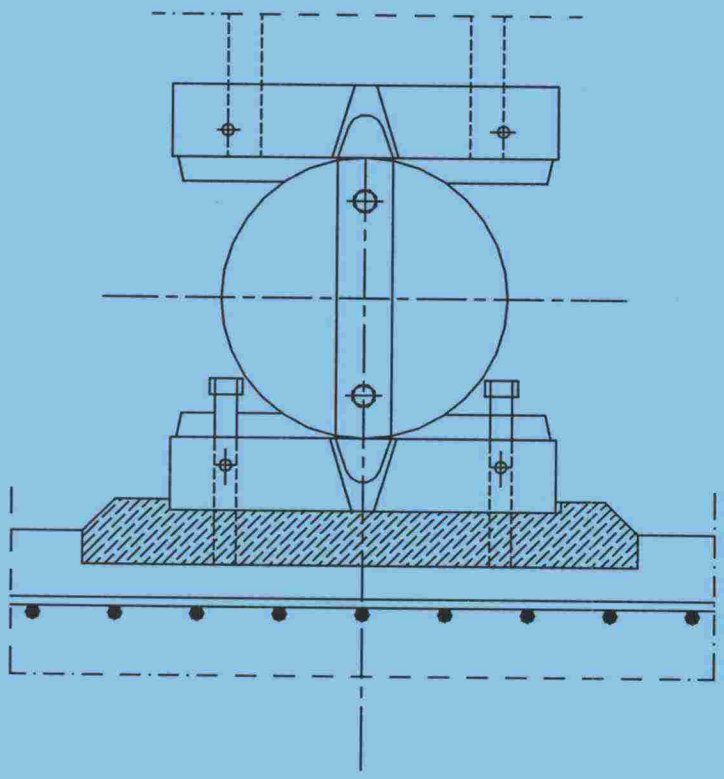
GENERAL QUALITY REQUIREMENTS

FOR BRIDGE CONSTRUCTION

Equipment and Accessories - SYL 7

Finnish National Road Administration



Specifications and quality requirements

Helsinki 1996

Bridge Engineering Unit

GENERAL QUALITY REQUIREMENTS

FOR BRIDGE CONSTRUCTION

Equipment and Accessories - SYL 7

Finnish National Road Administration
Bridge Engineering Unit

Helsinki 1996

ISBN 951-726-222-1
TIEL 2210009-96
Oy Edita Ab
Helsinki 1996

Publication and sale:
Finnish National Road Administration, Service Unit,
Printed Publications
Fax: Int. + 358 (0)204 44 2652

Finnish National Road Administration
Opastinsilta 12 A
P.O. Box 33
00521 HELSINKI
Tel: Int. + 358 (0)204 44 150

PREFACE

The general quality specifications covering equipment and accessories for bridge construction have previously been outlined in the version of this manual SYL 7 published in April 1992.

This document has been amended and revised on the basis of practical experience by the addition of the requirements for acceptability measurements. Kalevi Falck MSc. (Eng.) of Laatukonsultit Oy has been the consultant engineer for the Finnish National Road Administration at this point. The work has been managed and supervised by Jouko Lämsä MSc. (Eng.) of the Bridge Engineering Unit.

Opinions and advice has been sought from all the Finnish National Road Administration's Road Regions, the Finnish State Railway, the Helsinki City Public Works Office and various contractors and importers of equipment, etc.

The text has been revised by the Bridge Engineering Unit at the Finnish National Road Administration.

Helsinki, August 1996

Bridge Engineering Unit

Contents

7 EQUIPMENT AND ACCESSORIES

7.0 A PRODUCT MANUFACTURED IN ANOTHER EUROPEAN COUNTRY

A product which has been manufactured in another Member State of the European Union or in another country in the European Economic Area should be deemed upon application to be in conformity with the quality requirements presented in this publication on the following preconditions:

1. The tests and inspections have been performed in the country of manufacture in accordance with the methods and requirements employed in Finland or ones yielding a corresponding standard of quality and safety, and the results show that the product meets the requirements set for it.
2. The body which performed the test and inspections is approved for these tasks by the country of manufacture.

The Finnish National Road Administration is keeping abreast of European standardisation in the sector and will amend the guidelines to conform with European standards once they are ready.

7.1 GENERAL

7.1.1 Area of application

This section of the General Quality Specifications for Bridge Construction shall be complied with when manufacturing and installing equipment and accessories of bridges by the 'LVR' method or by the traditional construction method, and also with other equivalent works in relevant sections.

The general quality requirements and instructions for bridge construction are laid down in SYL 1 /2/.

When executing concrete work the specifications laid down in SYL 3 /3/ shall be complied with and for steel construction works with SYL 4 /4/, unless otherwise referred to in the design for the project or shown differently hereinafter.

The binding quality requirements and instructions are laid down as text in wide columns and useful information, guidelines and details of working practices for contractors as text in narrow columns. Deviation from the latter is permissible with the approval of the supervisor.

7.1.2 Terms

Equipment and accessories used on bridges include such items as bearings, expansion joint devices, approach slabs, safety equipment (guard rails, barriers, etc.), drain pipes and down pipes, as well as other equipment and accessories dealt with below.

Sealing strip is a foam rubber or PVC based product designed to seal expansion joints with limited play to make them watertight.

Hot applied asphaltic plug expansion joints shall be made from special compounds and other related structural components which have the function of making expansion joints watertight.

Expansion joint device is a single-seal watertight expansion joint or a series of watertight multi-seal expansion joints. Usually a patented product.

Other definitions used refer to the relevant sections of this manual and are used according to the definitions of terminology in these sections.

7.1.3 Works management

The person in charge of work involving the installation of equipment and accessories shall have a minimum of two years' experience in the inspection and installation of such structural components.

Compliance with the requirements for the supervision of concrete casting work are stated in the applicable parts of SYL 3.

7.1.4 Technical work plans and quality plans

The manufacture of equipment and accessories shall be duly inspected. In other circumstances the manufacturer is assumed to have an acceptable and functioning quality system and he shall prepare manufacturing and quality plans according to the specifications in Section 1.3.3 of SYL 1. These plans shall be submitted to the work supervisor at the latest two weeks before the manufacturing begins.

Where the contractor carrying out of the installation work is not within quality system approved and accepted by the client, the contractor shall have the quality assurance system to be applied accepted by the client at least two weeks before assembly work starts. The quality assurance arrangements shall at least include plans for the installation work, a reporting of measurements, proof of acceptability and reports of any deviations from the specifications.

7.1.5 Proof of acceptability and reporting

Proof of acceptability and reporting shall comply with the requirements in the applicable parts of Section 1.3.4 in SYL 1.

7.2 EXPANSION JOINTS

7.2.1 General quality requirements

This section deals with expansion joints like sealing strips, hot applied asphaltic plug joint expansion joints or joints made watertight with an expansion joint device.

Expansion joint devices shall be of a type approved by the Bridge Engineering Unit.

> Specifications for the sizing and design of expansion joint devices are laid down in the SILKO Directive 1.701 /1/.

Expansion joint devices shall be manufactured and installed so that parts which wear can be changed later on where necessary.

Expansion joints shall be watertight. Watertightness means that the seal withstands without leaking various weather conditions, the effects of water pressure and the wear caused by traffic and structural deformations due to temperature fluctuations and shrinkage. Joints shall maintain their operational capacities in a temperature range from -40°C to +70°C.

The sealing strip extending to the outer face of edge beam and the rubber profile of the expansion joint device shall extend 100 mm and the steel structure 50 mm to the outside of the outer face of the edge beam.

Materials used in expansion joint devices shall fulfil the requirements for strength grade and the quality in the standards following from the category code indicated in the design. Steel used for fixing lugs shall be of a grade which can be welded.

Expansion joint devices shall have good wearing properties for mechanical impact.

If the total play of an expansion joint exceeds 100 mm, the total play per tightening rubber profile may not exceed 60 mm in bridges at semi-motorways and motorways, and 80 mm in other types of busy roads and 100 mm on lightly trafficked bridges as well as pedestrian and bicycle bridges.

> Material certificates are usually required. Where the manufacturing of the joint devices is duly inspected and the product certificates are submitted at the approval by the Finnish National Road Administration, certificates are not required.

The compounds of hot applied asphaltic plug expansion joints and elastomeric compounds used in expansion joint devices as well as the expansion joint itself shall be able to withstand de-icing salt, oil, petrol, weak acids and alkalis as well as the effects of UV radiation and ozone.

7.2.2 Installation

7.2.2.1 Sealing strips

The gradient of the strip shall be a minimum of 2.5 % crosswise over the bridge to ensure the run-off of water.

The installation of expanded polymer-based sealing strip shall be carried out so that the sealing strip is always in compression.

> It is recommended to install the sealing strip in the temperature between 0°C and +15°C. Before installation a double coat of tar epoxy, polymer bitumen coating or other material specified by the manufacturer shall be applied to the vertical concrete surfaces of the joint.

PVC based sealing strip shall be installed before concrete casting so that there is no great compression stress at any stage in the conditions where the joint operates.

It is recommended to install the strip in the summer, when the temperature is above +15° C.

PVC sealing strip shall be extended by heating (torching).

7.2.2.2 Expansion joint devices

The plans to be prepared for the installation of expansion joint devices are listed in Section 7.1.4.

While installing an expansion joint device it shall be assured, that the device will function as shown in the design and that the predetermined gap is correct.

> Ultimately the contractor is responsible for making sure that the predetermined gap corresponds to the actual situation of temperature, etc., at the installation stage. If half sections are fixed together at the time of casting, the fixing shall be removed immediately when curing of concrete has started.

The installation tolerance for the level on the top surface of the expansion joint device compared to the top surface of the nosing and pavement is between 0 mm and -5 mm.

The grouting of the nosings at the both sides of the device shall be done in an approved manner, alternative A or B:

Alternative A:
Nosings are made of asphalt mastic or polymer bitumen asphalt mastic with the applicable mix in accordance with Section 6.4. When nosings are made from these materials, the top surface course is roughened by rolling wear resisting chipping with a gradation of 16 mm to 20 mm at a rate of 10 kg/m^2 into the wearing course.

Alternative B:
Nosings are made of polymer concrete (PC) or polymer cement concrete (PCC) grade K50, in accordance with the specifications in SYL 3. The concrete shall be shrinkproof and frost resistant to grade P50. Steel fibre reinforcement is added to the mix at a rate of >= 30 kg/m^3.

Cracks over 0.2 mm which may appear shall be sealed off by capillary injection.

> Approved compounds for injection are listed in the SILKO Directives /1/.

Expansion joint profile splice welds shall comply with the grade WC requirements in Standard SFS 2379 /3/.

Welding or straightening of splice bars or other buckled parts shall be carried out at a machine shop in accordance with the design.

Particular attention shall be paid to fire safety while welding. The necessary fire extinguishers shall be available on the bridge deck during working hours.

All surfaces of the steel components other than those cast in concrete shall be surface-treated in accordance with the specifications in SYL 4. The coating combination shall be of stress group M4 or equivalent, either of the 'SEE' or 'SEEPUR' type, with a total dry coat thickness >= 200 µm. The coating shall extend a minimum of 20 mm into the concrete.

The formwork, made of expanded polystyrene sheeting or equivalent, used for casting the second stage grouting at expansion joints shall be removed while form stripping.

7.2.3 Proof of acceptability and reporting

The acceptability of materials shall be indicated by material certificates and delivery notes. The material certificate is not, however, needed if the manufacturing of the equipment is duly inspected.

The quality of the completed expansion joint with regard to the precise dimensions shall be demonstrated by checking in a measurement log.

The watertightness of an expansion joint is demonstrated, where necessary, by a watertightness test.

During the watertightness test the equipment shall be sprinkled and the run-off of water is followed along the rubber profile. At the same time it is observed that the device and all the concrete surfaces in the end of the deck and on the breast wall of the abutment underneath the deck will remain dry.

The acceptability of the nosing material is proved in the manner shown in SYL 3. See also SYL 1, Section 1.3.4.

7.3 BEARINGS AND HINGES

7.3.1 General quality requirements

General

Bearings and their components shall maintain their service abilities at temperatures to -35°C in Southern and Central Finland and at temperatures

to -45°C in Eastern and Northern Finland.

Designs for bearings shall be completed and approved by the client. The contractor shall supply detailed information on bearings, which are needed when the applicability of the bearings shall be assessed as required, unless the type and the brand of the bearing has been approved earlier.

Design of bearings shall be submitted to the client for approval at the latest two weeks before starting to manufacture the bearings.

Only the number of bearings and hinges, the raw data and required properties shall be shown on the bridge design. The drawings for the bridge shall show the raw data both in the ultimate limit state and service state. The manufacturer shall draw up detailed design based on European Standards prEN 1337 Parts 1 to 11 and complying with the design directives by the Bridge Engineering Unit.

The final design of bearings may cause changes in the height level of the bearing seat.

The installation and possible future changes to the substructure shall be taken into consideration in the design of bearings.

If bearings are temporarily supported by steel wedges before the casting of the base, while designing and sizing the bearing that load condition shall be taken into consideration and examined separately (especially while designing the lower plate).

The bearing shall be dismountable when bridge is raised 5 mm in the position of the bearing. If it is not possible to dismantle the bearings due to it's structure, they shall be provided with additional bottom and top plates so that the whole bearing can be detached for servicing and repair.

Moveable bearings shall have an indicator and measuring scale showing the movement.

The steel parts of bearings and hinges shall be cleaned in accordance with Standard SFS 4957 /6/ and the directions in SYL 4 and painted in an approved manner.

Spray galvanized surfaces shall be cleaned to cleanliness grade of Sa 3.

Painting combinations to be used are: Galvanizing, 80 µm +(2 to 3) × epoxy or polyurethane paint with a total combined

coating thickness of 200 µm (or equivalent). The shade of surface paint shall be grey (KY 4). Sliding and running surfaces on plates and rollers are left uncoated along the width of moving sections. These shall be treated with an approved water-repellent bearing grease or varnish which also has anti-corrosion properties.

Bearing materials and products shall be tested according to the approved bearing design. Test results shall demonstrate that the quality requirements laid down are met.

If there is reason to suspect the acceptability of bearings, they shall be dismantled as required for inspection by the supervisor before installation.

Bearings manufactured in Finland shall be inspected by the supervisor or by individual inspection by arrangement with a specialist from the Bridge Engineering Unit. Inspection of imported bearings is generally to be carried out according to quality control agreements by an independent local material testing or research institution.

Elastomeric laminated bearings

The shear module of bearings used is tested at -30 °C. In Eastern and Northern Finland, to the north of a line across from Oulu to Kajaani, only elastomeric laminated bearings having shear coefficient of at most 1.5 times the one at +20° C may be used. Elsewhere in the country the minimum shall be twice the figure.

Special bearings

The prevailing weather and operating conditions at the bridge site, etc., shall be taken into consideration when designing to use special bearings.

The polytetrafluoroethylene (PTFE) on the sliding surface of the bearing shall be of 'bridge quality' and a minimum of 4.5 mm thick. The sliding surfaces of the bearings shall be protected against dust by a separate dust shield.

The steel from which steel bearings (e.g. roller and rocker bearings) are made of shall be quenched and tempered. The impact strength (Charpy V) shall be tested at -40° C by the procedure EN 10045-1.

Hinges

The requirements for steel hinges and their design are laid down in the

applicable sections above.

In hinges where sheet membranes are used the polymer bitumen membrane K-MS 170/3000 used shall comply with the requirements in Section 6.2.2.7, SYL 6. The gluing bitumen shall fulfil the quality requirements for polymer bitumen KB100 in the Table 2, Appendix 3 of SYL 6.

7.3.2 Installation

7.3.2.1 General

The plan for installation work shall be prepared in the manner described in Section 7.1.4.

The installation plan shall show, among other things temporary supporting of bearings, horizontal loads, installation sequence, base casting and thermal protection.

Before installation it shall be ensured that the bearing has the required play and predetermined position is as shown in the design and that the bearing has a marking showing the direction of pre-positioning. The predetermined position shall be installed in such a way that the movement of the bearing remains within the specified limits for the whole service life of the structure.

An example of the marking which is used to demonstrate the direction of the bearing's movement is an arrow stamped on the top surface of the top plate.

The structure shall be installed on its bearings so that the loads remain within the determined limits and that the structure does not get additional loads due to its supporting (see Section 7.3.1 and SYL 3 and SYL 4). If necessary, measurements shall be performed to check the accuracy of the supporting forces.

7.3.2.2 Precision of installation

Bearings shall be installed so that there is no more than 0.3% difference in the tilt gradient of the bottom and top plate compared with that in the design.

The installation tolerance for bearings lengthwise along the bridge in proportion to the substructure shall be ± 0.05 % × span length, but not however more than ± 50 mm. More precise positioning than ± 20 mm is not required.

The installation tolerance crosswise over the bridge in proportion to the substructure is ± 20 mm.

7.3.2.3 Fixing to substructure

In steel girder bridges and in bridges of prefabricated concrete units the bottom plates of the bearings may not be fixed to the base before the superstructure is fully in position, unless otherwise stated in the installation plans.

Bearings shall be installed to the substructure in the manner shown in the design, so that the bearing's bottom plate is fully supported. Air bags may not remain under the base plate and lateral forces shall be transferred to the substructure.

A pourable mortar shall be used to fasten the bearings. The strength of the mortar shall be at least K50 after two weeks. In the absence of reliable information concerning the strength and other properties of the material in question, its suitability shall be shown by preliminary testing.

> Products approved by the Finnish National Road Administration are listed in SILKO Directives /1/.

Before pouring the mortar under the base, adequate curing conditions shall be ensured. Temperatures shall be measured by a thermometer.

> Where necessary the upper section of the substructure shall be heated to at least +5° C before casting the concrete and the heating shall be continued during the curing stage until a minimum strength of K/2 is achieved.
>
> While fixing bearings to the substructure, movement arising from temperature changes in the structure shall be taken into consideration.

7.3.2.4 Fixing to the superstructure

In steel bridges, bearings shall be attached to the girders so that the loads are transferred from the bearings to the stiffeners of the girders as evenly as possible.

Where elastomeric laminated bearings are used in prefabricated concrete girder bridges and steel girder bridges with reinforced concrete deck, the ends of the bridges shall be raised up from the bearings, in turn, after the

bridge deck surface structures are completed, and then lowered back again after the elastomeric laminated bearing has straightened to the zero position.

The arrow or indicator showing the movements of the moveable bearings shall be installed so that that the position of the bearing is visible from the side of the bridge.

In special bearings, the bolts locking the different components of the bearing so that they cannot move compared to each other during transportation and installation and so that they are fixed together shall be replaced by plastic screws delivered by the bearing supplier before the bearing is fixed to the superstructure. If those screws are not available, the cavities shall be filled with durable putty.

After the pourable mortar for the base is hardened, all assembly mounting plates, screws, etc., of and other ancillary components shall be removed immediately. These components shall not prevent movements of the bridge at any stage of the operation.

7.3.3 Proof of acceptability and reporting

A record shall be made of the installation of bearings and components.

A site log or separate record shall be kept during installation and the following information shall be recorded: the positioning of bearings, the predetermined position of moveable bearings, air temperature and temperature of the structure at the time of installation work, the maximum temperatures of concrete for cast in situ bridges, and the pourable mortars and methods of heating.

The proof of acceptability for bearings and hinges shall be demonstrated by material certificates, delivery notes and inspection records for structural components.

Material certificates are, however, not needed if the manufacturing of the bearings is duly inspected. The inspection record shall show the following, amongst other things:

- bearing dimensions
- evenness of surfaces
- surface coating thickness

To confirm the acceptability of pourable mortars, at least tree cylindrical samples having a diameter and a height of 100 mm shall be prepared during

casting work for each project for determination of compression strength. The test samples shall be kept close to the casting place and tested after seven days, at which point the compression strength shall be a minimum of 40 MN/m². The results from all the test samples shall comply with the prescribed compression strength. The manufacturing and the testing of test samples shall otherwise comply with the directives of Standard SFS 4474 /6/.

The installation precision of bearings shall be established by horizontal and vertical measuring. An additional measurement shall be taken for moveable bearings with regard to their position and the temperature at that time. The measurements shall be recorded.

If the acceptability can not be otherwise demonstrated, a load test or other serviceability test shall be carried out.

See also SYL 1, Section 1.3.4.

7.4 MACHINERY AND CONTROL CABINS

7.4.1 General

For concrete, steel and timber structures the relevant specifications shown in SYL 3, SYL 4 and SYL 5 shall be applied.

7.4.2 Materials, equipment and accessories

For the material, equipment and accessories used, acceptable material certificates, inspection logs and operating licences and instructions shall be submitted to the supervisor.

7.4.3 Installation

Plans for installation work shall be prepared according to Section 7.1.4.

After installation is completed the work shall be inspected to check it has been carried out according to the design. The inspection records are submitted to the supervisor.

The installation of electrical equipment shall be carried out in conjunction with the additional statutory inspections.

7.5 APPROACH SLABS

Specifications for the casting and quality of approach slabs are dealt with in the relevant parts of SYL 3 and SYL 6.

Approach slabs may not cast tightly against wing walls.
The width of the gap shall be 50 ± 10 mm.

7.6 SAFETY EQUIPMENT

7.6.1 Railings and guides

7.6.1.1 General

Railings and guides shall be manufactured and the acceptability proved as shown in SYL 4. Additional requirements to be taken into consideration are laid down hereinafter.

7.6.1.2 Quality requirements

The material of steel railings shall fulfil the requirements based on the quality marks and strength marks according to the SFS-EN Standards. The steel shall be silicon compacted (Si) steel.

All sharp edges of surfaces as well as joints and corners shall be bevelled.

The splice weld on the top side of the guide shall be ground down to the base material and the weld splash removed before the surface finishing treatment.

Butt welding of the guide and of posts shall fulfil the quality specifications of Class WB of Standard SFS 2379 /6/. When required these welds shall be inspected by ultrasonic testing. Otherwise railing welds shall fulfil the specifications for Class WC of Standard SFS 2379.

Painting on top of hot-dip galvanizing shall be done in accordance with the painting system 4.3 of the environmental attack class M4.

7.6.1.3 Installation

7.6.1.3.1 General

Plans for installation of railings shall be prepared as laid down in Section 7.1.4.

Railings shall be installed according to the horizontal and vertical alignment of the road even although the structure to which they are attached may differ in this respect, for example where the superstructure is straight in a wide curve of the road. Any deviation from this theoretical position may not be more than L/1000, and however at most ± 20 mm. More precise accuracy than ± 2 mm is not required. The distance between measurement points is arbitrary. Posts and lattice bars shall be fastened vertically.

The guide of the railing shall be fastened in such a way that any vertical unevenness in the superstructure of the bridge which has come about at the construction stage is not seen in the guide. Any long term changes in concrete shall if necessary be taken into account. In prestressed bridges, guides shall be fixed only after tensioning is completed.

There shall not be any bend of more than 2 mm over one metre length in either horizontal or vertical direction.

The amount of play shall be the same on the guard rail as on the guide. One of the splices of the narrow steel guard rail shall be positioned between the same pair of posts as the expansion joint of the railing.

> If necessary the holes for the bolt in the guard rail shall be enlarged or a special guard rail extension piece is used. Enlarging of holes shall comply with the applicable parts of the regulations in Standard SFS 3200 /4/. The hole may not be enlarged by flame-cutting.

Railings shall be fixed by welding to the superstructure, only after the bridge is erected. At the installation phase an estimate shall be made of those curvatures which may arise from the weight of the deck surface structure on the railing guides.

Installation welds and holes for railing shall be shot blasted to cleanliness degree of Sa 3 and surface-treated in an approved way.

> Unless otherwise laid down in the design, the erection welds and holes shall be protected by spray galvanizing and by vinyl coating in accordance with Standard SFS 3107 /6/ or by a triple

application of a single component zinc-rich paint layer. The coating thickness shall be equivalent to that for other railing parts.

Screws for guard rails and guides shall be galvanized according to Standard SFS 4449 /6/.

Rail posts and temporary installation wedges may not be welded on to the reinforcement of edge beams.

Open void boxes for rail posts shall be protected over the winter to prevent damage caused by frozen water.

7.6.1.3.2 Fixing the railing with bolts

When steel bolts are manufactured from stainless or acid-proof stainless steel, the bolts shall be isolated from other steel parts with a plastic cover. When galvanized screws are used, these shall have been allowed to oxidise for a minimum of six weeks, or the surface shall be sealed by an alkali-resistant resin before installation.

Bolts for rail posts shall be fitted before in-situ casting of edge beams, with the aid of, for example, temporary plywood fixing plate. The threads of screws shall be protected from splashes of concrete by adhesive tape. The fixing plate shall rest on the bolts (nuts with small thickness) of the post. A gap of approximately 50 mm shall be left between the plate and the top surface of the edge beam. The nuts underneath the fixing plate of the group of bolts shall be carefully tightened to the same height. The group of bolts are then to be tightened by the fixing plate to the correct position so that the rail post is always vertical. While casting the concrete shall be carefully compacted at the bolts and the surface of the edge beam float finished as well as possible, also underneath the fixing plate. The fixing plate shall be removed as soon as possible after casting as the concrete splashes can be more easily removed from the bolts by cleaning with water.

After this has been done the level of the height of the group of bolts and the group which deviates most from the designed positions can be found. The final level of the rail post shall be determined by raising or lowering the nuts underneath the base plate. The posts with their base plates are then to be lifted into position, and final adjustments can be made. Before tightening the nuts, the guide and the narrow guard rail shall be installed. Finally, the nuts are tightened fully and the base stand cast. The casting form shall be made of sheet metal, for example, which

is supported by a wooden framework.

7.6.1.3.3 Fastening of railing in cast blockout

The technical plan for fastening railings by casting is laid down in the manner described in Section 7.1.4.

Fastening may be done by grouting into rectangular blockout or into a cylindrical hole which is bored afterwards.

Before grouting (pressure grouting) all loose material and cement mortar shall be removed from the edges of the blockout. There shall be a minimum of 20 mm of void space in every direction between the rail post and the concrete for the blockout before grouting.

The distance from the top surface of the edge beam to the installation wedges shall be a minimum of 80 mm.

The grout shall be frost-resistant P50 and shrink-proof with a strength rating of at least K35, unless otherwise provided for in the design.

After concrete casting it shall be ensured that the blockout of the rail post remains open to allow any incoming or condensing water to escape through the blockout.

Hardened grouting may not loosen from the sides of the blockout or the top surface of the edge beam by more than 0.2 mm and in the top surfaces may of the grouting there shall not be any cracks having a width of more than 0.2 mm.

7.6.1.4 Proof of acceptability and reporting

The acceptability of the material used for steel railings shall be proved with material certificates and delivery notes.

The acceptability of the railings shall be indicated by inspection logs.

The acceptability of grout shall be proved as laid down in SYL 3. Where the mortar is a product approved by the SILKO Directive 3.231 /1/, the frost-resistance and strength do not have to be tested separately, assuming that the preparation of the compound has been done according to the directions for the product in question.

See also SYL 1, Section 1.3.4. .

7.6.2 Kerbs

The quality and approved standards for concrete kerbs are shown in the relevant parts of Sections 3.2.4 and 3.4.10 of SYL 3 respectively .

Kerbs shall be of frost-resistant grade P50 and of strength rating K40.

Kerbs made from stone shall fulfil the specifications of Standard SFS 4159 /6/ and their acceptability approved in the inspection logs.

Manufacturers of kerbs are listed in SILKO Directives /1/.

7.6.3 Other safety devices

Design for the manufacture and quality assurance of booms and other safety devices (including collision barriers and protecting shields at high voltage electric wires) shall be prepared as is shown in SYL 1.

A technical plan for the installation of safety devices shall be prepared as shown in Section 7.1.4.

After installation the work shall be examined to check that it has been carried out in accordance with the design. The inspection records shall be handed over to the supervisor.

The installation of electrical equipment shall be carried out with regard to statutory inspection.

By the installation of safety devices for bridges spanning electrified railways the requirements and directives of the Finnish State Railway shall be obeyed.

7.7 OTHER EQUIPMENT AND ACCESSORIES

7.7.1 Gaps and voids

Adding gaps and voids over and above what is shown in the design is considered as being a change to the design and shall be approved and permitted by the supervisor before work commences.

Reinforcing bars which span gaps and voids may not be broken or moved

aside without permission from the supervisor. Cut bars shall usually be replaced with additional reinforcement positioned next to the gap. Freezing in voids shall be prevented.

The tolerance for positioning of gaps and voids is ± 15 mm.

The tolerance for the dimensions of gaps and voids are -5 mm and +15 mm.

7.7.2 Batch pipes and mountings for explosives

The tolerance for the horizontal and vertical positioning of batch pipes and mountings for explosives is ± 40 mm.

The position, the material and the type of painting for batch pipes and mountings for explosives shall be indicated in the design.

7.7.3 Drain pipes

Drain pipes shall be made from stainless acid-resistant steel according to the specifications of Standard SFS 725 /6/. Finishing standards of surfaces shall comply with Standard SFS 700 grade 2D /6/. Welding shall be carried out using rustproof filler metal and by complying with the Standards applying to the steel being used. Weld joints are pickled with suitable paste in line with the Standards.

The tolerance for positioning drain pipes is +0 mm to -10 mm compared with the level of the top surface of the deck, in relation to the bottom surface of the deck the margin is +20 mm to -5 mm.

Water sprayed on to the deck shall not form puddles but flow down through drain pipes.

Particular attention is drawn to the fact that water on the bridge deck flows to the closest drain pipe also at the end of the bridge. If necessary the top surface of the bridge deck shall be designed so that water is carried to the pipes and any bumps which could prevent this shall be removed. Boring holes into the finished structure shall be considered as a change to the design and additional conduits shall be approved by the supervisor.

If the surface is to be reshaped after the concrete has cured, repairing shall be carried out according to SYL 3. Bonding of

repairing compounds to the cured concrete surface shall be ensured.

The flange around the top end of the pipe is sealed with a double coat of a heat-resistant epoxy resin, tolerant to + 210° C.

7.7.4 Down pipes

Down pipes and their supports shall be made from stainless acid-resistant steel, according to Standard SFS 757 /6/. Surface finishing shall be carried out to grade 2D, Standard SFS 700 /6/. Welding shall be carried out using rustproof filler metals and in compliance with the standards applying to the steel being used. Weld joints shall be completed to the approved standard and pickled with paste which is approved for the purpose.

The tolerance for positioning down pipes is +0 mm to -10 mm compared with the level on the top surface of the deck, in relation to the under surface of the deck the margin is +20 mm to -5 mm.

The latticework on top of the pipes shall be installed crosswise over the deck.

7.7.5 Venting pipes

Venting pipes are made of stainless steel according to Standard SFS 725 /6/.

The tolerance for positioning venting pipes is +0 mm to -10 mm compared with the level of the top surface of the deck, and +20 mm to -5 mm in relation to the bottom surface.

7.7.6 Subsurface drains

Subsurface drains shall be of water conductible material.

Drains are generally made to the thickness of the protecting course of the waterproofing structure.

Subsurface drains shall be filled with an extremely water-permeable polymer-bound or bituminized coarse aggregate. Geotextile is spread on top of the aforesaid compound to prevent the pavement bitumen from running into the compound.

The more detailed directives for preparing undersurface drains are laid down in SILKO Directives, see /1/.

7.7.7 Cable ducts and cable ledges

The tolerances for positioning of cable ducts and ledges is ± 20 mm.

The cable shall be able to move freely and shall allow elongation inside the protective duct.

> At the expansion joints, it shall be ensured, that during casting no concrete is allowed to penetrate into expansion joint splices of the cable duct.

The water-outlet duct shall be installed at the lowest point of the cable duct.

7.7.8 Monitoring pins and contact pins

Monitoring pins required to monitor deflections and movements shall be installed in concrete structures in accordance with Section 1.4.4 of SYL 1. These shall be installed in such a way that they do not touch the reinforcement.

For the same reason permanent measurement points shall be made for steel and timber structures.

Contact pins are installed as laid down in Section 3.1.6 of SYL 3.

7.7.9 Fixing plates and devices plus flap doors for man holes

The tolerance for positioning of fixing plates and devices is -0 mm to +5 mm compared with the horizontal and vertical surface levels.

The tolerance for flap doors is ± 20 mm.

Flap doors shall be able to be opened and closed without difficulty and safeguarded by a lock.

7.8 BIBLIOGRAPHY

Specifications and Directives by the Finnish National Road Administration:

/1/ Sillankorjausohjeet, SILKO, TIEH
Finnish Bridge Repair Manual, SILKO Directives, Finnish National Road Administration

1.601 Sillan ja siltapaikan kuivaus
Drainage of the Bridge and the Bridge Site

1.701 Liikunta- ja kutistumissaumat
Expansion and Contraction Joints

1.901 Siltapaikan viimeistely
Bridge Site Finishing Work

2.236 Halkeaman injektointi
Injecting Cracks with Epoxy

2.239 Halkeaman sulkeminnen imeyttämällä
Repairing Cracks by Capillary Penetration

2.351 Kaiteen paikkamaalaus
Surface Treatment Touch-up Painting a Railing

2.613 Reunasalaojan teko
Making an Edge Drain

2.614 Poikittaisen salaojan teko
Making a Crosswise Subsurface Drain

3.231 Paikkausaineet
Patch Materials

3.352 Pintakäsittelyaineet
Impregnants and Sealants

1.301 Teräs sillankorjausmateriaalina
Metals as Bridge Repair Materials

4.301 Konepajat ja metalliverstaat
Machine and Metal Workshops

/2/ Sillanrakentamisen yleiset laatuvaatimukset. Yleiset ohjeet - SYL 1.
General Quality Requirements for Bridge Construction. General Instructions -1.
Helsinki. Finnish National Road Administration 1996 . 2210003.

/3/ Sillanrakentamisen yleiset laatuvaatimukset.Betonirakenteet - SYL3.
General Quality Requirements for Bridge Construction. Concrete Structures - 3.
Helsinki. Finnish National Road Administration. 1996. 2210005.

/4/ Sillanrakentamisen yleiset laatuvaatimukset. Teräsrakenteet - SYL 4.
General Quality Requirements for Bridge Construction. Steel Structures -4.

Helsinki. Finnish National Road Administration. 1996. 2210006.

/5/ Sillanrakentamisen yleiset laatuvaatimukset. Kannen pintarakenteet - SYL 6.
General Quality Requirements for Bridge Construction. Deck Surface Structures - 6.
Helsinki. Finnish National Road Administration. 1996. 2210008.

SFS Standards:

/6/ SFS 2379. 1983. Hitsaus. Teräsrakenteiden hitsausliitokset. Hitsiluokat (Welding. Welded Joints of Steel Structures. Guidance on Quality Levels for Imperfections).
Helsinki. Finnish Standards Association SFS. 13 p.

SFS 3200. Teräsrakenteiden suunnitteluohjeet. (Design Standards for Steel Structures.)
Helsinki. Finnish Standards Association SFS.

SFS 2765. 1988. Metalliset pinnoitteet. Teräksen ja valuraudan kuumasinkkipinnoitteet kappaletavaroille. Yleistietoja ja vaatimuksia (Metallic Coatings. Hot Dip Galvanized Coatings on Fabricated Ferrous Products. General Information and Requirements).
Helsinki. Finnish Standards Association SFS. 6 p.

SFS 3107. Metallien pinnoitteet. Sinkki- ja alumiiniruiskutus teräksen ja valuraudan korroosioestoon. (Metal Coatings. Zinc and Aluminium Spray Coating for Anti-corrosion for Steel and Cast Iron.)
Helsinki. Finnish Standards Association SFS.

SFS 4449. 1979. Metallien pinnoitteet. Kierteitettyjen teräskappaleiden kuumasinkitys. Metriset pulttikierteet. (Coatings of Metals. Hot Dip Galvanized of External Threaded Components of Steel. Metric Threads.)
Helsinki. Finnish Standards Association SFS. 5 p.

SFS 4159. 1978. Reunakivet. (Granite Kerbs.)
Helsinki. Finnish Standards Association SFS. 4 p.

SFS 700. Austeniittiset ruostumattomat levyteräkset. Teräslaadut ja merkintä. (Austenitic Stainless Steel Plates. Steel Grades and Stamps on Steel Plates.)
Helsinki. Finnish Standards Association SFS.

SFS 725. Austeniittinen haponkestävä teräs 725. (Austenitic Acid-resistant Steel 725.)
Helsinki. Finnish Standards Association SFS.

SFS 757. Austeniittinen ruostumaton teräs 757. (Austenitic Stainless Steel 757.)
Helsinki. Finnish Standards Association SFS.

SFS 4957. 1983. Korroosionestomaalaus. Esikäsittelyt (Anti-corrosive Painting. Surface Preparation).
Helsinki. Finnish Standards Association SFS. 5 p.