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M-23

VIBRATION ISOLATOR

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Foreword:

CCS Product Inspection and Testing Guideline (hereinafter referred to as this Guideline) contains the technical requirements, inspection and testing criteria related to classification and statutory survey of marine products to be applied for CCS approval/inspection.

This Guideline frees the users to adopt other test methods and requirements which are equivalent to or are stricter than this Guideline.

This Guideline is published and updated by CCS, and is released at <http://www.ccs.org.cn>. Your comments or suggestions are welcomed and may be sent to our email addressed mp@ccs.org.cn.

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VIBRATION ISOLATOR

1 Application

1.1 This guideline is applicable to vibration isolators which use metal and rubber as the vibration isolating materials and are used to reduce the vibration and noise of ship power equipment. Reference to this guideline may be made for vibration isolators made of other vibration isolating materials (e.g. soft timber, air, liquid).

2 Normative references

2.1 The Basis for approval and inspection used in this Guideline are as follows:

CCS Rules for Classification of Sea-going Steel Ships and Amendments thereto

CCS Rules for Materials and Welding and Amendments thereto

2.2 The provisions in the abovementioned reference documents for approval and inspection become the provisions of this guideline through reference thereto. All dated reference documents and all the subsequent revisions (not including corrections) and revised editions are not applicable for the purpose of this guideline. Therefore, attention is to be paid to compliance with the requirements of the latest revisions of these documents when the product is being designed, manufactured and inspected. The latest revisions of all undated documents listed above are applicable for the purpose of this guideline.

3 Terms and definitions

3.1 The terms and definitions given in CCS Rules for Classification of Sea-going Steel Ships are applicable for the purpose of this guideline.

3.2 The relevant definitions in this guideline are as follows:

(1) Stiffness

The ratio of the change of force (or moment) applied on the elastic element to the change of the translational deformation (or torsional deformation) generated

(2) Dynamic stiffness

The ratio of the complex number of the force at a certain point to the complex number of the displacement of this point or another point in a mechanical system

(3) Natural frequency

The frequency of free vibration of undamped or damped linear vibration system

(4) Damping

Energy dissipation along with time or distance

(5) Shore hardness

Shore hardness is usually used to measure the ability of plastic or rubber surfaces to resist the extrusion by hard objects. The hardness of rubbers is expressed in Shore A.

4 Drawings and documentation to be submitted

4.1 The applicant is to submit the plans and technical documents listed below to CCS when applying for initial product inspection of vibration isolators.

4.1.1 The following drawings and documentation to be submitted are to be submitted to CCS for approval:

(1) Product performance parameter list (which is generally to include the parameters such as rated load, deformation allowance, vertical stiffness or/and lateral stiffness, etc.)

(2) Mechanical and mechanical property sheet for main parts (which is generally to include the mechanical and chemical properties of metallic parts, hardness, tensile property and bonding strength of rubber parts, etc.)

(3) General assembly drawing

(4) Main parts diagram (shell, elastic elements, stopper block, etc.)

(5) Test program

4.1.2 The following drawings and documentation to be submitted are to be submitted to CCS for review:

(1) General assembly details

(2) Instructions for use of the product

5 Design and technical requirements

5.1 Material

5.1.1 The rubber parts of vibration isolators are generally to be made of oil resistant rubber. Where the rubber parts are made of non-oil-resistant rubber, the surfaces are to be protected against oil.

5.1.2 The metallic parts of vibration isolators are to be corrosion resistant or the surfaces are to be protected against corrosion.

5.1.3 The hazardous substances contained in the non-metallic materials of vibration isolators are not to exceed the control limits specified by relevant standards.

5.2 Structure

5.2.1 The vibration isolators are to be adequate to damp the structure vibration of power equipment and satisfy the need of vibration isolation required for ships and power equipment.

5.2.2 The vibration isolators are to meet the requirements of the service environment conditions of ships.

5.2.3 The vibration isolators are to be so structured as to ensure that the rubber parts will not be damaged in environments of severe impact.

5.2.4 The surface of metallic parts bonded to rubber is to be free from any acute angle. The metallic bonding face is to be degreased, grit or shot blasted or phosphated prior to sulfidizing treatment.

5.2.5 The components of vibration isolators are to be free from detachment and damage under

rated static load, dynamic load or impact. The metallic components are to be free from plastic deformation except being impacted.

5.2.6 The dimensions of vibration isolator, especially the height along the main load bearing direction, are to meet the design requirements..

5.3 Performance

5.3.1 Environmental conditions

The environmental requirements for vibration isolators are to be no lower than the requirements for environmental conditions of the vibration-isolated equipment.

The vibration isolators are to be functional throughout the specified service life under the conditions of oil contamination, salt mist, humidity and sunlight.

5.3.2 Static property

In general, only the static property along the main load bearing direction is provided for the static load deformation property of vibration isolators. The static property along other directions is to be provided where requested by the user.

When the rated deformation of vibration isolators is greater than 1mm, the range of deformation tolerance is to be no greater than $\pm 15\%$; and when the rated deformation of vibration isolators is smaller than or equal to 1mm, the range of deformation tolerance is to be no greater than $\pm 30\%$.

5.3.3 Dynamic property

In general, only the dynamic property along the main load bearing direction is provided for the dynamic load property of vibration isolators.

For vibration isolators of the same type, the range of natural frequency change under rated load along the main load bearing direction is to be no greater than $\pm 15\%$, and the range of natural frequency change along other directions is to be no greater than $\pm 20\%$.

5.3.4 Impact property

The range of natural frequency change of the same vibration isolator along the main load bearing direction before and after the impact is to be no greater than $\pm 15\%$, and the range of natural frequency change along other directions is to be no greater than $\pm 20\%$.

5.3.5 Damage load property

When a damage load is applied along the main load bearing direction of a vibration isolator, its rubber parts are not to be detached from the metal or to sustain any crack or other damage.

5.3.6 Salt mist resistant property

For vibration isolators that have been salt mist tested, the metallic components are not to have any apparent corrosion, the surface of rubber materials is not to have any cracking or flaking, and the rubber-metal bonded face is not to have any detachment and damage.

5.3.7 Mechanical property of rubber compound test slice

The mechanical properties of rubber compound test slice of the rubber (e.g. nitrile butadiene rubber, chloroprene rubber) parts of oil resistant vibration isolators, after sulfurized, are to comply with the requirements of Table 5.3.7(1); and the mechanical properties of rubber compound test slice of the rubber parts of non-oil-resistant vibration isolators, after sulfurized, are to comply with the requirements of Table 5.3.7(2).

The mechanical properties of other special purpose rubbers (e.g. silicone rubber, polyurethane rubber) used for vibration isolators and rubber compounds having a hardness value below 40HA or above 70HA are to be determined through consultations between the buying party and the

design unit or manufacturer.

Properties of Rubber Compound Test Slice of Oil Resistant Vibration Isolators Table 5.3.7(1)

Item	Index	
Tensile strength	$\geq 16\text{MPa}$	
Rate of elongation at break	$\geq 450\%$ (40HA~55HA)	$\geq 400\%$ (55HA~70HA)
Permanent deformation at break	$\leq 25\%$	
Bonding strength	$\geq 3.9\text{MPa}$	
Percentage change in ageing property (70 °C×96h)	-20%~20%	
Brittle temperature	$\leq -25\text{ °C}$	
Shore hardness	40HA~70HA(recommended value)	

Properties of Rubber Compound Test Slice of Non-oil-resistant Vibration Isolators Table 5.3.7(2)

Item	Index	
Tensile strength	$\geq 20\text{MPa}$	
Rate of elongation at break	$\geq 550\%$ (40HA~55HA)	$\geq 450\%$ (55HA~0HA)
Permanent deformation at break	$\leq 25\%$	
Bonding strength	$\geq 3.9\text{MPa}$	
Percentage change in ageing property (70 °C×96h)	-20%~20%	
Brittle temperature	$\leq -25\text{ °C}$	
Shore hardness	40HA~70HA (recommended)	

Note: Where rubber compounds not in compliance with abovementioned requirements are used, the designation and main technical parameters of the rubber materials are to be submitted to CCS for review.

6 Type test

6.1 Sampling principle of type test

The vibration isolators for type approval are to be classified depending on type and one set is to be selected from each type of vibration isolators for type test.

6.2 Type test items are to include:

- (1) Marine environmental conditions test (if applicable)
- (2) Elastic element performance test
- (3) Dimensional inspection
- (4) Surface quality
- (5) Static property test
- (6) Dynamic property test
- (7) Damage test
- (8) Fatigue test

6.3 Type test methods and requirements

- (1) Marine environmental conditions test

Vibration isolators intended to be used on board for the first time are to be subject to mechanical and environmental tests such as inclining, swing, vibration, impact tests, etc. With the approval of CCS, the tests of dynamic properties along three main axial directions (vertical, lateral and longitudinal) may replace the inclining and swing tests.

Vibration isolators for service in hot and humid environments are to be subject to alternate damp heat test;

Vibration isolators for service in salt mist environments are to be subject to salt mist test;

Vibration isolators for service in humid environments are to be subject to fungus test;

Vibration isolators for service in oil contaminated environments are to be subject to oil resistance test;

Vibration isolators for service in sunlit environments are to be subject to ultraviolet ageing test.

- (3) Dimensional inspection

The external dimensions and installation dimensions of vibration isolators are to meet the requirements of product drawings.

- (4) Surface quality

The surface of rubber parts is to be smooth and free from defects such as lump, flash, crack, sand hole, air void, etc. However, local rough cracks or stamp dents no more than 0.5mm in depth are allowed.

The metal surface is to be smooth, free from crack, corrosion or other mechanical damage and coated against corrosion.

The bolt holes for installation of vibration isolators are to be free from any scrap rubber.

- (5) Static property test

Static property testing devices are generally to consist of machinery capable of applying force evenly and instruments for measuring force and deformation.

Static deformation and static stiffness under rated load are to be mainly measured. The relationship curve of the static load and static deformation along the load bearing direction is to be

plotted. And the static stiffness at rated load along the three main axial directions is to be provided where necessary.

(6) Dynamic property test

Static property testing devices are generally to consist of sine force generating equipment and instruments for measuring frequency and vibration displacement.

The natural frequency (rated load), damping ratio and dynamic stiffness of the vibration isolator under the rated load along the main load bearing direction are to be measured. And the dynamic stiffness along the three main axial directions is to be provided where necessary.

(7) Damage test

The vibration isolator is to be fixed onto the testing device and the load is to be evenly applied along the main load bearing direction to 5 times of the rated load. The test results are to meet the requirements.

(8) Fatigue test

Fatigue test is employed to check the consistency between the life of the vibration isolator's structures and functions and the life of the system. The vibration isolator is to be mounted for test onto the testing system capable of simulating the actual service conditions. The vibration isolator, upon completion of the test, is to be free from any main failure and degradation of function or performance of the system.

7 Unit/batch inspection

7.1 Unit/batch inspection for manufacturers which have obtained B type approval from CCS

7.1.1 Unit/batch inspection for manufacturers which have obtained B type approval from CCS is to be carried out in accordance with the product inspection plan (relevant details in quality control plan) already approved at the time of approval, and is generally to include the following items:

(1) Dimensional inspection

(2) Surface quality

(3) Static property test

7.1.2 The test items defined in the inspection plan may be completed by the manufacturer independently and integrated test reports are to be issued and submitted to the surveyor for review;

7.1.3 The surveyor is to select the products for retest of abovementioned test items, on a random basis, from the current batch of vibration isolators by the principle of selecting at least one set from each batch/specification, or provide on-site witness when such tests are carried out by the manufacturer;

7.1.4 At each time when a request for unit/batch inspection is being addressed, the following manufacturer technical documents of the product batch are to be submitted along with the request for review by CCS surveyor:

(1) Product quality certificates complying with the requirements

(2) Material certificates for main parts

(3) Manufacturer inspection and test reports

7.2 Unit/batch inspection for manufacturers which have not obtained approval from CCS

7.2.1 The inspection is to cover plan approval and type test:

(1) Plan approval: Plans/technical documents are to be prepared and submitted by the manufacturer to CCS for approval/review in accordance with the requirements of the Guidelines.

(2) Type test: Vibration isolators for which product inspection is applied are to be subject to all type test items required by the Guidelines on a set by set basis.