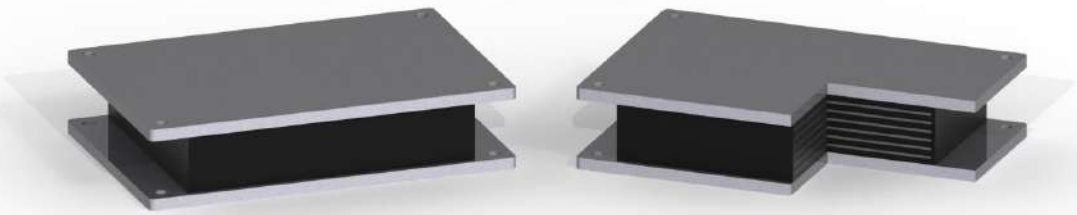
Ideas, Engineering and Manufacture

AGOM®



AGOM E-Link

Elastomeric bearings

AGOM INTERNATIONAL SRL
Via Mesero, 12 – 20002 Ossona (MI) – Italy - www.agom.it
PH.: +39 02 9029111 – FAX: +39 02 9010201 – agom@agom.it

AGOM International: Experience and Quality

Bridges are subjected to movements and rotation caused by traffic, temperature changes, earthquakes, shrinkage, prestressing, creep, etc. Bridge construction requires carefully designed and manufactured bearings, anti-seismic devices, shock absorbers and expansion joints to ensure that such forces are properly dealt with throughout the life of the structure.

Agom has over 50 years' experience in design and manufacturing bridge bearings, bridge expansion joints, anti-seismic devices and shock absorbers for bridge-building and construction industry. All products comply with the latest European standards and all main international standards.

The quality and durability of these products are ensured by:

- our team of skilled engineers, who can conceptualise and design the most appropriate engineering solutions
- qualified professionals, trained and continually updated in quality production techniques
- virgin raw materials that are quality assessed in our on-site testing laboratory
- ISO 9001:2015 quality standard accreditation
- strict quality control processes
- periodical external inspections by globally recognized bodies such as the TZUS of Prague and Certiquality:
- independent international inspection and certification authorities.

AGOM E-Link – Elastomeric bearings

General features of elastomeric bearings

AGOM elastomeric bearings are built to withstand loads and simultaneous deformation in any direction, while also allowing for minor rotations in any of the bearing's axes. AGOM E-Link bearings can be made entirely of rubber or can be reinforced with special sheet steel to increase capacity and transversal strength.

Bearings can also be produced with special anchor plates or with sliding surfaces to improve the structure's displacement capacity. This kind of bearings can withstand vertical loads of up to 22000 kN.

Elastomeric bearings – simple types

E-Link F plain pad bearings

AGOM E-Link F non-reinforced bearings can be used in many construction and civil engineering applications to support concrete and steel structures, and where a simple, low-cost rubber separation strip is capable of carrying compressive loads, while at the same time providing transactional movement and rotational capacity. Plain pad bearings have a large and varied range of possible applications though these bearings are more typically used in prefabricated structures.

On request the E-Link F plain pad bearings can also be provided with a non-fading mark directly moulded on the rubber.

E-Link B laminated bearings

AGOM reinforced bearings E-Link B are designed for use in bridge and building structures as a vertical load bearing component capable of providing transactional movement in any direction and simultaneous rotational capacity.

AGOM E-Link B elastomeric bridge bearings with simple reinforcement are made up of multiple elastomeric layers separated by reinforcing steel plates moulded on the actual layers and can be manufactured in a rectangular or circular shape to meet individual engineering requirements.

These products are simple, robust and corrosion free as the steel inserts are covered entirely in rubber. Easy to install, they will provide long problem-free service.

Elastomeric bearings with external anchor plates

One or two anchor plates can be directly vulcanised to the elastomeric bearings during manufacturing, in order to connect the bearing to the structure by means of mechanical anchorage, so avoiding problems of relative movements.

AGOM can manufacture and supply different types depending on the anchorage system that is required by the Project.

E-Link Type C2

Elastomeric bearing with two external plates and holes for plain anchor bars, primarily for use on in situ cast concrete structures.

E-Link Type C2E

Elastomeric bearing with two external plates and holes, greater than the rubber shape. The horizontal loads are transferred from structures to bearing by means of steel bars or screws bolted to the external plates.

E-Link Type C3

Elastomeric bearing with two outer plates with threaded holes for use on metal structures, or as an anti-lift device; in the latter case, suitable anchor bars to withstand the design loads must be inserted into the support.

E-Link Type C4

Elastomeric bearing with external plates and pins that connect to suitable steel counterplates in order to secure the bearing to the structure and to allow an easy replacement.

E-Link Type C4E

Elastomeric bearing with external plates and an upper pin that connect to a suitable steel counterplate in order to secure the bearing to the structure and to allow an easy replacement.

E-Link Type C5

Elastomeric bearing with two suitably etched external plates to facilitate the bearing's bonding to the structure with glue.

E-Link Type BF

Elastomeric bearing with external plates and restraints that prevent any horizontal movement, in order to obtain a fixed point.

E-Link Type BG

Elastomeric bearing with external plates and restraints that prevent horizontal movements in one direction while allowing (limited) movements in the perpendicular direction, in order to obtain a guided bearing.

Elastomeric bearings with PTFE surface

When a large horizontal displacement capability is required, it's possible to use elastomeric bearings with a PTFE / stainless steel sliding surface. The options are as follows:

E-Link Type D

Elastomeric bearing with a vulcanized PTFE sheet to reduce the coefficient of friction with the welded stainless steel on the upper movable plate: it's a support designed to allow free movement in the longitudinal and transverse directions. According to EN1337-3, this type can only be used as temporary support.

E-Link Type E

Elastomeric bearing with a PTFE sheet embedded in the vulcanised top plate, to reduce the coefficient of friction with the welded stainless steel on the upper movable plate: it's a support designed to allow free movement in the longitudinal and transverse directions.

E-Link Type EG

Elastomeric bearing with a guided sliding plate: it allows movements in the longitudinal direction, while preventing them in the transverse direction by means of steel guides. A sheet of PTFE is embedded in the vulcanized top plate, to reduce the coefficient of friction with the stainless steel, welded to the upper movable plate.

Elastomeric bearings – special applications

E-Link bearings combined with anti-lifting system

AGOM E-Link bearings can be equipped with anti-lifting tool in order to absorb the negative tensile vertical forces. The anti-lifting tools can be applied to all the E-Link bearing (fixed, guided and free sliding) with different systems depending on the bearing type and tensile load value.

It is possible to cover a very wide range of tensile loads by suitable design of anti-lifting tools.

E-Link bearings for bridge launching

The launching bearings are normally used for the incremental launching of the prefabricate bridge by sliding it on PTFE bearings into the final position without the aid of scaffolding.

AGOM design and manufacture either temporary elastomeric launching bearings or permanent pot launching bearings that can be act like a normal permanent pot bearing after the launching operation. The construction time of the bridge can be reduced by means of AGOM launching bearings.

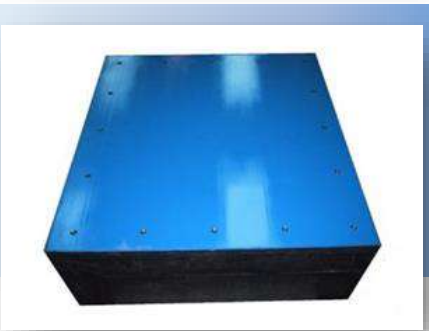
E-Link bearings with holes

Agom can manufacture special bearings with passing holes for post-tensioning bars or fixing devices.

E-Link bearings oversize

AGOM can manufacture elastomeric bearings with plan dimension greater than 1000x1000 mm to withstand even the most non-standard technical requirements.

In the picture E-Link C3 1200x1200x450 is shown.



Materials

Rubber compound

The elastomer used in the machining process can be polychloroprene or neoprene (CR), natural rubber (NR) or SBR according to the required specifications. The mechanical properties of the elastomer according with the main Standard Codes are shown in the tables below; AGOM can use rubber compounds also according with other international standards (BS5400, CSA, NBR..). AGOM quality control department controls each batch and certifies compliance with the standards, as provided by the required international regulations.

Natural Rubber compound (NR)

PROPERTY	UNIT	EN1337-3	AASHTO M251
Hardness	ShA	60 ± 5	60 ± 5
		[ISO 48]	[ASTM D 2240]
G modulus	ShA	0,9 ± 0,15	(0,55 ÷ 1,72)
		[EN1337-3 Annex F]	[AASHTO LRFD BDS]
Tensile strength	MPa	≥ 16	≥ 15,5
		[ISO 37 type 2]	[ASTM D 412]
Elongation at break	%	≥ 425	≥ 450
		[ISO 37 type 2]	[ASTM D 412]
Tear resistance	kN/m	≥ 8	not specified
		[ISO 34-1 Trouser]	
Compression set	%	≤ 30	≤ 25
		[ISO 815]	[ASTM D 395B]
		25% 70°C 24h	25% 70°C 22h
Bond test	N/mm	not specified	≥ 7
			[ASTM D 429B]
Brittleness temperature	°C	≤ -40	≤ -40
		[ISO 812]	[ASTM D 2137]
Ageing in air test code		[ISO 188]	[ASTM D 573]
Ageing temperature	°C	70	70
Ageing duration	h	168	70
Hardness max variation	ShA	-5 / +10	±10
Tensile strength max variation	%	-15	-25
Elongation at break max variation	%	-25	-25
Ozone test code		[ISO 1431-1]	[ASTM D 1149]
Ozone concentration	pphm	25	25
Elongation	%	30	20
Temperature	°C	40	38
Duration	h	96	48
Test result		no cracks	no cracks

Polychloroprene Rubber compound (CR)			
PROPERTY	**UNIT**	**EN1337-3**	**AASHTO M251**
Hardness	ShA	60 ± 5	60 ± 5
		[ISO 48]	[ASTM D 2240]
G modulus	ShA	0,9 ± 0,15	(0,55 ÷ 1,72)
		[EN1337-3 Annex F]	[AASHTO LRFD BDS]
Tensile strength	MPa	≥ 16	≥ 15,5
		[ISO 37 type 2]	[ASTM D 412]
Elongation at break	%	≥ 425	≥ 350
		[ISO 37 type 2]	[ASTM D 412]
Tear resistance	kN/m	≥ 10	not specified
		[ISO 34-1 Trouser]	
Compression set	%	≤ 15	≤ 35
		[ISO 815]	[ASTM D 395B]
		25% 70°C 24h	25% 70°C 22h
Bond test	N/mm	not specified	≥ 7
			[ASTM D 429B]
Brittleness temperature	°C	≤ -40	≤ -40
		[ISO 812]	[ASTM D 2137]
Ageing in air test code		[ISO 188]	[ASTM D 573]
Ageing temperature	°C	100	70
Ageing duration	h	72	70
Hardness max variation	ShA	±5	±15
Tensile strength max variation	%	-15	-15
Elongation at break max variation	%	-25	-40
Ozone test code		[ISO 1431-1]	[ASTM D 1149]
Ozone concentration	pphm	100	100
Elongation	%	30	20
Temperature	°C	40	38
Duration	h	96	100
Test result		no cracks	no cracks

Steel for reinforcement plates

Reinforcement plates and outer plates are made with steel according to the standard EN 10025.

Austenitic steel sheet

The austenitic steel used for sliding surfaces is X5CrNiMo17-12-2 in accordance with EN 10088-2 1.4401 with a minimum thickness of 1.5 mm.

The roughness is $R_{y5i} \leq 1$ µm. The hardness is ≥ 150 HV1 and ≤ 220 HV.

PTFE

AGOM uses only virgin PTFE without regenerated or filler materials.

The minimum thickness for bonded PTFE is 1.5 mm.

The minimum thickness of recessed PTFE is 4.5 mm and varies according with the bearings size and standard.

Bearing fixing

Generally, E-Link bearings with external steel anchor plates are provided with anchor bars suitable for attachment to the lower and upper parts of the structure.

In the case of prefabricated structures, bearings can be provided with an upper pin and a counterplate to be embedded in the concrete; in the case of steel beams, bearings can be supplied with an upper pin and / or fixing screws.

To account for the angle of inclination of the superstructure, the top plate of the elastomeric support can be made according to the drawing, taking into account the equivalent angle of inclination.

In case of simultaneous horizontal loads <20% of the vertical load and if there is sufficient friction between the support and the structure, it's possible to avoid the use of a mechanical anchorage with structure, and use cement or epoxy resins (if local regulations allow it).

E-Link bearings accessories

Movement gauge

The movement indicator allows monitoring the sliding plate displacements by using a reference arrow fixed to the bearing base and a graduate indicator moving with the sliding plate. The movement gauge allows to check the initial presetting of the bearing (if required) and to verify the bearing movement during the future inspections.

Dust protection

The (removable) dust protection around the sliding plate ensures the cleaning of the sliding surfaces to minimize the friction during sliding movements and guarantees the durability of the PTFE sliding material.

Comprehensive Labelling

All the bearings with outer steel plates are provided with a metal label detailing the proprieties of the bearings:

- bearing type
- maximum vertical and horizontal loads
- rotation
- order number
- date of manufacture
- CE Mark

The top face of the bearing gives information on the type of the bearing, the direction of the axis of the bridge, the presetting (if any), the position.

Furthermore, all E-Link bearings are provided with a non-fading mark directly molded on the rubber outlining the properties of the bearing:

- international standards
- order number
- date of manufacture
- CE Mark

Corrosion protection

Steel components exposed to the elements are protected against corrosion. AGOM adapts the corrosion protection in accordance with the aggressiveness of the environment in which the bearings are to be installed and to each customer's requirements.

The standard corrosion protection according EN 1337-9 is as follows:

- sandblasting grade SA2.5.
- two components high thickness epoxy zinc paint (min 250 µm).

The high resistant corrosion protection (metallization) is as follow:

- sandblasting de grade SA2.5
- metal spraying to 85 µm with Zn/Al 85/15
- sealing: epoxy sealer 20-25 µm
- topcoat: polyurethane paint (min 100 µm)

Quality and International Standards

AGOM E-Link elastomer bearings are designed and manufactured in accordance with the requirements of the European standard EN 1337-3 and are qualified with the CE mark.

AGOM can also provide elastomeric bearings in accordance with other standards of a wide range of international standards (British BS 5400, American AASHTO, Canadian CSA,...). The compound used in the molding process can be polychloroprene (neoprene), natural rubber or SBR depending on the required specifications. Every single steel component is mechanically worked and assembled by fully qualified and trained workers inside the AGOM factory under strict ISO 9001:2015 accredited quality control standards.

Qualification, approval tests and certifications

All the qualification and approval tests are performed by independent and worldwide recognized laboratories to assure that the E-Link bearings' performances comply with the project and with international standard requirements.


TECHNICKY A ZKUSEBNI USTAV STAVEBNI PRAHA, s.p.
Technical and Test Institute for Construction Prague, [illegible]

CERTIFICATE
OF CONSTANCY OF PERFORMANCE

No. 1020 – CPR – 0004/0324

Structural bearings
[illegible]

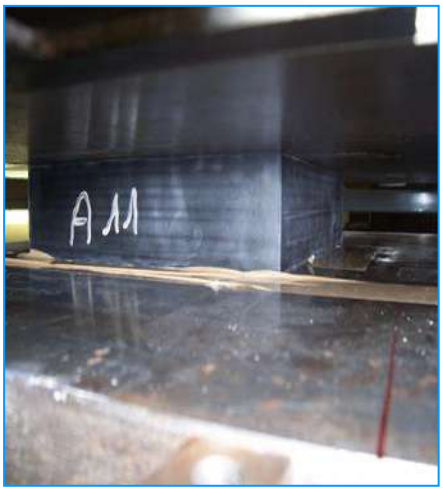
AGOM INTERNATIONAL S. r. l.

AGOM INTERNATIONAL S. r. l.

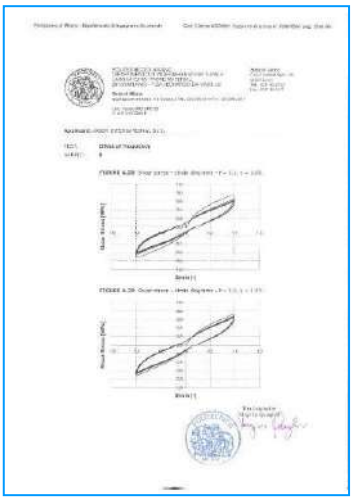
EN 1337-3:2005

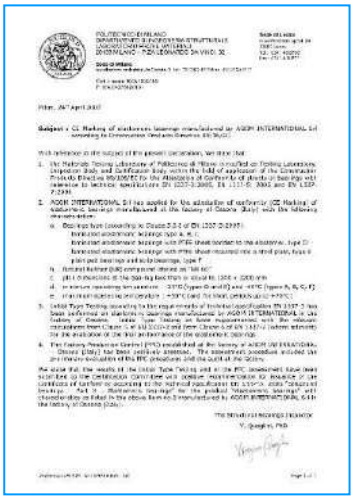
consistency of performance of the construction product.

CE MARK



DYNAMIC TESTS
ON COMPOUNDS

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Subject: CE Marking of elastomeric bearings manufactured by AGOM INTERNATIONAL Ltd according to Construction Products Directive 89/106/EC

TYPE TESTS

Handling and storage

Care should be taken in storage to prevent contamination and damage to the working surfaces. AGOM bearings should be stored in a controlled environment where they are protected from contamination, misuse and excessive moisture.

Robust transportation devices are fitted to all bearings to ensure that the movable components are maintained in their correct relative positions before and during installation. These devices are normally finished in red paint and shall be removed after installation.

Unless special devices have been specified, they should not be used for slinging or suspending the bearings beneath beams.

Due to unpredictable conditions, which may occur during transportation or handling on site, the alignment and presetting (if applicable) of the assembled bearing should be checked against the drawing.

Do not try to rectify any discrepancies on site.

Bearing too heavy to be lifted by hand should be properly slung using lifting equipment.

Pre-setting

If bearing is required to be pre-set, e.g. where once only large movements may occur during stressing operations, this should be specified as a requirement and should only be carried out in AGOM prior to despatch. Do not attempt this operation on site.

Installation

Under control of the Engineer who designed the bridge, bearings must be installed by expert workers, with precision to meet the bridge and bearing design criteria.

Inappropriate handling, storage and installation will have an adverse effect on the bearing life, usually estimated in more than 50 years providing right maintenance.

AGOM structural bearings are manufactured to close tolerances by skilled technicians working in clean conditions. To obtain the requisite performance from bearings it is imperative that they are properly handled at the work site and installed with the same care as when they were assembled in the factory.

AGOM bearings are clearly identified and marked on the top plate (if present) to ensure correct installation. The typeface on the

cover or sliding plate gives information on the type, size and number of the bearing. Moreover, arrows indicate the movement axis and the pre-setting direction (if applicable).

For all the detailed information about installation procedure and maintenance, see AGOM manual “E-Link Installation & maintenance” that can be download from AGOM web site www.agom.it.

Maintenance

The service life of an elastomeric bearing is usually estimated in more than 50 years.

The most important thing to assure such a long lifetime is a correct and careful maintenance of the bearing, that is usually installed in a severe environment.

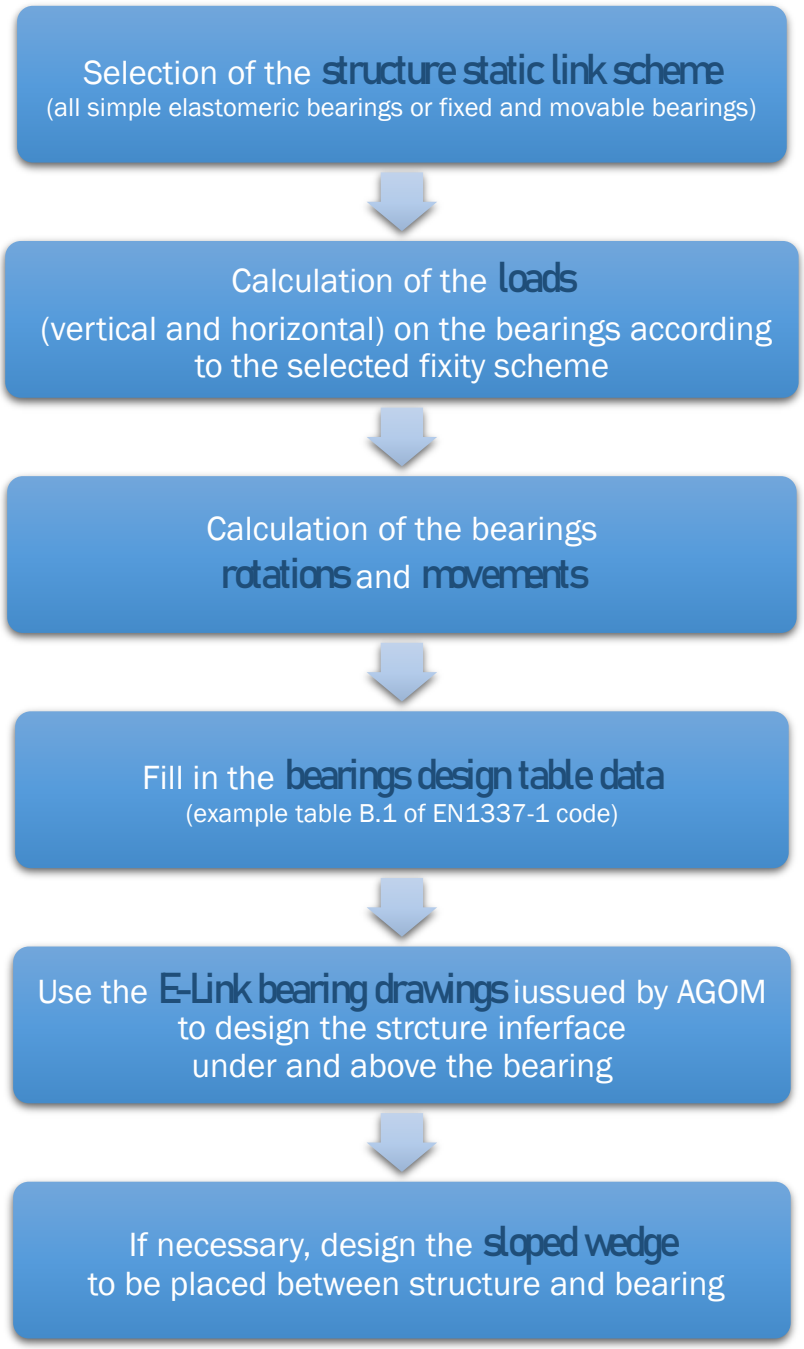
The requested bearing inspection and maintenance program that could be adapted and improved by the Bridge Designer to the specific service conditions of the bridge is fully described in the “E-Link - Inspection and warranty manual” that can be download from AGOM web site www.agom.it.

Guidelines for the design of a structure with AGOM E-Link bearings

In this section a simple guideline for the design of a structure equipped with AGOM bearing is presented.

The design procedure is summarized in the following steps:

1. Selection of the structure static link scheme (all simple elastomeric bearings or fixed and movable elastomeric bearings).
2. Calculation of the loads (vertical and horizontal) on the bearings according to the fixing scheme.
3. Calculation of the bearing rotations and movements.
4. Insertion of all the bearing design data into the bearing design table (example table B.1 of the EN1337-1 code attached at the end of the document).
5. Using the bearing drawings provided by AGOM, design of the interface parts between structure and bearings as: bearing lower plinth with adequate position for installing the bearing anchor bars (if required), level of the plinth to fit the vertical space between lower and upper structure to place the bearing and the upper structure interface where the bearing upper plate (if present) will be positioned.
6. If necessary, design of the slope compensator to be placed between the bearing and upper structure in order to adjust the permanent slope (longitudinal and transverse slopes of a bridge deck). The deck's slope must be always compensated in order to keep the sliding surface in the horizontal plane (normally the slope is compensated above the bearing between its sliding plate and the upper structure). In any case the whole bearing cannot be installed inclined.


Selection of the structure static link scheme
(all simple elastomeric bearings or fixed and movable bearings)
Calculation of the loads
(vertical and horizontal) on the bearings according to the selected fixity scheme
Calculation of the bearings rotations and movements
Fill in the bearings design table data
(example table B.1 of EN1337-1 code)
Use the E-Link bearing drawings iussued by AGOM to design the strcture inferface under and above the bearing
If necessary, design the sloped wedge to be placed between structure and bearing

Comparison of bearing types performances

Here below we summarize the main features of the different bearing types in order to direct the choice towards the most convenient type.

	V-MAX **pot** bearing	**R-MAX** **spherical** bearing	**E-LINK** **rubber** bearings
Vertical load	High	High	Medium
Horizontal displacement	No Limits	No Limits	Medium
Rotation	Medium	High	Low-Medium
Dimension	Small-Medium	Small-Medium	High

Advantages of using AGOM E-Link elastomeric bearings

AGOM E-Link bearings fulfil the following requirements.

a. Transmit the vertical loads due to permanent and accidental effects; it is possible to cover a wide range of loads about up to 22000 kN.

b. Transmit the horizontal loads with or without elastic response.

c. Allow rotation as per a spherical hinge.

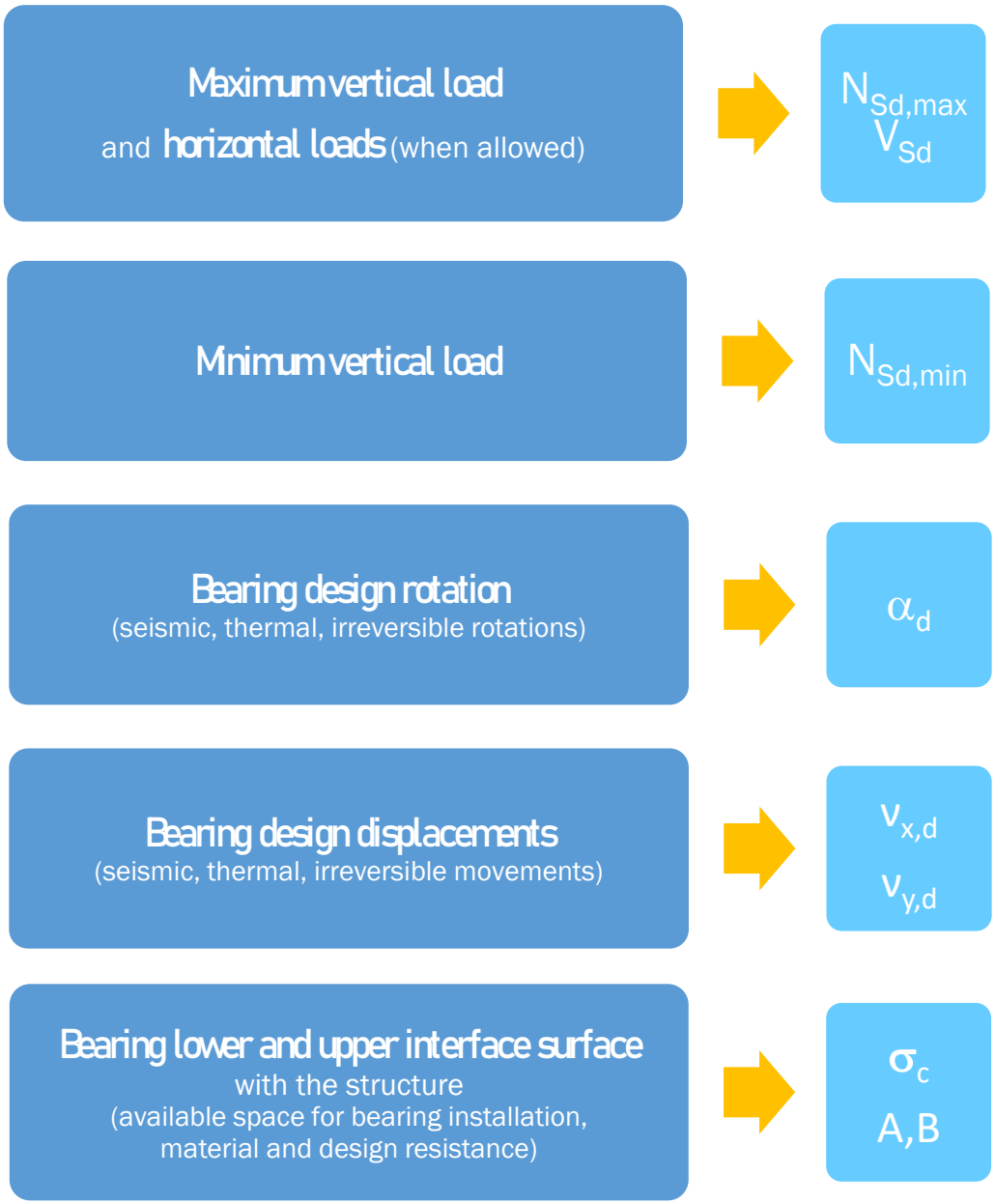
d. Capacity of horizontal displacement.

e. Suitable for all structures steel and concrete bridges and buildings.

f. High durability and no maintenance.

AGOM E-Link design parameters

Normally the required input parameters that the structural Designer must provide to AGOM Engineers for device design and constructions are the ones shown for example by the table B.1 of EN1337-1 code (see following pages):



Bearing design table according to EN1337-1 code

The purpose of this bridge bearing schedule is to list the information normally required for the design of the bearings for a particular structure. This information should ensure that bearings are designed and manufactured so that, under the influence of all possible actions, unfavourable effects of the bearing on the structure are avoided. A drawing should accompany the schedule showing the layout of the bearings with identification marks, including a typical cross section of the bridge and particular of any special locating requirements. Bearing function should be indicated on the drawing by appropriate symbols.

Every item listed in the "bearing design table" should be considered, but some may not be applicable to a particular bearing. Only relevant information should be given and when an item in the schedule is not applicable this should be stated. Additional information should be added when special conditions exist.

Here above you can find a short explanation of each item listed in the "bearing design table".

BEARING IDENTIFICATION MARK	Bearing with different function or load carrying requirements should be distinguished by a unique reference mark.
NUMBER OFF	The required number for each item.
SEATING MATERIAL	The materials on which each outer bearing plate bears should be stated as it may affect the design and finish of these plates.
AVERAGE DESIGN CONTACT PRESSURE	The pressure of the effective contact area.
DESIGN LOAD AFFECTS	The structure designer should give the worst individual values of the design load effects in the schedule. The most adverse combination of these values is usually sufficient for a satisfactory design of bearing. Only in special cases would greater economy be achieved by considering the actual coexistent values of load effects, in which case these should be given in detail.
DISPLACEMENT	Displacement of the structure at a bearing should be determined and factored. Allowance should be made for any movement of the supporting structures. Transverse and longitudinal movements are normally in a direction perpendicular and parallel to the longitudinal axis of a bridge span, respectively. Where there is any likelihood of ambiguity directions of movement should be clearly indicated on the accompanying drawing.

ROTATION	The irreversible and reversible rotations at the serviceability limit state (SLS), which the bearing is required to accommodate, should be given in radians. In the case of elastomeric bearings, the maximum rate should be given: 100 x (rotation [rad]/coexisting design vertical load [kN]).
MAXIMUM BEARING DIMENSIONS	The maximum sizes of the bearing that can be accommodated should be stated.
TOLERABLE MOVEMENT OF BEARING UNDER TRANSIENT LOADS	The movement that can be tolerated at the bearing under transient loads, in directions in which the bearing is meant to provide restraint.
ALLOWABLE RESISTANCE TO TRASLATION UNDER SLS [kN] *(if relevant)*	In the design of the structure, reaction to displacement movements may be of significance, in which case the acceptable horizontal force generated by the bearing should be given for the serviceability limit state (SLS). The values to be given are those for slowly applied movements at normal temperatures (any necessary extra allowance for low temperatures and rapidly applied movements should be made by the designer of the structure).
ALLOWABLE RESISTANCE TO ROTATION UNDER SLS [kN*m] *(if relevant)*	In the design of the structure, reaction to rotation may be of significance in which case the acceptable moment of reaction generated by the bearing, when subjected to the critical design load effects, should be given for the serviceability design state.
TYPE OF FIXING REQUIRED	Various means of fixing the bearing to the superstructure and substructure are available, appropriate to different type of bearing. Particular requirements, such as friction, bolts, dowels, keys or other devices, should be stated.

Bearing Design Table

Reference:..... **Date:**.....

Bridge Name: ..... **Table:** ..... **of** .....

BEARING IDENTIFICATION MARK							
NUMBER OFF							
SEATING MATERIAL (e.g. cement, mortar, epoxy mortar, in situ concrete, precast concrete, steel, timber)	Upper surface						
	Lower surface						
AVERAGE DESIGN CONTACT PRESSURE [N/mm^2]	Upper face	SLS					
		ULS					
	Lower face	SLS					
		ULS					
DESIGN LOAD EFFECTS [kN]	ULS	vertical	Max				
			Perm.				
			Min.				
		Transverse					
		Longitudinal					
	SLS	Vertical					
		Transverse					
		Longitudinal					
DISPLACEMENT [mm]	ULS	Transverse					
		Longitudinal					
	SLS	Transverse					
		Longitudinal					
ROTATION [mrad]	ULS	Transverse					
		Longitudinal					
MAXIMUM BEARING DIMENSIONS [mm]		Transverse					
		Longitudinal					
		Overall Height					
TOLERABLE MOVEMENT OF BEARING UNDER TRANSIENT LOADS [mm] *(if relevant)*		Vertical					
		Transverse					
		Longitudinal					
ALLOWABLE RESISTANCE TO TRASLATION UNDER SLS [kN] *(if relevant)*		Transverse					
		Longitudinal					
ALLOWABLE RESISTANCE TO ROTATION UNDER SLS [kN·m] *(if relevant)*		Transverse					
		Longitudinal					
TYPE OF FIXING REQUIRED		Upper face					
		Lower face					

AGOM E-Link – Elastomeric bearings

MORE THAN 50 YEARS EXPERIENCE DESIGNING AND MANUFACTURING DEVICES FOR CONSTRUCTION, OFFSHORE AND INDUSTRIAL MARKETS

Expansion joints

Elastomeric joints
Joints for high movements
Finger joints
Buried joints
Railway joints

Bridge bearings

Elastomeric Bridge bearings
Pot bearings
Spherical bearings
Incremental launching bearings
Horizontal load bearings
Special bearings

Seismic Protection

Seismic Isolators
High damping rubber bearings
Lead core rubber bearings
Multilayer rubber bearings
Shock transmitters
Viscous dampers
Rubber dampers

Services

Design
Consulting
On site assistance
Installations
Tests
Inspection