	old resistance	-	Impact be belo	Impact brittleness temperature shall be below -30°C (below -40°C in cold district)		e shall in cold	Low temperature impact brittleness test JIS K 6261-2	
Adhesion strength			N/mm			≥7			90° peeling test JIS K 6256

Table 417.1 Physical Properties of Rubber Material for Elastomeric Bearings

Table 417.2 Chemical Composition of Rubber for Elastomeric Bearings

Test	Requirement	Test Method
Polymer Identification	Chloroprene rubber (CR)	ISO 4650, JIS K 6230, or equivalent
	Natural Rubber (NR)	ISO 7270-1, JIS K 6231, or equivalent
Polymer Content ^{*A}	> 50%	ISO 9924-1, JIS K 6226-1,
		ISO 1158, JIS K 7229, or equivalent

Test	Requirement	Test Method
Reinforcing Agents ^{*B}	10-35%	For Black Carbon:
		ISO 9924-1, JIS K 6226-1, or equivalent
		ISO 1408, JIS K 6227, or
		equivalent
		For white carbon:
		ISO 5794-1, JIS K 6430
Ash Content (excluding reinforcing agents)	< 10%	ISO 9924-1, JIS K 6226-1, or equivalent

- Notes:
- 1. *A: Including Oligomer

2. *B: Reinforcing agents are black carbon and white carbon.

3. ISO 4650/JIS K 6230 – Rubber - Infrared spectrometric methods

4. ISO 7270-1/JIS K 6231- Rubber - Analysis by pyrolytic gas-chromatographic methods

5. ISO 1158/JIS K 7229 - Plastics — Vinyl chloride homopolymers and copolymers — Determination of chlorine content

6. ISO 9924-1/JIS K 6226-1- Rubber and rubber products - Determination of the composition of vulcanizates and uncured compounds by thermogravimetry - Part 1: Butadiene, ethylene-propylene copolymer and terpolymer, isobutene-isoprene, isoprene and styrene-butadiene rubbers

7. ISO 1408/JIS K 6227 - Rubber - Determination of Carbon Black Content - Pyrolytic and Chemical Degradation Methods

8. ISO 5794-1/JIS K 6430- Rubber compounding ingredients — Silica, precipitated, hydrated — Part 1: Non-rubber tests

9. JIS K 6251 - Rubber, vulcanized or thermoplastic-Determination of tensile stress-strain properties

10. JIS K 6257 - Rubber, vulcanized or thermoplastic -- Determination of heat ageing properties

11. JIS K 6262 - Rubber, vulcanized or thermoplastic -- Determination of compression set at ambient, elevated or low temperatures

12. JIS K 6259 - Rubber, vulcanized or thermoplastic -- Determination of ozone resistance -- Part 1: Static and dynamic strain testing

13. JIS K 6261-2- Rubber, vulcanized or thermoplastic-Determination of low-temperature properties- Part 2: Lowtemperature brittleness

14. JIS K 6256- Adhesion testing methods for rubber, vulcanized or thermoplastic

417.2.2.2 Rubber Material for Seismic Isolation Bearings

All rubber materials used in the manufacture of the bearing assemblies shall be new and unused with no reclaimed material incorporated into the finished assembly. All bonding of components shall be done under heat and pressure during the vulcanizing process. The rubber materials for the bearing and assemblies shall conform to the physical properties in Table 417.3 for the High Damping Rubber Bearing with or without Lead Plug, and Table 417.4 for the Lead Rubber Bearing in accordance with ISO 22762-1, Elastomeric Seismic Protection Isolators – Part 1: Test methods and ISO 22762-2, Elastomeric Seismic-Protection Isolators – Part 2: Application for bridges - Specifications. Chemical properties shall conform to the requirements prescribed in Table 417.5 Chemical Composition of Rubber for Seismic Isolation Bearing.

Table 417.3 Physical Properties of High Dampin	g Rubber	Bearing	with or	without
Lead Plug				

			Loud	ing			
	Pr	operty	Unit	Re	quirem	ent	Test Mathed
Static	Shea	ar Modulus, G	MPa	0.8	1.0	1.2	rest Method
		Main Body	(High C	Dampir	ng Rub	ber)	
sic teristics	-	Elongation at break	%	≥ 650	≥ 600	≥ 550	ISO 37, JIS K 6251, or
Ba Charac		Tensile strength	MPa		≥ 10		equivalent
	ng test	Stress change rate at 70°C for 168 h	%		± 25		ISO 37, JIS K 6251, or equivalent
urability	Agir	Elongation change rate at 70°C for 168 h	%		≤ -50		ISO 188, JIS K 6257, or equivalent
Aging and Dur		Compression set at 70°C for 24 h	%		≤ 60		ISO 815-1, JIS K 6262, or equivalent ISO 815-2, JIS K 6262, or
Ad	N/mm		≥ 7		equivalent ISO 813, JIS K 6256-2, or equivalent		
		Rubber C	over (N	atural	Rubbe	er)	
E	longa	tion at break	%	≥ 550	≥ 550	≥ 500	ISO 37, JIS K 6251, or equivalent
Ozone resistance at 40°C for 96 h,50 pphm, 20% elongation				Visual	check. N	lo crack	ISO 1431-1, JIS K 6259, or equivalent
	Cold	resistance	°C		≤ -40		ISO 812, JIS 6261-2, or equivalent

Notes:

1. ISO 37/JIS K 6251 - Rubber, vulcanized or thermoplastic -- Determination of tensile stress-strain properties

 ISO 188/JIS K 6257- Rubber, vulcanized or thermoplastic – Accelerated ageing and heat resistance tests
 ISO 815-1/JIS K 6262 Rubber, vulcanized or thermoplastic -- Determination of compression set – Part 1: At ambientor elevated temperatures

ISO 812/JIS 6261-2 - Rubber, vulcanized or thermoplastic -- Determination of low-temperature brittleness
 ISO 813/JIS K 6256-2- Rubber, vulcanized or thermoplastic -- Determination of adhesion to a rigid substrate

^{4.} ISO 815 -2/JIS K 6262 - Rubber, vulcanized or thermoplastic -- Determination of compression set - Part 2: At low temperature

^{5.} ISO 1431-1/JIS K 6259 Rubber, vulcanized or thermoplastic –Resistance to ozone cracking – Part 1: Static and dynamic strain testing

Inspection Item			Unit	Re	equireme	ent	Test Method	
Static She	ar M	odulus, G	MPa	0.8	1.0	1.2	rest method	
		Maii	n body (Natural	Rubber)			
ic eristics	Elo	ngation at break	%	≥ 550	≥ 550	≥ 500	ISO 37, JIS K 6251,	
Bas Charact	Ter	nsile strength	MPa		≥ 15		equivalent	
urability	to Stress change rate at 70°C for		%		± 25		ISO 37, JIS K 6251, or equivalent	
g and Di	AG	Elongation change rate at 70°C for 168 h	%		≤ -50		ISO 188, JIS K 6257, or equivalent	
Agin	(Compression set at 70°C for 24 h	%		≤ 35		ISO 815-1, JIS K 6262, or equivalent ISO 815-2, JIS K 6262, or equivalent	
Adhesion Strength			N/mm		≥ 7		ISO 813, JIS K 6256-2, or equivalent	
	Rubbe	r Cover	(Natur	al Rubb	er)			
Elongation at break			%	≥ 550 ≥ 550 ≥ 500		≥ 500	ISO 37, JIS K 6251, or equivalent	
Ozone Resistance at 40°C for 96 h,50 pphm, 20% elongation				Visual	check. No	o crack	ISO 1431-1, JIS K6259, or equivalent	
Cold F	Resis	tance	°C		≤ -40		ISO 812, JIS 6261-2, or equivalent	

Table 417.4 Physical Properties for Lead Rubber Bearing

Notes:

1. ISO 37/ JIS K 6251 - Rubber, vulcanized or thermoplastic -- Determination of tensile stress-strain properties

2. ISO 188/JIS K 6257- Rubber, vulcanized or thermoplastic – Accelerated ageing and heat resistance tests 3. ISO 815-1/JIS K 6262 - Rubber, vulcanized or thermoplastic -- Determination of compression set – Part 1: At ambient or elevated temperatures

4. ISO 815-2/JIS K 6262 - Rubber, vulcanized or thermoplastic -- Determination of compression set – Part 2: At low temperature

5. ISO 1431-1/JIS K 6259 - Rubber, vulcanized or thermoplastic – Resistance to ozone cracking – Part 1: Static and dynamic strain testing

6. ISO 812/JIS 6261-2 - Rubber, vulcanized or thermoplastic -- Determination of low-temperature brittleness

7. ISO 813/JIS K 6256-2- Rubber, vulcanized or thermoplastic — Determination of adhesion to a rigid substrate — 90degree peel method

Table 417.5 Chemical Composition of Rubber for Seismic Isolation Bearing

Test	Requirement	Test Method
Polymer Identification	Natural Rubber	ISO 4650, JIS K 6230, or equivalent
	Synthetic rubber	ISO 7270-1, JIS K 6231, or equivalent

Test	Requirement	Test Method
Polymer Content ^{*A}	> 40% (in case of High Damping Rubber Bearings with or without Lead Plug)	ISO 9924-1, JIS K 6226-1,
Polymer content	> 50% (in case of Lead Rubber Bearings)	ISO 1158, JIS K 7229, or equivalent
Reinforcing Agents ^{*B}	10–45% (in case of High Damping Rubber Bearings with or without Lead Plug)	For Black Carbon: ISO 9924-1, JIS K 6226-1, or equivalent ISO 1408, JIS K 6227, or
	10–35% (in case of Lead Rubber Bearings)	equivalent For white carbon: ISO 5794-1, JIS K 6430
Ash Content (excluding reinforcing agents)	< 10%	ISO 9924-1, JIS K 6226-1, or equivalent

Notes:

1. *A: Including Oligomer

2. *B: Reinforcing agents are black carbon and white carbon.

3. ISO 4650/JIS K 6230 – Rubber - Infrared spectrometric methods

4. ISO 7270-1/JIS K 6231 - Rubber - Analysis by pyrolytic gas-chromatographic methods

- 5. ISO 1158/JIS K 7229 Plastics Vinyl chloride homopolymers and copolymers Determination of chlorine content
- 6. ISO 9924-1/JIS K 6226-1 Rubber and rubber products Determination of the composition of vulcanizates and uncured compounds by thermogravimetry - Part 1: Butadiene, ethylene-propylene copolymer and terpolymer, isobutene-isoprene, isoprene and styrene-butadiene rubbers
- 7, ISO 1408/JIS K 6227 Rubber Determination of Carbon Black Content Pyrolytic and Chemical Degradation Methods
- 8. ISO 5794-1/JIS K 6430 Rubber compounding ingredients Silica, precipitated, hydrated Part 1: Non-rubber tests

417.2.3 Lead

The purity of the lead shall be determined by chemical analysis in accordance with the applicable requirements of JIS H 2105:1955, Pig Lead and ASTM B29, Standard Specification for Refined Lead or equivalent. The purity of lead shall be at least 99.99%.

417.2.4 Masonry, Sole, and Shim Plates

Tensile properties of metal plates used in masonry, sole, and shim plates, unless otherwise specified, shall conform to AASHTO M 270M (ASTM A709M) Grade 36 (Grade 250), JIS G 3101, JIS G 3106, or equivalent. It shall be tested in accordance with ISO 6892-1 (JIS Z2241) – Metallic Materials – Tensile Testing – Part 1: Method of Test at Room Temperature or AASHTO T 244 (ASTM A370), Standard Method of Test for Mechanical Testing of Steel Products.

417.2.5 Anchor bolts

Anchor bolts shall meet the mechanical property requirements (hardness and tensile) of ASTM A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength, JIS G3101, or JIS G 4051. It shall be tested in accordance with ISO 6892-1 (JIS Z2241) – Metallic Materials – Tensile Testing – Part 1: Method of Test at Room Temperature or AASHTO T 244 (ASTM A370), Standard Method of Test for Mechanical Testing of Steel Products.

417.2.6 Elastomeric Rotational Element for Pot Bearings

The elastomeric rotational element used in the construction of pot bearings shall contain only virgin, crystallization-resistant polychloroprene (Neoprene), conforming to AASHTO M251 (ASTM D4014) or Virgin natural polyisoprene (natural rubber), conforming to AASHTO M 251 as the raw polymer. The physical properties of Neoprene and natural rubber shall conform to the Specifications above with modifications as follows:

- 1. The Shore A Durometer hardness shall be 50 +/-10 points.
- 2. Samples for compression set tests shall be prepared using a Type 2 die.

417.2.7 Sliding Material for Sliding Bearing (Pot and Disc Bearings)

PTFE sheet and strip requirements for sliding material for sliding bearing (pot and disc bearings) shall conform to the provisions of Article 18.8 of the AASHTO LRFD Bridge Design Specifications.

Other sliding materials shall be allowed given the basis of material friction test evidence conforming to Article 18.1.5.2.3 of the AASHTO LRFD Bridge Construction Specifications and as shown in the Plans.

417.2.8 Polyether Urethane Structural Element for the Disc Bearing

The polyether urethane structural element used in the construction of disc bearings shall be molded from a monolithic polyether urethane compound. The physical properties of the polyether urethane shall conform to the minimum requirements listed in Table 417.6.

Table 12/10/11/blear rober deb of roly earler of earlier									
Physical Properties	Requirements	Test Method							
Hardness, Type D Durometer	≥45	ASTM D2240, JIS K6253-3, or							
		equivalent							
Minimum Tensile Stress, MPa At 100% elongation	≥10.3	ASTM D412, JIS K6251, or equivalent							
Tensile Strength, MPa, Min.	≥27.6	ASTM D412, JIS K6251, or equivalent							
Ultimate Elongation, %, Min.	≥350	ASTM D412, JIS K6251, or equivalent							
Compression Set, 22 h at 158	<40	ASTM D395, JIS K6262, or equivalent							
°F, Method B, %, Max.									
Tensile Strength, MPa, Min. Ultimate Elongation, %, Min. Compression Set, 22 h at 158 °F, Method B, %, Max.	≥27.6 ≥350 <40	ASTM D412, JIS K6251, or equivalent ASTM D412, JIS K6251, or equivalent ASTM D395, JIS K6262, or equivalent							

 Table 417.6 Physical Properties of Polyether Urethane

Notes:

1. ASTM D2240 - Standard Test Method for Rubber Property—Durometer Hardness

2. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension

3. ASTM D395 - Standard Test Methods for Rubber Property— Compression Set

4. JIS K 6253-3 – Rubber, vulcanized or thermoplastic – Determination of hardness – part 3: Durometer method

5. JIS K 6251 - Rubber, vulcanized or thermoplastic- Determination of tensile stress-strain properties

6. JIS K 6262 - Rubber, vulcanized or thermoplastic- Determination of compression set at ambient, elevated or low temperatures

417.2.9 High-Strength Brass

High-strength brass casting shall be used in the manufacture of the curved bearing plate of spherical bearings and shall conform to the applicable requirements of JIS H 5120:2016 Copper and copper alloy castings (alloy CAC304) or ASTM B22:2017 Standard Specification for Bronze Casting for Bridges and Turntables (alloy C99100, C86300, or C90500).

In order to reduce sliding friction when following horizontal and rotational displacements, solid lubricants such as fluorocarbon resin, molybdenum disulfide, graphite, etc., mixed with various additives to improve lubricating film characteristics shall be used embedded in the body of the bearing plate, using concentric rings with or without central circular recesses.

417.2.10 Bedding of Masonry Plates

Bedding of Masonry Plates shall conform to the provisions of Article 18.10.2 of the AASHTO LRFD Bridge Design Specifications.

417.2.11 Load Plates

Plates shall conform to the provisions of Article 18.12 of the AASHTO LRFD Bridge Design Specifications.

417.2.12 Non-shrink Grout

Non-shrink grout shall conform to the requirements of Item 727, Non-shrink Grout.

417.2.13 Anti-corrosion System

Exposed steel surfaces, if any, shall be protected from rust by an anti-corrosion system as per Manufacturer's recommendation approved by the Engineer or as shown on the approved Plans. If galvanized coating is specified on the Plans, structural steel shall be galvanized according to AASHTO M 111M (ASTM A123M), Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products, or JIS H 0401 – Test Methods for Hot Dip Galvanized Coatings and JIS H 8641 – Hot Dip Galvanized coatings, or equivalent.

417.2.14 Dimensions

Bridge bearings shall be built as specified in the contract documents within the tolerances of AASHTO LRFD Bridge Construction Specification or the Handbook for Highway Bridge Bearings.

417.3 Construction Requirements

Construction and installation of bearing devices {plain elastomeric bearings pads, laminated bearings, pot, disc, sliding, spherical, rocker, roller, seismic isolation bearings [High Damping Rubber Bearing (HDRB), High Damping Rubber Bearing (HDRB) with Lead Plug, Lead Rubber Bearing]} shall be as shown on the Plans as per approval of the Engineer. The Contractor shall ensure the quality of the equipment, proper handling during transport, protection against elements and proper installation of the bridge bearing.

417.3.1 Drawings

Drawings shall be in accordance with Section 18.1.1—Working Drawings of the AASHTO, Load and Resistance Factor Design (LRFD) Bridge Construction Specification. Details of bearings including material proposed for use shall be shown. Fabrication shall not begin until drawings are approved by the Engineer.

417.3.2 Submittals

Prior to start of the construction and/or installation, the following shall be submitted to the Engineer for evaluation and approval, which shall include but not limited to:

- 1. Shop drawings for each of bearings indicating dimensions, weights, details of connector and laminated structures;
- 2. Quality test reports of products and materials;
- 3. Required testing and inspection procedure;
- 4. Manufacturer's specifications and manuals (installation and maintenance);
- 5. Schedule of manufacture, testing and delivery, including name and address of testing laboratory; and,
- 6. Warranty/Guarantee from the manufacturer/supplier.

417.3.3 Packaging, Handling, and Storage

Each bearing component shall be clearly identified and shall be marked on its top the location and orientation in the structure before shipping. The bearings must be securely fastened, bolted, or strapped to prevent relative movement.

During shipping, handling, or storing bearings shall be packaged to prevent damage.

Bearing assemblies shall not be dismantled on-site unless necessary for inspection or installation. Dismantling shall be under the direct supervision or with the approval of the manufacturer.

A listing of all individual bearing numbers shall be furnished.

417.3.4 Installation

The bearings shall be clearly marked with their longitudinal and transverse axes, their types, numbers, and their intended locations in the Works. The Contractor shall fix and bed all bearings in accordance with the Manufacturer's recommendations and have to submit for the Engineer's approval. Proposals for the thickness and type of bearing plinths and beds shall be submitted by the Contractor and approved by the Engineer in advance of bearing installation.

417.3.5 Furnishing

Bearings shall be in accordance with the approved design Plan and manufactured by an ISO 9000 series certified company.

417.3.6 Performance Requirements

All bearing devices shall be evaluated by visual inspection and certification from a manufacturer with an ISO 9000 certification or an effective testing and inspection system.

417.3.6.1 Elastomeric Bearings

Finished elastomeric bearings shall be subjected to the tests described in AASHTO M 251 or the applicable requirements of Table 6.2.1 of Handbook for Highway Bridge Bearings which was summarized in Table 417.7.

Inspection Item		ction Item	Inspection Procedure	Applicable Test/Inspection			n
				Dispersion	Fixed	Movable	Pad
Performance Inspection of Rubber Bearing	rmance Test	Compressive Displacement	Test condition: Compressive load equivalent to the design maximum reaction shall be applied 3 times, and the value obtained at the 3rd loading shall be determined as measured value. <u>Acceptance criteria:</u> Compressive displacement amount under rotational verification load shall be larger than design value of rotational displacement amount. For terminal support, compressive displacement amount from dead load reaction to verification load shall be within +1 mm against design value of compressive displacement amount at verification load.	М	М	М	Μ
	Vertical Perforn	Vertical Stiffness	<u>Test condition</u> : Same as above. <u>Acceptance criteria:</u> Compressive stiffness at bearing stress between 1.5 to 6.0 N/mm ² shall be within ±30% against design value <u>Test condition:</u> Same as above. The following	E	E	E	X
		Appearance	Same as above. The following items shall be checked with naked eyes. Acceptance Condition: No deformation such as unusual bulge. No abnormalities in quantity and spaces between inner plates.	М	Μ	Μ	М

Table 417.7 Performance Tests for Elastomeric Bearings

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Inspection Item			Inspection Procedure	Applicable Test/Inspection			
				Dispersion	Fixed	Movable	Pad
	ertical Performance Test	Appearance (Movable Bearing only)	Test condition: Apply vertical load equivalent to design dead load, and apply displacement equivalent to 70% of rubber layer's thickness. <u>Acceptance criteria:</u> Hold the predefined shape which can support vertical load under above the provided	Х	X	Μ	Μ
	2		no hazardous defects in rubber section such as crack and bulge.				
			Test condition:				
n of Rubber Bearing		Equivalent Stiffness (Longitudinal)	Apply vertical load equivalent to design dead load reaction, and apply repeated displacement to positive and negative direction for 3 times that is equivalent to 175% of rubber layer's thickness. Third loading shall be determined as measured value.	М	Х	Х	Х
pecti			Acceptance criteria:				
ance Insp	ance Test		The value shall be within $\pm 10\%$ against the design value.				
erfori	form	Equivalent Damping Ratio	Test condition: Same as above				
Pe	I Per		Acceptance Condition:	_	x	N N	X
	orizonta		More than design value.	E		Х	Х
	Ť		Test condition:				
		Appearance	Same as above. Following items shall be checked with naked eyes.				
			Acceptance criteria:	м	x	x	x
			Hold the predefined shape which can support vertical load under shear deformation. There shall be no hazardous defects in rubber section such as crack and bulge.	n	X	X	~
			Acceptance criteria:				
Appearance of Rubber Body		nce of Rubber Body	There shall be no hazardous defect, contamination of foreign substances, or partial deformation.	Μ	М	Μ	Μ

Т

Notes:

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1. E - The corresponding test shall be carried out only if specified by the Engineer.

2. M - The corresponding test is required/mandatory for this type of elastomeric bearing.

3. X - The corresponding test is not required for this type of elastomeric bearing.

417.3.6.2 Fixed and Sliding Bearings (Pot and Disc Bearings)

Testing for fixed pot and disc bearings shall be in accordance with 18.3.4.4.4 Proof Load Test of the AASHTO LRFD Bridge Construction Specification.

Sliding bearings (Pot and Disc Bearings) shall be tested with 18.3.4.4.3 Long-Term Deterioration Test, 18.3.4.4.4 Proof Load Test and 18.3.4.4.5 Sliding Coefficient of Friction of the AASHTO LRFD Bridge Construction Specification.

417.3.6.3 Spherical Bearings

The manufacturer shall provide evidence of having carried out the following Type Tests on the high-strength brass bearing plate to confirm the vertical loading capacity, durability, and rotation capability. Scaled-down test pieces are acceptable. Unlike Routine Tests that are required to be performed for quality control of the production, previous Type Tests conducted in bearing plates of the same material may be submitted.

1. Vertical Load Capacity and Friction Test

The bearing plate, made of high-strength brass casting and embedded with solid lubricant, shall be tested to confirm its vertical load capacity and friction characteristics. The vertical load and cycles of horizontal displacement shall be applied as follows:

- a. Vertical load corresponding to the design compression stress of the bearing plate shall be applied and gradually increased to 3 times the design compression stress; and,
- b. Cycles of horizontal movement shall be applied to measure the frictional properties.

No abnormal deformation shall be observed, and the solid lubricant shall remain on the contact surface. The friction coefficient shall remain stable throughout the testing process with variations within the design value.

2. Durability Test

The bearing plate made of high-strength brass casting and embedded with solid lubricant, shall be loaded in the vertical direction and cycles of horizontal displacement shall be applied according to the following procedure:

- a. A vertical load corresponding to the design compressive stress shall be applied on the bearing plate; and,
- b. A total horizontal displacement equal to or larger than the estimated accumulated displacement of the girder during 100 years of service under temperature variations shall be applied.

Calculations of the applicable accumulated displacement shall follow the procedure described in Section 10 of Reference Materials of the Handbook for Highway Bridge Bearings. The friction coefficient shall remain stable during the test.

3. Rotation Capacity Verification Test

The bearing plate made of high-strength brass casting and embedded with solid lubricant, shall be loaded in the vertical direction while applying cycles of rotation as follows:

- a. A vertical load corresponding to the design compressive stress shall be applied; and,
- b. The bearing plate shall be subjected to 100 cycles of a rotation of 1/150 rad.

During the testing, the rotational resistance moment and the corresponding rotational displacement values shall be measured and shall show similar values at the beginning and end of the test.

417.3.6.4 Seismic Isolation Bearings

For seismic isolation bearings (High Damping Rubber Bearings with or without Lead Plug and Lead Rubber Bearings), performance tests specified in Performance Routine Tests and Performance Type Tests shall be carried out in accordance with the applicable requirements of ISO 22762-1. All test results shall identify the bearings by the Manufacturer's serial number.

1. Performance Routine Tests

All seismic isolation bearings (High Damping Rubber Bearings with or without Lead Plug and Lead Rubber Bearings) shall be subjected to Performance Routine Test prior to installation.

a. Compression Test

The compressive properties of the High Damping Rubber Bearings with or without Lead Plug and Lead Rubber Bearings shall conform to the requirements specified in Subsection 6.5.2 of ISO 22762-2 and shall be tested in accordance to Subsection 6.2.1 of ISO 22762-1.

b. Compression Shear Test

The shear properties of the High Damping Rubber Bearings with or without Lead Plug and Lead Rubber Bearings shall conform to the requirements specified in Subsection 6.5.4 of ISO 22762-2 and shall be tested in accordance to Subsection 6.2.2 of ISO 22762-1 using a shear stiffness tolerance of $\pm 10\%$.

2. Performance Type Tests

Type Tests shall be conducted to ensure that the design parameters were achieved or to verify the material's performance and properties during development. Unlike Routine Tests that are required to be performed for quality control of the production, previous Type Test may be submitted provided that:

- a. Materials are fabricated in a similar manner and from the same compound or adhesive;
- b. All corresponding external and internal dimensions are within 10% of each other;
- c. The second shape factors are within ± 10 %; and,
- d. The test conditions such as maximum and minimum vertical load applied in the ultimate property test in the shear displacement capacity is more severe.

A complete test report and a certification from manufacturer attesting that the above conditions were satisfied shall be issued by the manufacturer to the Contractor and must be

submitted to the Engineer for approval. All Type Test reports shall have an original Authentication Certificate from the state or country of origin indicating the date of certification.

A. Shear Displacement Capacity Test

The testing procedure for the shear displacement capacity test shall be in accordance with the applicable requirements of Subsection 6.4 of ISO 22762-1.

A compressive load equivalent to the dead load shall be applied simultaneously with the following cycles of horizontal displacement:

- a. 11 fully-reversed cycles equivalent to 175% shear strain;
- b. 6 fully-reversed cycles equivalent to 250% shear strain; and,
- c. 2 fully-reversed cycles equivalent to 300% shear strain.

When a displacement corresponding to a shear strain of 175% is applied, the equivalent lateral stiffness and equivalent damping ratio, computed as the average lateral stiffness from cycles 2 to 11, shall be respectively within $\pm 10\%$ and strictly superior to the design value. The bearing shall maintain its predefined shape during the test. No abnormal deformation, e.g., unusual bulges, shall be found during visual inspection after the test.

B. Durability Test

Degradation, creep and fatigue tests shall conform to the requirements of Subsection 6.5.8 and Subsection 6.5.9 of ISO 22762-2 and shall be tested in accordance with Subsection 6.6 of ISO 22762-1.

417.3.6.5 Rocker and Roller Bearings

Steels used in rocker and roller bearings shall be of the types and grades as specified in the contract documents. The steel at the contact surface of a metal bearing may be hardened provided that, after hardening, the steel satisfies the strength and ductility requirements of the contract documents and the material specifications. Rocker and roller bearings shall follow the requirements of AASTHO LRFD Section 18.4 or the Handbook for Highway Bridge Bearings.

417.3.7 Labeling

All bearings shall be labelled with the company name, serial number, and bearing type engraved permanently on a visible part of the bearing after installation.

417.3.8 Acceptance

Inspection shall be conducted for the installation of bridge bearings in conformance with the Plans and Specifications

Certified True Copy of the Test Result and/or Mill Certificate, shall be submitted with original authentication certification from the state or country of origin indicating the date of certification.

417.4 Method of Measurement

Bearing devices shall be measured by the number of each installed bearings in accordance with this Specification and as shown on the approved Plans accepted by the Engineer.

417.5 Basis of Payment

The accepted quantity, measured as prescribed in Section 417.4 Method of Measurement, shall be paid for at the Contract Unit Price for bearing devices which price and payment shall be full compensation for furnishing and placing all materials, including all labor, equipment, tools, and incidentals necessary to complete the work prescribed in this Item.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
417 (1)a	Seismic Isolation Bearings, Lead Rubber Bearing	Each
417 (1)b	Seismic Isolation Bearings, High Damping Rubber Bearing	Each
417 (1)c	Seismic Isolation Bearings, High Damping Rubber Bearing with Lead Plug	Each
417 (2)	Elastomeric Bridge Bearings	Each
417 (3)a	Pot Bearing, fixed	Each
417 (3)b	Pot Bearing, sliding	Each
417 (4)a	Disc Bearing, fixed	Each
417 (4)b	Disc Bearing, sliding	Each
417 (5)	Sliding Bearing	Each
417 (6)	Rocker Bearing	Each
417 (7)	Roller Bearing	Each
417 (8)	Spherical Bearing	Each

References:

- 1) DPWH Standard Specification for Item 412, Elastomeric Bearing Pads of DPWH Standard Specification for Highways, Bridges and Airports, Volume II, 2012 Edition
- 2) Department Order No. 149, Series of 2015: DPWH Standard Specification for Item 417, Bearing Devices

3) DPWH Design Guidelines, Criteria and Standards (DGCS) Volume 5 - Bridge Design

4) AASHTO LRFD Bridge Design Manual, ASHTO LRFD Bridge Construction Specifications

5) Handbook for Highway Bridge Bearings (latest edition, Japan Road Association)

6) AASHTO M 251 - Standard Specification for Plain and Laminated Elastomeric Bridge Bearings

7) AASHTO M 270M, Standard Specification for Structural Steel for Bridges

8) Japanese Industrial Standards

- a) JIS G 3101 Rolled Steels for General Structure
- b) JIS G 3106 Rolled Steels for Welded Structure
- c) JIS Z 2241 Metallic materials -- Tensile testing -- Method of test at room temperature

d) JIS G 5102 – Steel castings for welded structure

- e) JIS Z 2242 Method for Charpy pendulum impact test of metallic materials
- f) JIS G 4304 Hot-rolled stainless steel plate, sheet, and strip
- g) JIS G 4305 Cold-rolled stainless steel plate
- h) JIS G 4303 Stainless Steel bars

i) JIS K 6251 - Rubber, vulcanized or thermoplastic-Determination of tensile stress-strain properties

j) JIS K 6257 - Rubber, vulcanized or thermoplastic -- Determination of heat ageing properties

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- *k)* JIS K 6262 Rubber, vulcanized or thermoplastic -- Determination of compression set at ambient, elevated or low temperatures
- *I)* JIS K 6259 Rubber, vulcanized or thermoplastic -- Determination of ozone resistance -- Part 1: Static and dynamic strain testing
- *m)* JIS K 6261 Rubber, vulcanized or thermoplastic -- Determination of low-temperature properties -- Part 1: General introduction and guide
- n) JIS K 6256-2 Rubber, vulcanized or thermoplastic -- Determination of adhesion strength -- Part 1: Adhesion to a rigid substrate – 90 degree peel method
- o) JIS K 6230 Rubber Identification Infrared spectrometric methods
- p) JIS K 6231 Rubber Identification of polymers (single polymers and blends) Pyrolytic gas chromatographic method
- *q)* JIS K 6226-1 Rubber and rubber products Determination of the composition of vulcanizates and uncured compounds by thermogravimetry Part 1: Butadiene, ethylene-propylene copolymer and terpolymer, isobutene-isoprene, isoprene and styrene-butadiene rubbers
- *r)* JIS K 6226-2 Rubber, vulcanized or thermoplastic -- Determination of low-temperature properties -- Part 2: Low-temperature brittleness
- s) JIS K 6227 Rubber Determination of carbon black content Pyrolytic and chemical degradation methods
- t) JIS K 7229 Determination of chlorine in chlorine-containing polymers, copolymers and their compounds
- *u)* JIS K 6261-2- Rubber, vulcanized or thermoplastic-Determination of low-temperature properties- Part 2: Low-temperature brittleness
- v) JIS K 6430 Rubber compounding ingredients -- Silica -- Test methods
- w) JIS K 6256- Adhesion testing methods for rubber, vulcanized or thermoplastic
- x) JIS H 2105 Pig Lead
- y) JIS G 4051 Carbon steels for machine structural use
- z) JIS H 5120 Copper and copper alloy castings
- aa) JIS H 0401 test Methods for Hot Dip Galvanized Coatings
- bb) JIS H 8641 Hot dip galvanized coatings

9) American Society for Testing and Materials

- a) ASTM A709 Standard Specification for Structural Steel for Bridges
- b) ASTM A802 -Steel Castings, Surface Acceptance Standards, Visual Examination
- c) ASTM A788 Standard Specification for Steel Forgings, General Requirements.
- d) ASTM B29- Standard Specification for Refined Lead
- e) ASTM A307- Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
- f) ASTM D4014- Standard Specification for Plain and Steel-Laminated Elastomeric Bearings for Bridges
- q) ASTM C920- Standard Specification for Elastomeric Joint Sealants
- h) AASHTO M 111M- Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- *i)* ASTM A123- Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 10) ISO standards
 - a) ISO 6892-1 Metallic materials Tensile testing Part 1: Method of test at room temperature
 - b) ISO 148-1 Metallic materials Charpy pendulum impact test Part 1: Test method
 - c) ISO 22762-1 Elastomeric Seismic Protection Isolators Part 1: Test methods
 - d) ISO 22762-2 Elastomeric Seismic-Protection isolators Part 2: Application for bridges Specifications
 - e) ISO 37 Rubber, vulcanized or thermoplastic -- Determination of tensile stress-strain properties
 - f) ISO 188- Rubber, vulcanized or thermoplastic Accelerated ageing and heat resistance tests
 - *g)* ISO 815-1 Rubber, vulcanized or thermoplastic -- Determination of compression set Part 1: At ambient or elevated temperatures
 - *h)* ISO 815 -2 Rubber, vulcanized or thermoplastic -- Determination of compression set Part 2: At low temperature
 - *i) ISO 1431-1 Rubber, vulcanized or thermoplastic –Resistance to ozone cracking Part 1: Static and dynamic strain testing*
 - j) ISO 812 Rubber, vulcanized or thermoplastic -- Determination of low-temperature brittleness
 - *k) ISO 813 Rubber, vulcanized or thermoplastic -- Determination of adhesion to a rigid substrate 90* degree peel method *ISO 4650 – Rubber – Identification – Infrared spectrometric methods*
 - *I) ISO 7270-1 Rubber Analysis by pyrolytic gas-chromatographic methods Part1: Identification of polymers (single polymers and polymer blends)*

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- *m)* ISO 9924-1 Rubber and rubber products Determination of the composition of vulcanizates and uncured compounds by thermogravimetry Part1: Butadiene, ethylene-propylene copolymer and terpolymer, isobutene-isoprene, isoprene and styrene-butadiene rubbers
- n) ISO 1158 Plastics Vinyl chloride homopolymers and copolymers Determination of chlorine content
- o) ISO 1408 Rubber Determination of carbon black content pyrolytic and chemical degradation methods
- *p)* ISO 5794-1 Rubber compounding ingredients Silica, precipitated, hydrated Part 1: Non-rubber tests
- q) ISO 4650 Rubber Identification Infrared spectrometric methods
- r) ISO 9000 Quality management systems Fundamentals and vocabulary