Inspection & Maintenance Manual

for

steel finger expansion joints (types GF and RSFD)

Contents

1 Applicability

This manual can be used in connection with the inspection and maintenance of the following types of mageba bridge-type expansion joint:

- *TENSA®FINGER (Type GF)* sliding finger joints (steel)
- *TENSA®FINGER (Type RSFD)* cantilever finger joints

The expansion joints to which this manual applies have generally been developed for use in bridge structures, but the manual can also be used, as appropriate, where such expansion joints are installed in buildings and other non-bridge structures. Where the word “bridge” appears in this manual, the word “structure” or “structural” can be understood to apply, as appropriate.

The extent to which the general guidelines in this manual should be applied to any particular expansion joint type and situation requires engineering judgement, and mageba should be contacted in case of any doubt.

2 Importance of inspection and maintenance

Starting on the day of installation, an expansion joint is continually exposed to natural elements (temperature changes, rain, snow, moisture, ozone, carbon dioxide, ultraviolet rays, etc.), and effects that are introduced by humans (traffic loading, chemical influences such as de-icing salts and industrial pollutants, etc.) and animals. The combined effect of these elements on the joint’s components is a steady and unavoidable deterioration process. Regular inspection and maintenance are thus critically important measures in ensuring the good long-term performance of any expansion joint.

3 Purpose of this Inspection & Maintenance Manual

This manual describes how the inspection, maintenance and repair of mageba expansion joints should be carried out, by suitably trained and competent personnel, and how any such works should be recorded. Care is required to ensure that the urgency of any required actions is recorded and communicated to the responsible parties, and that all required further investigation or repair work is carried out and properly completed in a timely manner. Complying with these instructions should then ensure that the expansion joints will continue to perform well throughout their lifetime. However, the work should not rely entirely on the guidance given in this document – the engineering judgement of the responsible personnel should also play a role.

This manual does not seek to address non-technical aspects of expansion joint inspection, maintenance or repair. Thus, issues such as safe access, Personal Protective Equipment (PPE) and other Health, Safety & Environment (HSE) considerations are outside the scope of this document. Traffic management measures, etc. (such as closure of a traffic lane or the whole carriageway) which may be required where inspection and maintenance work is carried out from above a joint (e.g. where access from below is not possible) are also not included in the scope of this document.

4 Availability and use of relevant information

All information that can help the responsible inspection and maintenance personnel to understand the design, history, etc. of the expansion joints they are about to inspect/maintain must be made available to them by the responsible supervising engineer and reviewed appropriately. In the absence of adequate relevant information about the expansion joint type or its structure-specific design, mageba should be consulted for assistance. The relevant information should include up-to-date versions of the following, where applicable and available.

4.1.1 General product information

Reference should be made to all relevant product information (brochures, product descriptions, etc.), in order to ensure that the responsible inspection and maintenance personnel have an adequate understanding of the design and functioning of the specific expansion joint type. Reference to the appropriate installation manual can provide useful insights into what is important in ensuring good long-term performance.

4.1.2 Structure-specific drawings, etc.

Reference should be made to all relevant structure-specific drawings and documents. Most importantly, these should include mageba's design drawings from the original supply of the expansion joints, so that special features and the functioning of the joint can be fully understood by the inspector.

4.1.3 Previous inspection reports and maintenance records

Reference must be made to all relevant reports and records from the installation of the joint and from previous inspection and maintenance work. This will provide an understanding of how the expansion joint's condition and performance have developed over time, and enable the occurrence and impact of previous maintenance work to be understood and evaluated. In particular, it will highlight issues that may require particular attention, and will enable any progressive deterioration to be noted. It will also enable the inspector to check that any required actions have been carried out, and that these have been successful in fulfilling the intended objectives.

4.1.4 Further instruction documents relating to inspection and maintenance

Should any other instruction documents (e.g. expansion joint type-specific) be provided or referenced by mageba, these must be consulted and complied with.

5 Competence of inspection and maintenance personnel

Inspection and maintenance of bridge expansion joints must be planned and carried out by competent and properly informed/inducted personnel. These should have good knowledge of mechanical structures in general and of the relevant type of expansion joint in particular.

Inspection personnel should be appropriately trained to detect slight changes in the condition of the expansion joint or the connecting structure, and provided with the appropriate information and records (including drawings and records of previous work and inspections, see Section 4) to enable them to undertake the work properly.

Should significant repair work be required for any reason, in particular any work which could impact on the correct functioning of the joint, mageba should be consulted in advance. Refer to Section 11 for guidance in relation to maintenance and repairs.

All work should be planned and carried out under the supervision of a suitably qualified, competent professional engineer, who should ensure the appropriateness of the actions taken, the competence of the staff, and the correct completion and recording of the work, and who should be ultimately responsible for all such works.

6 Access for inspections

Access to the underside of an expansion joint is generally to be recommended when carrying out inspections – for instance, to check for signs of lack of watertightness, or to inspect parts of the joint which cannot be readily inspected from the bridge's driving surface. However, adequate access to the underside of an expansion joint is not always available, perhaps because the bridge gap is too small or because access was not provided for in the bridge design. In such cases, access must be gained as necessary from above the joint.

Where access must be provided for inspections from above the joint's surface:

a) In the case of finger-type joints, it may be possible to temporarily remove surface plates. However, this is a complex operation and requires specialist knowledge and experience, so mageba must always be consulted in advance of undertaking such work.

In all cases, any parts removed must be immediately replaced after the inspection and all bolts properly tightened. The defined Pre-stressed bolts for the fixation of the finger plates to the sub construction shall not be re-used, but must be replaced. And a suitably qualified, competent responsible engineer must confirm that the joint is fit to be returned to service before it is.

The level of access required in an inspection, above or below the joint, depends on a number of factors, including:

- the expansion joint type
- the bridge geometry and access possibilities
- the inspection type and elements as defined in this document
- available knowledge about the condition of the joint or connecting structures from previous inspections

The approach to carrying out an inspection, particularly in relation to the access available and to be provided for each element of the inspection, must be determined by a suitably qualified, competent responsible engineer.

7 Inspection types and frequency

The primary purpose of an inspection is generally to identify possible defects or issues requiring attention, by whatever means necessary and appropriate. This section provides guidance on inspection types (*Preliminary* or *Comprehensive*) and timing/frequency, and the elements that typically belong to each inspection type (if relevant for the particular expansion joint type). However, the inspection should not necessarily be limited to this – the engineering judgement of the responsible inspector and local practices and regulations should also play a role.

7.1 Inspection types and timing/frequency

Inspections may by of the *Preliminary* or *Comprehensive* type, as defined by Sections 7.2 and 7.3 below. Inspections must be carried out as follows:

- ***A preliminary inspection*** should be carried out one year after the expansion joint has been placed in service, as an initial confirmation of the joint's design and installation.
- ***Comprehensive Inspections*** should be carried out every five years.

Further Inspections (*Preliminary* or *Comprehensive* as appropriate, as determined by the responsible, competent engineer) should be carried out as otherwise defined or appropriate, e.g.

a) following any unforeseen incidents which could impact on the joint
b) considering particularly onerous demands such as local environmental conditions or bridge movement characteristics
c) depending on the findings of previous inspections
d) according to the owner's needs
e) in accordance with local or other relevant regulations

Prior to the initial Preliminary Inspection, and during the periods between inspections, **attention should also be paid to the condition and performance of the expansion joints**, and any signs of potential or actual problems investigated or addressed as appropriate.

7.2 Preliminary inspection

The *Preliminary Inspection* comprises inspection of/for the following items, as applicable for the joint type, as described in detail in Section 9:

(1) Noise
(2) Evidence of water leakage
(3) Corrosion protection
(4) Adjacent bridge structures
(5) Alignment of joint
(6) Sliding surfaces, if any *(sliding finger joints only)*
(7) Drainage channel
(8) Replaceable components, if any *(sliding finger joints only)*
(9) Cover plates (at footpath / fascia / barriers), if any
(10) Opening and closing capacity of expansion joint

7.3 Comprehensive Inspection

The *Comprehensive Inspection* comprises all items of a *Preliminary Inspection*, plus the following items, as applicable for the joint type, as described in detail in Section 9:

(11) Bolts (including anchor bolts)
(12) Welds
(13) Connecting pavement (nosing)

8 Recording of work carried out

All inspection and maintenance work carried out on an expansion joint must be properly recorded using the **inspection report** contained in this manual (refer to Appendix 1: Inspection Report). This should be filled out as described in Section 9 below where appropriate, using the proposed shorthand system if helpful. Additional blank pages should be used if required, and the use and number of such pages noted on the main inspection report sheet.

Care is required to ensure that the urgency of any required actions is recorded, and communicated to the responsible parties in a timely manner.

A photographic record should be created.

After completion of all works and all necessary measures have been taken and confirmed, all reports and records must be carefully filed for future reference.

9 Key points to consider during inspection and maintenance works

An expansion joint forms a load-bearing bridging of the joint gap between a bridge's deck and its abutment, or between individual sections of the bridge deck, providing a driving surface for traffic while at the same time allowing the bridge deck to move as required by the bridge's design. Movements of the deck may arise due to expansion and contraction of the deck due to temperature changes and shrinkage/creep of concrete, wind, traffic forces, settlement of abutments, seismic effects and other sources. These movements may take the form of translations in any direction and/or rotations about any axis, insofar as such translations or rotations are permitted by the bridge design.

The following points should be considered wherever appropriate.

9.1 Watertightness of expansion joint

In general, expansion joints should be watertight in order to prevent damage and deterioration to the structure beneath (including bearings etc.), and should remain watertight throughout their service life. Leakage of water through a joint can be especially damaging when combined with temperature changes and chemical reactions due to contaminants/impurities/acidity. Refer to Sections 10.2, 10.7 and 10.13 below.

9.2 Condition and adequacy of corrosion protection

Parts and elements not covered (and thus protected from corrosion) by concrete should be corrosion protected in accordance with the joint's design drawing. Damage to corrosion protection must be avoided. Early detection and repair of any damage helps avoid more extensive, costlier repairs at a later date. Refer to Section 10.3 below.

9.3 Proper alignment of expansion joint

The alignment of an expansion joint (with respect to movements/displacements in every direction and rotations/tilts about every axis) is of critical importance, as deviations from the proper alignment can cause a reduction in driving comfort or, much more seriously, can have a negative influence on the expansion joint's performance and durability.

9.3.1 Undesigned contact:

As a rule, any undesigned contact (observed or suspected/possible) between elements of the joint and/or any other object/structure (such as the superstructure or substructure) must be avoided. Such undesigned contact is likely to result in damaging constraint forces. This applies in particular to any contact between independent parts at either side of a movement gap – e.g. contact between opposing finger plates. Unless specified as a form of pre-setting, the fingers from one side of the joint should in general / on average be centrally located in the gaps between fingers at the other side, not predominantly offset from central in one transverse direction as opposed to the other.

9.3.2 Flatness of driving surface

In general, an undesigned lack of flatness of the expansion joint's driving surface may indicate a lack or loss of correct vertical/rotational alignment.

9.4 Opening and closing capacity of the expansion joint

The expansion joint must be able to facilitate all opening and closing movements of the bridge, as well as all other movements and rotations, to avoid constraint forces which could damage the joint or the main structure. Refer to Section 10.10 below.

9.5 Condition and proper functioning of sliding surfaces, if any (sliding finger joints only)

Sliding finger joints feature sliding interfaces beneath the tips of the sliding fingers. Damage to sliding surfaces (including scratching) and contamination must be avoided to ensure that they remain in good working condition. Refer to Section 10.6 below.

9.6 Condition and proper functioning of drainage channel

An expansion joint's drainage channel, when connected to the main structure's drainage system or otherwise discharging as intended, must be watertight to prevent water from entering the structure below the joint and causing deterioration of the adjacent superstructure (including nearby bearings). It should also be cleaned of all construction dust and debris to enable it to drain properly. Refer to Section 10.7 below.

9.7 Pre-tensioning / Tightness of connections

All elements of an expansion joint must be securely held in place in such a way that they will not become loose or displaced, even after many years of service subjected to dynamic loading from traffic etc. Where bolted/screwed connections are required to be created on site, the proper tensioning of the connections should be verified using torque spanners and/or independent checking by another person, as appropriate. Pre-tensioned systems, such as those that ensure that the fingertips of the surface plates of sliding finger joints remain in contact with the sliding surface beneath, must function as planned with the correct amount of pre-tensioning. In case of any doubt, mageba must be contacted for guidance. Refer to Sections 10.8 and 10.11 below.

9.8 Condition and flatness of connecting pavement / nosing

The road surfacing (asphalt or alternative) adjacent to the expansion joint must be smooth, sound and free of damage in order to ensure a smooth over-rolling of the joint without heavy impacts. An uneven surface, with the road surface at the approach side being even just a few millimetres lower than the top of the expansion joint due to rutting etc., substantially increases dynamic loading on the expansion joint, reducing its lifespan considerably. Deformation/rutting of an asphalt surface can be prevented by the placing of *ROBO®DUR* asphalt-strengthening ribs at the edge of the joint. Refer to Section 10.13 below.

10 Assessment criteria and actions

This section describes typical elements of expansion joint inspections, as referred to in Sections 7.2 and 7.3. Each element is described in one of the subsections below. For ease of referencing, and especially cross-referencing with the inspection report included in this manual (see Appendix 1: Inspection Report), each element has its own identification number, which is indicated in Sections 7.2 and 7.3, and also noted in brackets at the end of each subsection heading.

Actions to be taken – Shorthand system:

The following shorthand referencing system is used when completing the Inspection Report in the Appendix, with one or more letters inserted in the "Actions" column.

None	(**N**)	No actions needed
Investigate	(**I**)	Further measurements and/or long-term observations are required, e.g. at extreme temperature / with uneven load distribution
Minor	(**M**)	Minor repair works such as cleaning, paint repair required
Substantial	(**S**)	Substantial repairs or complete replacement required

Further details of what *Investigate*, *Minor* or *Substantial* might entail in the case of each individual inspection element are detailed in the appropriate subsection below. If one of the **proposed wordings [(a), (b), etc.]** is relevant and adequate in any particular situation or inspection, the corresponding letter may be written in the inspection report as further shorthand; if not, the required actions should be written by the inspector in detail. In particular, it must be ensured that any urgency or recommended timeframe is indicated.

For all repair work, **refer also to Section 11 for further details** of how such work should be carried out.

10.1 Noise (1)

Noise generated by the expansion joint under traffic loading can be used as an indicator of the condition and performance of the joint itself, and also of the adjacent main structure. The causes of any irregular/unusual noise (e.g. high-pitched sounds, sound of metal-metal contact) should therefore be investigated and understood and the root causes addressed.

Possible causes:
- Loosened bolts
- Loose, damaged or deformed elements (e.g. surface elements, drainage channel or cover plates, if any)
- Loose or damaged key components (e.g. sliding bearings or spiral springs of steel sliding finger joints)

Actions	**N**one:		No irregularities noted, no repair required
	Minor:	a)	Loose bolts must be replaced; replaced bolts shall be tightened acc. RL 6443 or ass specified acc. production drawing *(Torque for Grade 8.8, HDG bolts generally: M12 = 69 Nm, M16 = 170 Nm)*
	Substantial:	b)	Damaged key components (e.g. sliding bearings or spiral springs of steel sliding finger joints) must be replaced or re-tensioned (refer to Section 11.4)
		c)	Damaged or deformed drainage channel must be replaced (refer to Section 11.6)
		d)	Damaged or deformed elements must be repaired or replaced as appropriate, like for like, using suitable parts (refer to Section 11 as appropriate)

10.2 Evidence of water leakage (2)

In general, expansion joints should be watertight in order to prevent damage and deterioration to the structure beneath (including bearings etc.), and should remain watertight throughout their service life. Leakage of water through a joint can be especially damaging when combined with temperature changes and chemical reactions due to contaminants/impurities/acidity.

Condition:
- Damage to the main structure, spalling concrete
- Corroded steel parts, e.g. reinforcement bars, drainage pipes
- Rust staining, dirt staining and contamination
- Formation of water puddles and ice

Notes:
- If leaking is due (solely) to the condition/performance of a **drainage channel**, refer to Section 10.7

Actions		
	None:	No irregularities noted, no repair required
	Substantial:	a) Lack of watertightness to be addressed as indicated by inspector b) mageba to be contacted to provide guidance on how to address leaking

10.3 Corrosion protection (3)

The condition of the corrosion protection must be carefully checked. Early detection and repair of damage helps avoid more extensive, costlier repairs at a later date. On the top surface of a steel expansion joint, corrosion protection may be worn off by vehicles' tyres within a short period, but this has no influence on the joint's performance due to continual polishing by wheels, and is no cause for concern.

Parts and elements not covered (and thus protected from corrosion) by concrete should be corrosion protected in accordance with the expansion joint's design drawing.

Condition:
- Superficial damage to corrosion protection (flaking, cracking etc.), staining of structure
- Damage to the bridge structure, spalling of concrete

Actions		
	None:	No irregularities noted, no repair required
	Minor:	a) Superficial damages: Refer to Section 11.3 b) More serious damages / damage down to metal: Refer to Section 11.3

10.4 Adjacent main structures (4)

The inspection of the joint must also include inspection of the adjacent main structure at each side. If damages are detected, they must be repaired as soon as possible to avoid further deterioration or problems.

Condition:
- Broken/cracked concrete or asphalt
- Broken corners and edges
- Rust staining
- Freely visible, exposed reinforcement bars

Actions		
	None:	No irregularities noted, no repair required
	Investigate:	a) Further actions according to instructions of the authorities or bridge engineer

10.5 Alignment of joint (5)

The alignment of an expansion joint is a helpful indicator of the general condition and behaviour of the main structure, and of any existing or developing problems. Movements/displacements and rotations/tilts must be assessed, as deviations from the proper alignment can cause a reduction in driving comfort or, much more seriously, can have a negative influence on the expansion joint's performance and durability.

In general, the alignment of the expansion joint should be assessed with respect to movements/displacements in every direction and rotations/tilts about every axis. Any deviations from the expected/proper alignment must be properly investigated as necessary to enable the causes and implications to be fully understood.

In particular, the following checks should be performed as appropriate (depending on expansion joint type etc.):

- Undesigned contact: As a rule, any undesigned contact (observed or suspected/possible) between elements of the joint and/or any other object/structure (such as the superstructure or substructure) must be noted and investigated, and discussed with mageba. Such undesigned contact is likely to result in damaging constraint forces. This applies in particular to any contact between independent parts at either side of a movement gap – e.g. contact between opposing finger plates of a finger-type expansion joint. The longitudinal alignment of the joint should be checked by assessing the degree to which the fingers from one side of the joint are located centrally in the gaps between fingers at the other side. If the fingers are predominantly offset from central, in one transverse direction as opposed to the other, this may indicate an undesired transverse movement of the superstructure. However, it could also be a sign of imperfect installation, and so must be properly investigated.
- Flatness of driving surface: In general, an undesigned lack of flatness of the expansion joint's driving surface may indicate a lack or loss of correct vertical/rotational alignment. Flatness can generally be checked by visual observation, including when traffic is rolling over the joint. If a notable lack of flatness is observed, or the over-rolling traffic experiences notable jolts or similar, then the flatness of the joint's surface should be checked, longitudinally and transversely, using a 4-metre straight edge. The gap between the joint's top surface and the straight edge should not exceed 5mm at any point, except insofar as this has resulted from the designed rotational capability of a sliding finger joint about the joint's longitudinal axis.

Possible conditions:
- Alignment is acceptable and not a cause for concern
- Alignment requires further investigation in the near future
- Alignment requires special observation going forward to recognise developments
- Alignment is considered to present an immediate problem (e.g. undesired contact)

Actions		
	None:	No irregularities noted, no repair required
	Investigate:	a) Further investigation required to establish the causes of any deviations and consider appropriate actions (if any). In case of doubt, and particularly in case of undesired contact that may cause constraint forces, mageba must be contacted
		b) Long-term observation required, with recording of observations/actions/results

10.6 Sliding surfaces, if any (sliding finger joints only) (6)

On sliding finger joints, sliding surfaces are located between the fingers at the fixed side of the joint. All sliding surfaces should be checked where access permits to ensure that they remain in good working condition, using a mirror and torch if necessary. Based on experience over many years, damages are very unlikely to occur.

Condition:
- Irregularities, cracks, scratches, fissures
- Spots with dirt, cement slurry, corrosion

Actions	**N**one:	No irregularities noted, no repair required
	Minor:	a) Spots from dirt and rust to be removed carefully. A thin silicon grease film should then be applied to any stainless steel sliding surfaces
	Investigate:	b) Sliding surfaces may need to be replaced, mageba to be immediately contacted for guidance
	Substantial:	c) Sliding surfaces clearly need to be replaced, mageba to be immediately contacted for guidance and support

10.7 Drainage channel (7)

An expansion joint's drainage channel must prevent water from entering the structure below the joint. Leakage of water, combined with temperature fluctuations and chemical reactions due to impurities, acidity, etc., may cause deterioration of the adjacent superstructure (including nearby bearings).

Condition:
- Pulled out / loose / bent / cracked / rough / brittle / torn / cut
- Deterioration/contamination of the adjacent structure (e.g. bearings)

Actions	**N**one:	No irregularities noted, no repair or cleaning required
	Minor:	a) Cleaning by hand brushing or pressurised air (refer to Section 11.2) b) Cleaning with water (refer to Section 11.2)
	Substantial:	c) Repair drainage channel (refer to Section 11.5) d) Replacement of the drainage channel (refer to Section 11.6)

10.8 Replaceable components, if any (sliding finger joints only) (8)

Various checks should be carried out to ensure that the replaceable components of steel sliding finger joints (type GF) remain in good condition and continue to perform properly and effectively.

- Tightness of connections: Verify that stainless steel springs are still securely held in place. This checking can be done by hand, on a sample which can be considered representative, based on consideration of all available evidence such as noise under traffic and considering ease of access, to conclude that a significant problem of loose elements does not exist. In general, if it is possible to move/rotate an element, the element is no longer adequately secured.
- Pre-tensioning of pre-tensioned connections: Verify the correct pre-tensioning of the anchor bolts. An adequate and representative sample should be checked, typically using a calibrated torque wrench, to ensure that the required pre-tension is still acting – refer to mageba for further details as required.
- Sliding pads: Verify that sliding pads under the tips of fingers of sliding finger joints remain properly secured and in good working order, with enough thickness to remain in place and prevent undesired contact across the sliding interface.

Condition:
- Broken / cracked / loosened (see above descriptions of checks that may be appropriate)

Actions		
	None:	No irregularities noted, no repair required
	Investigate:	a) Further investigation and observations required
	Substantial:	b) Connections require tightening, with all bolts etc. to be checked (refer to Section 10.11). c) Replacement of key components (stainless steel springs) is required (refer to Section 11.4).

10.9 Cover plates (at footpath / fascia / barriers), if any (9)

Cover plates are often provided to cover the gaps at the fascia (edge of bridge deck / parapet), or in the footpath area (for user comfort). In the case of finger-type joints, cover plates are often provided to form a flat, safe surface for cyclists passing over the joint.

Condition:
- Loose bolts
- Corrosion protection damaged
- Noisy (especially under traffic, or due to structure movements or wind)

Actions		
	None:	No irregularities noted, no repair required
	Minor:	a) Repair of corrosion protection (refer to Section 11.3) b) Replace/tighten bolts
	Substantial:	c) Complete replacement

10.10 Opening and closing capacity of the expansion joint (10)

Inspect for any indications that the expansion joint is unable to facilitate the opening and closing movements of the bridge which have arisen since its installation.

Condition:
- Signs of impacts between opposing sides of the joint or related constraint forces

Actions		
	None:	No irregularities noted, no action required
	Investigate/ **S**ubstantial:	a) Cause for concern observed. Concerns to be notified immediately to mageba or the responsible bridge engineer/owner as appropriate, and suitable actions agreed and arranged

10.11 Bolts (11)

The important connections between individual elements of mageba expansion joints are generally bolted (or screwed) to allow ease of removal and replacement if required, and for optimal fatigue performance. These connections are generally created using appropriately tightened high-tensile prestressed bolts, which helps to ensure that they remain tight. Only in rare cases might bolts/screws become loosened. Loose bolts/screws can often be located by/while checking for noise (see Section 10.1). However, a random check is also recommended.

Anchor bolts: This section also applies where appropriate to anchor bolts that may connect elements of an expansion joint to a concrete structure (e.g. the finger plates of a finger-type expansion joint).

Condition:
- Loose, missing, broken or otherwise damaged

Actions		
	None:	No irregularities noted, no repair required
	Minor/ **S**ubstantial:	a) Loose bolts/screws, that are part of a pre-tensioning system, must be replaced, and the new bolts/screws tightened with a torque wrench. The correct bolt/screw type (refer to joint's supply drawing) must be used if replacing any such items, and the appropriate pre-tensioning must be re-established; mageba should be consulted in advance. b) Other loose bolts/screws (not part of a pre-tensioning system) must be re-tightened with a torque wrench or replaced; mageba should be consulted in advance.
		c)

10.12 Welds (12)

The welds of the expansion joint should be checked. Unless otherwise indicated, a visual check for fissures and cracks in the welded connections that can be readily inspected is generally sufficient.

Condition:
- Welds are broken
- Welds show signs of cracking / fissures

Actions		
	None:	No irregularities noted, no repair required
	Investigate/ **S**ubstantial:	a) Must be discussed and appropriate actions agreed with mageba

10.13 Connecting pavement / nosing (13)

The road surfacing (asphalt or alternative) adjacent to the expansion joint must be free of damage in order to ensure a smooth over-rolling of the joint without heavy impacts. An uneven surface causes driver discomfort and also substantially increases impact loading on the expansion joint, reducing its lifespan considerably.

Condition:
- Deformation/destruction of the pavement/nosing, unevenness, rutting
- Deformation of connecting parts of the expansion joint
- Significant level differences between the structures at each side of the joint
- Deterioration of any mastic filler between expansion joint and road surfacing

Actions		
	None:	No irregularities noted, no repair required
	Minor:	a) Repair of minor damages to slow/prevent further deterioration and minimise unevenness of the driving surface
	Substantial:	b) Renewal/strengthening of the road surface / nosing per the instructions of the responsible authorities or bridge engineer, ensuring that any existing waterproofing membrane etc. is suitably repaired if required and placed, covered etc. as appropriate. It must also be ensured that a flat, level driving surface is achieved in the area of the expansion joint, to minimise wheel impacts. Refer to Section 11.7 for details and options.

11 Maintenance and repairs

11.1 General

In general, mageba expansion joints require little maintenance apart from normal cleaning and inspection. However, further maintenance or repairs may be required at times, e.g. following unexpected damage due to foreign objects or excessive structure movements, or due to normal wear. The need for such further maintenance or repairs should be identified in the course of an inspection as defined in Section 9 and recorded in an inspection report. Refer to the guidance in Section 9 where appropriate. Detailed guidance on how to carry out common maintenance and repair tasks is provided in the subsections below, but in case of any doubt or concern, mageba should be contacted to discuss and advise.

All required maintenance/repair work must be properly completed in a timely manner, with reference to all relevant inspection reports etc.

Most repair work, including replacement of drainage channels of finger joints (see instructions below), may be done by skilled workers with suitable experience (refer to the guidelines included in Section 5).

However the replacement of other key components (such as the sliding bearings and pre-tensioning spiral springs of steel sliding finger joints) is specialised work which requires appropriate training and experience. Such work can negatively impact on the condition and functioning of the joint if not carried out correctly, and requires appropriate care and attention.

In undertaking repair or replacement work, unnecessary impacts (influences) on the joint and its proper functioning should also be minimised. For instance, access should generally be gained from beneath the joint, where possible and adequate, to avoid having to temporarily remove elements of the joint's surface – especially where these are pre-tensioned in place, such as the finger plates of sliding finger joints, or where the elements make the surface watertight. Where access from above is required, any temporarily removed elements must be correctly replaced, and their correct functioning (pre-tensioning, watertightness, etc.) ensured and confirmed.

The following rule should generally be considered to apply, except if otherwise agreed in writing with mageba:
Any repair work having an influence on the proper functioning of the joints must be carried out or supervised by mageba or mageba's appointed expansion joint experts.

mageba expansion joints use specific components that ensure proper functioning of the joint as a system. Therefore, only original mageba components must be used.

11.2 Cleaning

Cleaning of drainage channels should be carried out at least once a year, and as often as necessary to prevent build-up of debris which could cause blockages or damage to the channel.

Suitable methods typically include hand brushing, use of pressurised air or use of water. The most suitable method should be selected for each situation. In no case should any debris or dirt be removed using sharp objects, such as steel bars stuck through the surface of the joint, as this could damage the channel.

Where cleaning is to be done using a water hose, the water pressure should not exceed a safe value which will ensure that no damage will be caused to the expansion joint, and water temperature should not exceed 25 °C. Where the expansion joint has been equipped with a specially designed cover plate for insertion or connection of a water hose for cleaning purposes, this should be used.

If necessary, the sliding surfaces which support the tips of the fingers of sliding finger joints, and the spaces between fingers, should be cleaned to prevent contamination or damage.

11.3 Repair of corrosion protection

Immediate detection and repair of any damage to corrosion protection helps avoid more extensive, costlier repairs at a later date. The corrosion protection applied to an expansion joint must be compatible with the expansion joint and its condition, and also with the existing corrosion protection system and its condition. It must also be suitable for the expansion joint's environment, for durability, effectiveness, etc. Consult with mageba for guidance, with particular reference to mageba's ***Work Instruction AW 8801*** which provides guidance on repairs to corrosion protection.

11.4 Replacement of replaceable key components (sliding finger joints only)

Replaceable key components typically control movements, transfer forces and facilitate sliding movements at key interfaces, and may often be classified as wear components.

The condition and proper functioning of these key components is of critical importance to the long-term performance of the expansion joint, so if the need arises to replace them, this should be done promptly.

Replacement of key components requires specialist knowledge, in particular to ensure that the correct level of pre-tensioning is established after the replacement work, so mageba should generally be consulted for guidance and/or assistance. Only original mageba components must be used.

- In the case of a *TENSA®FINGER (Type GF)* sliding finger joint (steel variety), the key components comprise the stainless steel spiral springs or disc springs that pre-tension the finger plates downwards, and the polyamide bearings/pads beneath the fixed and sliding ends of the finger plates / fingers that transfer loading and accommodate sliding movements and rotations. The replacement of these components is particularly specialised work requiring a high degree of competence, so mageba should be consulted in every case.

11.5 Repairs to a damaged drainage channel

Minor damage to a drainage channel (e.g. a puncture / leak) can typically be repaired by placing a repair patch (same material and thickness as the channel itself) over the damaged area and bonding it to the channel with suitable adhesive. If access is possible from below, the repair can be carried out from below to the underside of the channel (although this is generally not recommended), otherwise it must be done from above (typically requiring temporary removal of a surface plate etc.).

11.6 Replacement of a drainage channel

Replacement of a drainage channel of a steel finger joint requires knowledge of the design of the joint and its drainage channel, and reference should be made to the expansion joint supply drawings and/or other relevant information. mageba should be consulted wherever guidance or specific materials are required.

In many cases, where access permits, expansion joints with drainage channels are designed to allow replacement of the drainage channel from beneath (avoiding the need for traffic management etc.), by simple opening of screwed connections of a membrane to supporting plates at each side.

11.7 Asphalt strengthening / Surface repairs at edge of expansion joint

The road surfacing (asphalt or alternative) adjacent to an expansion joint must be smooth, sound and free of damage in order to ensure a smooth over-rolling of the joint without heavy impacts. An uneven surface, with the road surface at the approach side being even just a few millimetres lower than the top of the expansion joint in places due to rutting etc., substantially increases dynamic loading on the expansion joint, reducing its lifespan considerably. Therefore, the level of the joint's top surface must be within a few millimetres of, **but no higher than**, the connecting pavement.

- In normal circumstances, it is common for the top surface of road surfacing to be approx. 2 – 4 mm higher than the edge of the expansion joint when installed. This allows for some settlement/wear of the surfacing, and tolerance during installation of joint or placing of surfacing.
- In the area of any coverplates for pedestrians or cyclists, the surfacing adjacent to the joint must be particularly flat and even (in a plane which is obtained by extrapolating the expansion joint's surface plane away from the joint), for an appropriate distance, because the cover plate will slide on the road surface at one side of the joint in this area. The tolerance for this levelness is +/- 1 mm.

An uneven surface also increases the risk of damage by snow ploughs, and reduces driver comfort. Strengthening /repair where necessary of the asphalt surfacing in this critical area can combat all of these effects, and also help the structure to remain watertight in this area by protecting its waterproofing membrane.

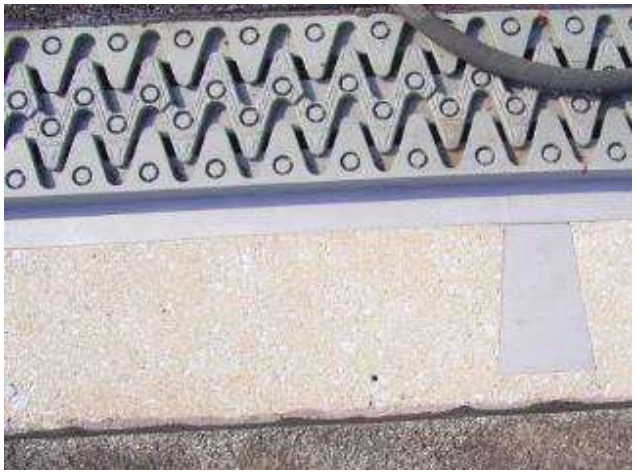
Strengthening of asphalt surfacing is best carried out at the time of the expansion joint's installation, but if it has not been, and especially if the asphalt requires replacement, strengthening can be carried out at any time.

11.7.1 *ROBO®DUR* asphalt-strengthening ribs

Deformation/rutting of asphalt surfacing can be prevented by *ROBO®DUR* asphalt-strengthening ribs along the edge of the joint. Slits are cut in the asphalt at an appropriate angle to the direction of traffic travel, and filled with high-strength *ROBO®DUR* mortar. Consult with mageba for further details and assistance.

11.7.2 *ROBO®STATIFLEX* expansion joint protection strips

ROBO®STATIFLEX protection strips consist of mageba's special *ROBO®FLEX* polymer concrete, which is also used to anchor *TENSA®CRETE* (type RE) expansion joints. The high-strength material is quick drying (typically allowing traffic to drive across it within just a few hours), thus reducing construction time and minimizing disruption to traffic during bridge rehabilitation or expansion joint replacement works. In contrast to *ROBO®DUR* asphalt-strengthening ribs as described above, *ROBO®STATIFLEX* protection strips also protect the structure's waterproofing membrane and enhance watertightness. Consult with mageba for further details and assistance.



11.7.3 Sealing of joints between expansion joint and road surfacing

Following renewal of surfacing adjacent to an expansion joint, the interface between the surfacing and the expansion joint should be sealed where appropriate, e.g. using a suitable hot-applied mastic sealant, to enhance durability and the watertightness of the joint.

Appendix 1: Inspection Report

Client:	Manufacturer:
Order No.:	Inspector (Name):
Drawing No.:	Date:

Preliminary Inspection *(Frequency per Section 7.1 of Inspection & Maintenance Manual – generally after one year of service)*

	Element of Inspection (refer Section 9)	**Actions** (shorthand) N = None, I = Investigate, M = Minor, S = Substantial	**Results / Comments**
(1)	Noise		
(2)	Evidence of water leakage		
(3)	Corrosion protection		
(4)	Adjacent bridge structures		
(5)	Alignment of joint		
(6)	Sliding surfaces, if any (sliding finger joints only)		
(7)	Drainage channel		
(8)	Replaceable components, if any (sliding finger joints only)		
(9)	Cover plates, if any (at footpath / fascia / barriers)		
(10)	Opening and closing capacity of expansion joint		

Comprehensive Inspection *(Frequency per Section 7.1 of manual)*. **All items above PLUS the following items:**

	Element of Inspection	**Action**	**Results / Comments**
(11)	Bolts		
(12)	Welds		
(13)	Connecting pavement (nosing)		

Further comments (use separate sheet if necessary)

Issued:	Accepted:
(Name) *(Date)*	*(Name)* *(Date)*
Signed:	Signed:

If correctly installed, and inspected and maintained in accordance with this manual, mageba expansion joints can be expected to perform well for many years – as demonstrated by the thousands of bridges around the world that already feature mageba expansion joints. Please enable your joints to perform just as well.

TENSA®MODULAR (Type LR) joints: Run Yang Bridge, China
– Modular joints for movements of up to 2140 mm

TENSA®FINGER (Type GF) joints: Audubon Bridge, USA
– Sliding finger joints (steel) for movements of up to 1240 mm

TENSA®FLEX (Type RC) joints: Viaduc d'Yverdon, Switzerland
– Sliding finger joints (composite) for medium movements

TENSA®FINGER (Type RSFD) joints: Can Tho Bridge, Vietnam
– Cantilever finger joints for small to medium movements

TENSA®GRIP (Type RS) joints: Golden Ears Bridge, Canada
– Single gap joints in normal concrete for small movements

TENSA®CRETE (Type RE) joints: Europa Bridge, Switzerland
– Single gap joints in polymer concrete for small movements

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