VOLUME 13

REPLACEMENT PROCEDURES FOR LONG HANGERS

(Panel Points 10 to 42 and 48 to 88)

Contents:

Contents: continued

1. Scope

This Replacement Procedure describes the procedures to be adopted for the replacement of Hanger Ropes at the following Panel Points:

Panel Points 10 to 42 inclusive, 48 to 88 inclusive, east and west.
Panel Points 10' to 42' inclusive, 48' to 88' inclusive, east and west.

The function of the temporary equipment to be used during the replacement of the above Hangers is also described herein.

For all other Hangers refer to the replacement procedure for the Replacement of Short Hangers, Volume 12 of the Health and Safety File.

2. References

Drawings:
M&T drawings:

Dwg. No.:	0.001	General Arrangement, General Notes
Dwg. No.:	1.201	Working Platform, General Arrangement, Elevation
Dwg. No.:	1.202	Working Platform, General Arrangement, Section A
Dwg. No.:	1.203	Working Platform, Equipment Arrangement
Dwg. No.:	1.204	Working Platform, Hydraulic Equipment Arrangement
Dwg. No.:	1.207	Working Platform, General Arrangement, Dismantling of old Hangers
Dwg. No.:	1.208	Working Platform, Moving of Working Platform on Main Cable to New Hanger Position, 1 and 2
Dwg. No.:	1.209	Working Platform, Moving of Working Platform on Main Cable to New Hanger Position, 3 and 4
Dwg. No.:	1.210	Working Platform, Detail 1
Dwg. No.:	1.211	Working Platform, Section B
Dwg. No.:	1.212	Working Platform, Detail 2
Dwg. No.:	1.213	Working Platform, Detail 3
Dwg. No.:	1.214	Working Platform, Detail 4 and 5
Dwg. No.:	1.215	Working Platform, Detail 6
Dwg. No.:	1.216	Working Platform, Detail 7
Dwg. No.:	1.220	Working Platform, Transport Unit, Arrangement
Dwg. No.:	1.221	Working Platform, Unit AB, wheel and bearing
Dwg. No.:	1.222	Working Platform, Unit AA, Detail 1, 2, 3 and 4, Section B and C
Dwg. No.:	1.223	Working Platform, Unit AC
Dwg. No.:	1.224	Working Platform, Unit AD and AF
Dwg. No.:	1.225	Working Platform, Unit AD and AF, Section C, Detail 1 and Detail 2
Dwg. No.:	1.226	Working Platform, Unit AD and AF, Section D
Dwg. No.:	1.227	Working Platform, Unit AA, Detail 5 and Unit AP
Dwg. No.:	1.228	Working Platform, Au-floor on Unit AA
Dwg. No.:	1.230	Working Platform, Unit AK and AL, Arrangement
Dwg. No.:	1.231	Working Platform, Unit AK and AL, Section E, F and G
Dwg. No.:	1.232	Working Platform, Unit AK and AL, Details
Dwg. No.:	1.233	Working Platform, Unit AK and AL, Shield, Roof and Alu-floor
Dwg. No.:	1.234	Working Platform, Unit AM, AN and AO
Dwg. No.:	1.235	Working Platform, Unit AR
Dwg. No.:	1.236	Working Platform, Unit AS, AT, AU and AV
Dwg. No.:	1.240	Working Platform, Unit DD
Dwg. No.:	1.301	Temporary Hanger System, Cable Band, Friction Test of Temporary Cable Band
Dwg. No.:	1.302	Temporary Hanger System, Cable Band
Dwg. No.:	1.303	Temporary Hanger System, Cable Band, Detail 1
Dwg. No.:	1.304 /	

Drawings: continued
M&T drawings: continued

Dwg. No.:	1.304	Temporary Hanger System, Cable Band, Detail 2 and Detail 3
Dwg. No.:	1.305	Temporary Hanger System, Cable Band, Detail 4
Dwg. No.:	1.306	Temporary Hanger System, Cable Band, Detail 5 and pin
Dwg. No.:	1.307	Temporary Hanger System, Cable Band, Unit BF and BH
Dwg. No.:	1.320	Temporary Hanger System, Anchor Beam, Plan
Dwg. No.:	1.321	Temporary Hanger System, Anchor Beam, Section A
Dwg. No.:	1.322	Temporary Hanger System, Anchor Beam, Section B, C and D
Dwg. No.:	1.330	Temporary Hanger System, Hydraulic Diagram A-system
Dwg. No.:	1.501	Circular Roller Track System, General Arrangement Elevation
Dwg. No.:	1.510	Circular Roller Track System, Unit AH
Dwg. No.:	1.511	Circular Roller Track System, Unit AH, Wheels Type 1 and Type 2
Dwg. No.:	1.512	Circular Roller Track System, Unit AX
Dwg. No.:	1.513	Circular Roller Track System, Unit AY, AZ, CP and CR
Dwg. No.:	1.520	Circular Roller Track System, Unit BM and BO
Dwg. No.:	1.521	Circular Roller Track System, Unit BN
Dwg. No.:	1.530	Circular Roller Track System, Clamps
Dwg. No.:	1.702	Temporary Jacking System, Small Beam
Dwg. No.:	1.703	Temporary Jacking System, Big Beam, Type 1
Dwg. No.:	1.705	Temporary Jacking System, Clamp, Hanger Console and Macalloy Bar
Dwg. No.:	1.706	Temporary Jacking System, Base and connection Plates
Dwg. No.:	1.712	Temporary Jacking System – Mk 2, General Arrangement Assembly of New Hangers
Dwg. No.:	1.713	Temporary Jacking System – Mk 2, General Arrangement Sections B, C and D
Dwg. No.:	1.716	Temporary Jacking System – Mk 2, Beam, Pin and Macalloy Bar
Dwg. No.:	1.730	Temporary Hanger System, Hydraulic Diagram B-system

Tensoteci drawings:/…

Drawings: continued

Tensoteci drawings:

Dwg. No.:	02007	Bushing for sockets, Main span
Dwg. No.:	02008	Bushing for sockets, Side span

VSL drawings:

Dwg. No.:	G 8449.1	Jack bottom	part of calculations
Dwg. No.:	G 8450.1	Padeye	part of calculations
Dwg. No.:	G 8451.1	Suspension Plate	part of calculations
Dwg. No.:	G 8452.1	Piston	part of calculations
Dwg. No.:	G 8453.2	Yoke	part of calculations
Dwg. No.:	G 8455.1	Hydraulic Jack HZP 75-700	
Dwg. No.:	G 8466.1	Eyeplate	part of calculations
Dwg. No.:	G 8482.2	Jack Body	part of calculations
Dwg. No.:	G 8489.1	Tensioning Device, Assembly	
Dwg. No.:	G 8490.2	Kolbenführung KRF	
Dwg. No.:	G 8493.1	Verankerung Litzen-fuhrung unten	
Dwg. No.:	T 5180.1		part of technical information
Dwg. No.:	T 5213.1		part of technical information
Dwg. No.:	T 5215.1		part of technical information

WAF drawings (List all As-builts?)

Dwg. No.:	33111/AB/14	Layout and Details of Hanger Rope Spacer Units (As-Built)

3. General

All operations and procedures as described in this document shall be governed by the Forth Estuary Transport Authority Health and Safety Procedures.

The hanger replacement sequence is based on the installation of temporary hangers.

An Inspection of the permanent structure at each hanger location is carried out before start of the replacement of the hanger, as outlined in Section 5.1 of this document.

The operations to be carried out to replace a long hanger, at the panel points noted in Section 1, are described in this replacement procedure, in Sections 5 through to 30 as detailed in the Contents. This replacement procedure shall be read in conjunction with the drawings listed in Section 2 References.

Most of the operations at cable band level are carried out from a working platform which runs on the main cable of the bridge. The working platform is lifted on to the main cable from bridge deck level and is then moved up to the relevant hanger cable band.

Where reference is made to approvals, decisions or the like by the Bridgemaster in this document, this shall be taken to be the Bridgemaster or his appointed representative(s) as identified to the workforce prior to commencing operations to replace a hanger.

4. Weather Precautions

The operational weather criterion is a max. gust wind velocity of 16 m/sec (short-term mean value over a few seconds, 3 - 5 sec.) at the working level. Work may be stopped by the Bridgemaster before the velocity reaches the 16 m/sec whenever in his opinion the conditions prevent safe working.

The operational criterion for lifting with the crane is, a max. gust wind velocity of 9.8 m/sec (short term mean value over a few seconds, 3 –5 sec.)

Heavy rain and low visibility should also be taken into account in determining safe working conditions.

If ice and frost occurs, access on the Main Cables should be prohibited unless emergency works are required at the instruction of the Bridgemaster.

If ice and frost occur on other working areas these areas should be sanded to prevent operatives sliding. Sanding of areas to permit work in such conditions shall be subject to the approval of the Bridgemaster

The safety of operatives working under cold weather conditions (ice and frost) or high winds shall be subject to specific Risk Assessment and conclusion of these Risk Assessments shall be adopted.

5. Preparatory Works

5.1 Inspection of Structure Prior to Commencement of Works

tbc

5.2 Scaffolding under Top Chord

Access is needed to erect temporary equipment such as anchor beam, jacks etc. for the temporary hangers. A suspended scaffold platform shall be erected to provide the required access.

No loads from temporary equipment will be transmitted to the scaffolding at any time.

A suitable scaffolding shall be provided by a scaffolding specialist to provide access equivalent to that provided by the M&T scaffold, as indicated on the M&T siubcontractor's drawing number ?????????.

6. Transport of New Hangers and Temporary Works

New hangers and all temporary works are to be transported to the required hanger location by a method that does not overload the footways. The method of transport proposed is to be approved by the Bridgemaster prior to adoption.

7. Erection of Working Platform

This section describes the erection of the Working Platform from its storage area until it is ready for use on the main cable and prior to moving to the relevant hanger location.

Erection of the Working Platform is carried out at Panel Point. 8, 8´, 90 and 90´ dependent upon the hanger to be replaced.

7.1 Pre-assembly of Transport Unit

The transport unit is pre-assembled prior to transport to the bridge.

The tools and equipment required include: Hand tools, Hiab crane, lever hoists.

Sequence of operation:

1. Place the Transport Unit AA in an upright position, making sure to leave sufficient space for the installation of the guide wheels.
2. The Transport Unit shall be supported at a reasonable level to ensure the circular roller track is not damaged in any way.
3. Assemble the main wheels on the Transport Unit. The pressure in the tyres shall be 9.5 bar. (refer to M&T Drg. No. 1.220)
4. Install the adjusting arrangement for the roller track on Transport Unit (refer to M&T Drg. No. 1.212)
5. Install the roller track (refer to M&T Drg. No. 1.510)
6. Install the guide wheels, units AC, AD and AF. The wheels should be retracted to achieve the greatest distance between the wheels (refer to M&T Drg. No. 1.211)
7. Install 3 No. Hydraulic Tirfor TU-32 winches (refer to M&T Drg. No. 1.204)
8. Test that all moving parts are working.

7.2 Pre-assembly of Framework Unit AK and AL

The framework units AK and AL are pre-assembled prior to transport to the bridge.

The tools and equipment required include: Hand tools, Hiab crane, lever hoists

Sequence of operation:

1. Units AK and AL are bolted together to form a stable framework whilst installing equipment.
2. Baskets for hydraulic equipment are installed on both ends of the framework. (refer to M&T Drg. Nos. 1.213 and 1.214).
3. The adjustable floor, Units AM and AN, is installed in both framework units (refer to M&T Drg. No. 1.216)
4. The power packs with hoses and couplers, for the VSL and Tentec equipment are installed in the baskets in accordance with M&T Drg. No. 1.204.

7.3 Widening of Distance between Handstrand Cables

Prior to erecting the Working Platform Transport Unit the distance between the handstrand cables requires to be widened to allow sufficient space for the widest part of the Working Platform. The distance between the handstrand cables is increased from approximately 945mm to 2000mm.

The tools and equipment required include: Rigging Screws, Spreader Unit, access scaffold – no scaffold used by M&T

How is equipment delivered to main cable?? Carried or hiab or crane?
Mention work undertaken from main cable??? – according to WAF Inspector M&T didn't use a scaffold for access to cable to do preliminary works however section 7.4 refers to erecting lower parts of temp cable bands from scaffold therefore there must have been access scaffold. In any case it would seem safer to have one. But the scaffold may obstruct erection of transport unit of units AK AL??? 1.740 point 8. Refers to scaffold for erection of lower part of cable bands.

Sequence of operation:

1. A rigging screw is fastened to both handstrand cables adjacent to the nearest handstrand support frame north of the panel point where the working Platform is to be erected. The rigging screw is to be located on the side nearest the erection location.
2. The above step 1 is repeated for the nearest handstrand support frame south of the erection location.
3. One Spreader Unit DF is installed 5.0m from the centreline of the panel point location where the Working Platform is to be erected, in both north and south directions.
4. Once the rigging screws and the spreader units have been checked as secure, the handstrand cables are released from the handstrand support frame.
5. The handstrand cables are secured by the use of pullers and soft slings wrapped around the main cable and fixed to the handstrand cables.
6. Disconnect the bolted clamps securing the handstrand cables to the handstrand support frame.
7. After releasing the handstrand cables from their clamps reconnect the clamps to the support frame.
8. After release of the handstrand from the support frame release and remove the pullers and soft slings attached to the handstrand cables. The handstrand will hang approx. 150 mm higher than original alignment during this time.
9. Once the handstrand is confirmed as released from the support frame and soft slings the spreader units are to be used to widen the distance between the handstrand cables to 1950mm. See Figure 7.3.1.
10. The handstrand support frame shall be removed as part of the working platform erection (see Section 7.4, steps 6 to 9).

7.3 Widening of Distance between Handstrand Cables, cont'd

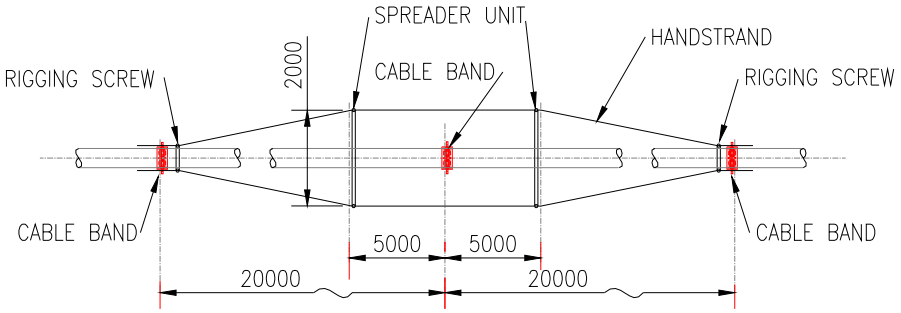

Figure 7.3 1 : Layout of Widened Handstrand

7.4 Erection of Temporary Cable Bands

Prior to erection of the Transport Unit of the Working Platform the Temporary Cable Bands require to be erected.

The tools and equipment required include: 20T mobile crane, web lashings, carriageway closure, Hiab, hand tools.

Sequence of operation:

1. The position where the Temporary Cable Bands are to be erected will be marked on the main cable.
2. Prior to assembling the Temporary Cable Bands on the main cable, the Bridgemaster must ensure the contact area for the Temporary Cable Bands are clean dry and free from any loose paint in order to achieve the required frictional restraint.
3. The main cable shall be cleaned using water and a stiff brush or by alternative methods approved by the Bridgemaster. Damaged areas of wrapping wire shall be protected and subsequently repaired to the approval of the Bridgemaster.
4. The road carriageway adjacent to the location for erection of the Working Platform shall be closed to all traffic.
5. The 20T mobile crane will go to the position for the erection of the Working Platform along the closed carriageway. For positioning of the mobile crane reference is made to Hewden Crane Hire Ltd. Drg. No. HSCAD10237-01A. The maximum force under any crane supporting leg shall be 160kN/m^2. Each crane supporting leg to have 1.2m x 1.2m x 22mm thick plywood protection mat or equivalent as approved by the Bridgemaster placed between the road surfacing and the crane support leg to prevent damage to the road surfacing. Any damage to the road surfacing will be repaired in accordance with Bridgemaster's instruction.
6. Prior to erecting the Temporary Cable Bands the existing handstrand support frame at the erection location shall be removed.
7. The handstrand support frame shall be secured to the crane by soft slings prior to releasing the connections to the permanent cable band.
8. Once secured by the crane the handstrand support frame shall be unbolted from the permanent cable band, with all hand tools secured by a safety line and a safe system of work employed to ensure the bolts, nuts and packers of the connections are secure against falling.
9. The handstrand support frame shall be lifted and lowered to the road deck level and taken to temporary storage for re-erection after the working platform departs this location.
10. The top part of the Temporary Cable Bands will then be lifted to the correct positions by the mobile crane from the pick up truck
11. As soon as the correct position of the Temporary Cable Bands is achieved the Temporary Cable Bands will be secured with web lashings **prior to** being unhooked from the crane.

7.5 Erection of Temporary Cable Bands, cont'd

12. The distance between the 'chimneys' on the upper part of the Temporary Cable Bands is adjusted to 3200mm +/- 4mm. The chimneys shall be in the same vertical plane along the main cable (tolerance +/- 4mm).
13. The lower parts of the Temporary Cable Bands, the wire terminals and spherical bearings, are placed on both Temporary Cable Bands using the access scaffold (see Section 5)
14. The wire terminals on the Temporary Cable Bands to the higher side of the main cable are pre-stressed to 30kN. The wire terminals on the Temporary Cable Bands to the lower side of the main cable are not pre-stressed.
15. After pre-stressing of the higher level Temporary Cable Bands the Temporary Cable Bands are ready to receive the Working Platform.

7.6 Erection of Transport Unit

Widening of the distance between the handstrand cables, removal of the handstrand support frame and erection and pre-stressing of the temporary cable bands requires to be completed prior to erection of the Transport Unit.

The tools and equipment required include: 20T mobile crane, web lashings, soft slings, shackles, pulleys, carriageway closure, Hiab, hand tools.

Sequence of operation:

1. The Transport Unit is transported from the pre-assembly area to the erection location on a lorry during the closure of the carriageway adjacent to the erection location.
2. The Transport Unit is lifted using the soft slings and shackles with a pulley attached to give horizontal movement control during lowering of the unit. The Transport Unit should be lifted at an angle equivalent to that of the main cable at the erection location to allow for positioning of the Transport Unit on the temporary cable bands (see Figure 7.5.1).
3. The Transport Unit is lifted and placed over the main cable and lowered slowly until the 'chimneys' at the temporary cable bands are passing through the tubes in the Transport Unit and continue until the sides guides are passing the main cable on each side.
4. Prior to releasing the Transport Unit from the mobile crane, the wire terminals in the lower temporary cable band are to be pre-stressed to 30kN. On completion of this pre-stressing the soft slings can be dismantled from the temporary cable bands.
5. The side guides on the Transport Unit should now be positioned at the centre of the main cable. These side guides are adjusted until the gap between the wheels and the main cable is 5mm on each side of the main cable. The Transport Unit is then fastened and secured and the connection to the crane can be released.
6. Upon completion of the Transport Unit erection the spreader units fastened to the handstrand cables can be released. The procedure for this release in the reverse of the operations described in Section 7.3

7.6 Erection of Transport Unit, cont'd

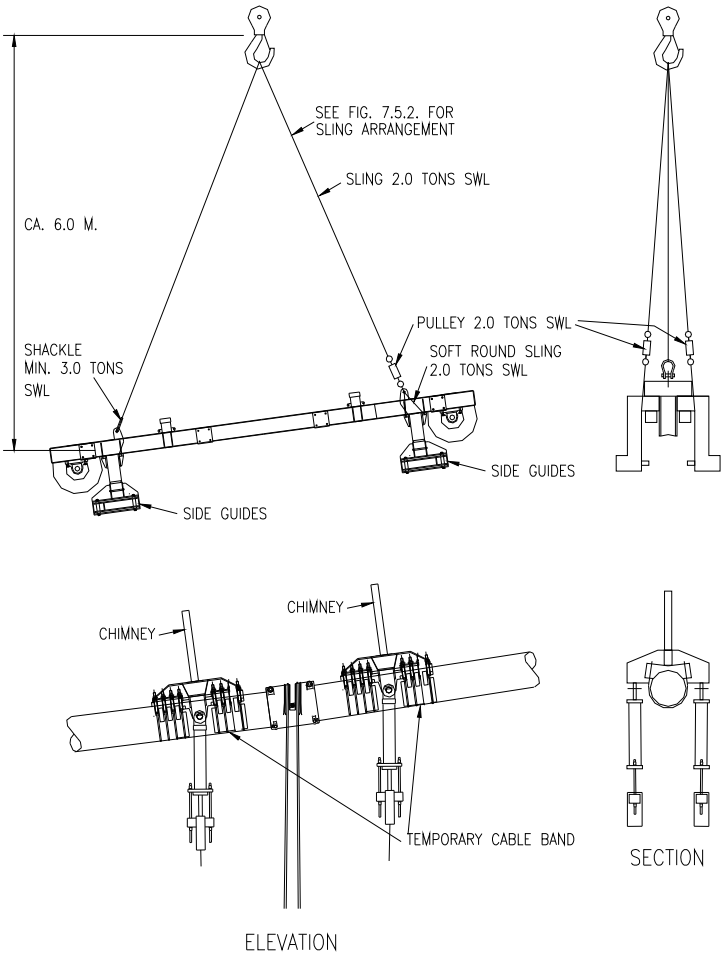

Figure 7.5.1: Lifting Arrangement

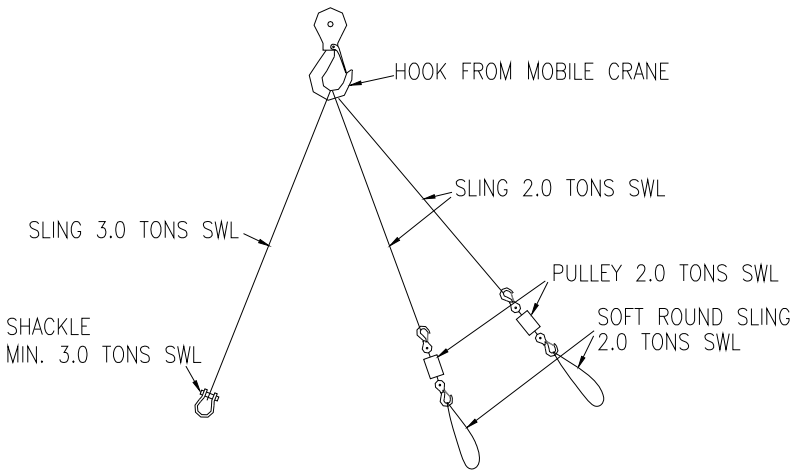

Figure 7.5.2: Sling Arrangement

Erection of Hydraulic Cylinders for Temporary Hangers

The general arrangement of the temporary hangers is shown on M&T Drg. No. 1.201.

WI 1.758 describes this operation being undertaken in the compound prior to erecting temp cable bands???

The tools and equipment required include: 20T mobile crane, web lashings, soft slings, shackles, pulleys, carriageway closure, Hiab, hand tools.

Sequence of operation:

1. The hydraulic cylinders are erected using soft slings and the mobile crane, during the carriageway closure.
2. Lift a hydraulic cylinder to the temporary cable band and attach the cylinder to the temporary cable band using a pin connector (refer to M&T Drg. No. 1.306).
3. Repeat step 2 on the opposite side of the first temporary cable band.
4. Repeat steps 2 and 3 for the remaining temporary cable band.
5. Hoses are connected to the VSL power pack and the system should be tested for extension and retraction of the hydraulic cylinders. which will be subject to the approval of the Bridgemaster.

7.7 Erection of Framework Units AK and AL

Erection of the working platform framework can commence after release of the handstrand cables (see Section 7.5 step 6). Units AK and AL should have been pre-assembled prior to commencing this operation (see Section 7.2).

The tools and equipment required include: 20T mobile crane, soft slings, shackles, pulleys, carriageway closure, Hiab, hand tools.

Sequence of operation:

1. The road carriageway adjacent to the location of erection shall be closed for this operation.
2. The pre-assembled Units AK and AL shall separated at their pre-assembly area and Unit AK shall have temporary props to provide stability to this single unit.
3. Unit AL shall be transported to the erection location and the mobile crane will be positioned as in Section 7.4.
4. Unit AL shall be lifted using soft slings shackles and pulleys. (see Fig 7.7.1) The framework unit should be lifted at an angle equivalent to that of the main cable at the erection location to allow for positioning of the framework unit on the transport unit.
5. The Unit AL shall be lifted to the side of the transport unit nearest to the footpath. The unit shall be positioned alongside the transport unit and then connected to the transport unit at the four bolted connections. After completion of the bolted connection the soft slings and pulleys can be released.
6. Steps 3 to 5 shall now be repeated for Unit AK. However Unit AK shall be erected on the side of the transport unit nearest the carriageway.

7.7 Erection of Framework Units AK and AL, cont'd

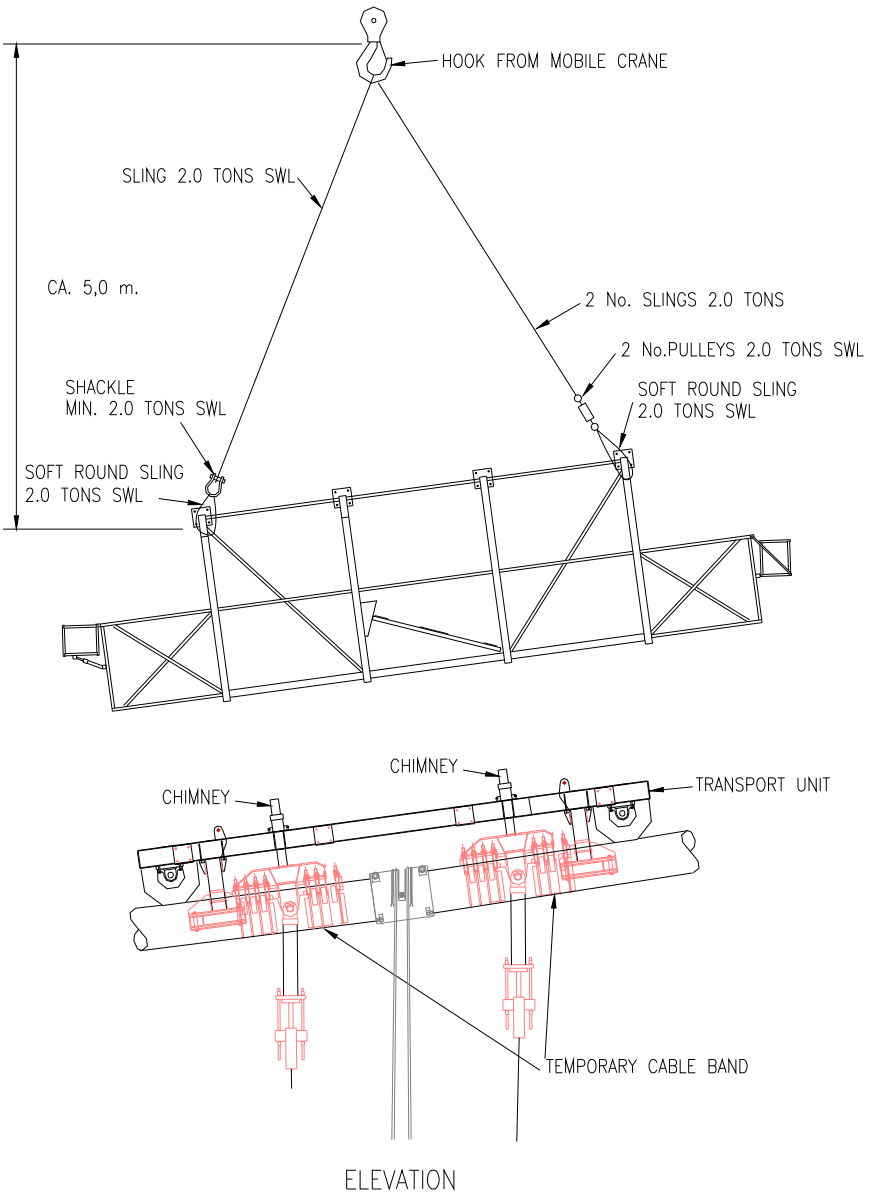

Figure 7.7.1: Lifting Arrangement

7.8 Erection of Small Parts

The erection of the working platform framework must be completed prior to this operation commencing.

Erection of small parts includes:

- Rope for Tirfor (moving working platform)
- PcP scaffolding planks for moveable platform
- Hand tools
- Counter-weights in accordance with M&T Drg. No. 1.203
- Connection of hoses for hydraulics

The tools and equipment required include: Hand tools, Hiab.

Sequence of operations:

1. All small parts will be lifted from the footpath using the Hiab and stored in the bottom of the working platform until further installation takes place.
2. All small parts must be secured with a safety line prior to final installation.
3. Operations for small parts include:
    - Finalise the connections for hydraulic hoses
    - Install counterweights
    - Final installation of hydraulic jacks for lifting temporary cable bands
    - Adjust guide wheels on Transport Unit
    - Check tyre pressure
    - Attach wires for cradles
    - The cradle is installed after the platform has been moved to where the hanger replacement is to take place.

8. Dismantling of Handstrand Support Frames

To allow the Working Platform to be moved along the main cable to the required hanger location, where a hanger replacement is to be undertaken, the handstrand support frames at the intermediate hanger locations require to be removed temporarily.

As the Working Platform approaches a cable band on the main cable the handstrand support frame has to be dismantled and removed to allow the working platform to pass the cable band.

The tools and equipment required include: Hand tools, soft slings, and web lashings

Sequence of operation:

1. The handstrand cables will be secured with web lashings before the handstrand support is dismantled.
2. The handstrand cable is secured by the use of pullers and soft slings wrapped around the main cable and fixed to the handstrand cables.
3. Disconnect the bolts and clamps securing the handstrand cable to the handstrand support frame.
4. The handstrand support frame is secured by soft slings and a winch line from the working platform.
5. The handstrand support frame is disconnected from the cable band, once secured to the winch, and lifted into the working platform.
6. Where the working platform is simply passing a cable band the handstrand support frame is re-installed after the working platform is clear of the cable band. (see Section 29).
7. Where the working platform has arrived at the required location to undertake a hanger replacement the handstrand support frame shall be stored on the working platform until the working platform is over the centre of the cable band. The support frame shall then be lowered to the footpath using the cradle (see Section 16) for removal to storage.
8. Once the handstrand support frame is removed the pulleys and soft slings are slackened and removed from the handstrand cables to allow passage of the working platform. The handstrand cables will hang approx. 150 mm higher than original alignment during this time.
9. The working platform can now pass and continue or be centred over the cable band.

9. Moving Working Platform to the location for Replacement of Hanger

This procedure can only commence when the working platform is fully equipped. Temporary hangers (VSL strands) will be installed at the location of the hanger to be replaced.

If during the operation to move the working platform the weather deteriorates and becomes a safety concern as determined by the Bridgemaster the temporary cable bands should be utilised to secure the working platform (see Section 10) until the weather conditions improve sufficiently.

The tools and equipment required include: 3 No. Tirfors, soft slings, shackles, web lashings, cable band wedges, protection boards, hand tools.

Sequence of operations:

1. Secure the hydraulic cylinders for the temporary hangers to the floor of the working platform framework with web lashings.
2. Install wedges at the cable band and secure to the main cable with web lashing FKU 4000 or similar wrapped around the main cable. (see Figure 9.1)
3. Install two Tirfor TU-32 wire ropes at the cable band two hanger locations higher than the erection location using soft slings and shackles, SWL of 6 tonnes. One sling and one shackle per wire rope. Protective timber, Azobe or equivalent, shall be installed and secured below the wire rope to prevent damage to the main cable wrapping wire to the approval of the Bridgemaster. (sequence 1.208 & 1.209)
4. A third Tirfor TU-32 wire rope shall be installed at the next higher cable band above that used in step 3, using soft slings, shackles and timber in a similar manner.
5. These three Tirfor wires shall then be used to pull the working platform up the main cable to the required hanger position.
6. As the working platform approaches a cable band the wedges shall be placed and secured by web lashings and the handstrand support frame dismantled temporarily (see Section 8).
7. As the working platform passes over the cable band the side wheels at the leading end of the platform should be retracted and be reset immediately after passing the cable band. This procedure should be repeated for the trailing end of the working platform**. Only one set of side wheels should be retracted at any one time.**
8. When the working platform reaches the first higher hanger position on the main cable the temporary cable bands shall be connected to the main cable to secure the working platform. The procedure described in Section 7.4 for ensuring the main cable is clean and free from loose material and cleaned if necessary should be followed at each connection of the temporary cable bands.

9. Moving Working Platform to the location for Replacement of Hanger, cont'd

9. After securing the working platform on the temporary cable bands the two Tirfor wires, installed under step 3 above, are relocated one at a time to the cable band two hanger positions higher than their current connection. Upon completion of the relocation of the two Tirfor wires the temporary cable bands are released and the working platform can be pulled up to the next cable band.
10. As the working platform departs from a cable band the handstrand support frame is re-erected (see Section 29) and the wedges removed for re-use at he next cable band.
11. On approach to the next cable band the procedure outlined in step 8 is repeated to allow relocation of the single Tirfor wire, two hanger positions higher than its current connection.
12. Steps 6, 7, 8, 9 and 10 are repeated until the working platform reaches the required hanger position to execute the hanger replacement.
13. Should the hanger replacement be required at panel points 40, 42 48 or 50 the uppermost Tirfor anchorage point shall be the main cable on the opposite side of the tower saddle.
14. Once located over the required hanger position the temporary cable bands are used to secure the working platform. (see Section 10).

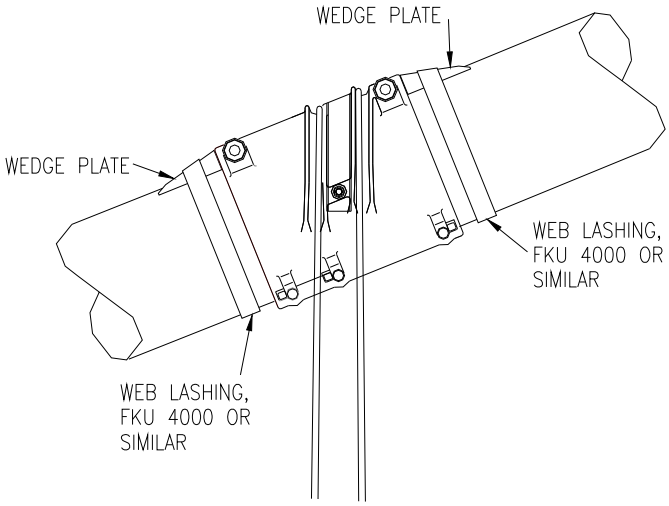

Figure 9. 1: Temporary Wedges at Cable Band

10. Assembling and Pre-stressing of Temporary Cable Bands

During transport along the main cable the two upper parts of the temporary cable bands are supported by the transport unit AA in an elevated position, whilst the four lower parts are dismantled and stored on the platform together with the wires and spherical bearings.

At the relevant hanger location, the working platform is centred as shown on M&T Drg. No. 1.201.

The temporary cable bands (upper parts) are lowered down on the main cable by use of the installed hydraulic jacks, and adjusted to correct position, horizontally and vertically according to the procedure provided in this Section.

Prior to lowering the upper part or installing the lower part of the temporary cable band on the main cable the Bridgemaster must ensure the contact area for the temporary cable band is clean dry and free from any loose paint in order to achieve the required frictional restraint.

The main cable shall be cleaned using water and a stiff brush or by alternative methods approved by the Bridgemaster where necessary. Damaged areas of wrapping wire shall be protected and subsequently repaired to the approval of the Bridgemaster.

If ice and frost occur, special consideration will be taken to keep the friction area free from ice, for example by the use of heating-blankets as determined and approved by the Bridgemaster.

Installation procedures for erecting the temporary cable bands (upper parts) are described overleaf and sketch details of the staged operation are provided in Drawing No. 33111/H&S/Vol.13/10 enclosed with this document.

Sequence of Operation (overleaf)/…

10. Assembling and Pre-stressing of Temporary Cable Bands, cont'd

Sequence of Operation

1. The working platform is centred over the hanger location (refer to M&T Drg. No 1.201).
2. Once the cleanliness of the main cable has been confirmed the upper part of the temporary cable band at the highest end of the working platform is lowered using the hydraulic jacks until contact is made with the main cable.
3. The working platform is then moved slowly down the main cable a small distance just sufficient to allow the temporary cable band to achieve full contact with the main cable, as determined and confirmed by the Bridgemaster.
4. Once full contact of the upper part of this temporary cable band is confirmed the lower parts of this temporary cable band are assembled and fitted to the upper part. Web lashings shall be used to hold the lower parts in position temporarily until the wire terminals are installed and pre-stressed as shown on M&T Drg. No. 1.302.
5. Upon full fastening of this temporary cable band at the higher end the working platform, the working platform is moved down the main cable until the temporary cable band 'chimney' is supporting the working platform.
6. The temporary cable band at the lower end of the working platform is then lowered until contact is made with the main cable. At this point a hoist is used to pull the bottom of this temporary cable band slightly towards the upper end of the working platform to allow this temporary cable band to be finally lowered and achieve full contact with the main cable over the full length of this cable band, as determined and confirmed by the Bridgemaster.
7. Once full contact of the upper part of this temporary cable band is confirmed the lower parts of this temporary cable band are assembled and fitted to the upper part. Web lashings shall be used to hold the lower parts in position temporarily until the wire terminals are installed and pre-stressed as shown on M&T Drg. No. 1.302.
8. The final pre-stress load in the wire terminals of both of the temporary cable bands should be 125kN, equivalent to a moment of 474 Nm. The threads and under the nuts of the pre-stressing assembly will be lubricated with Molyben (Mos) or equivalent during the pre-stressing and load measurement.
9. If not already completed at the working platform erection location the temporary cable bands will be subject to a Friction Test to prove the shear capacity of the temporary cable bands. (see Section 11).
10. The working platform is now ready to accept the erection of the Temporary Hangers.

11. Friction Test of Temporary Cable Bands

Prior to using the temporary cable bands in the replacement of a permanent hanger a friction test will be performed to test the shear capacity of the temporary cable band, unless otherwise instructed by the Bridgemaster. The temporary cable bands shall only be adopted for use in a hanger replacement following satisfactory results from an approved friction test at the sole discretion of the Bridgemaster. The temporary cable bands shall be fully assembled and pre-stressed prior to undertaking this Friction Test.

The tools and equipment required include: 2 No. Macalloy bars (25mm dia), 2 No. hydraulic jacks (40Te), hand tools

Sequence of operation:

1. The two Macalloy bars and jacks will be erected as shown on M&T Drg. No. 1.301.
2. The two jacks are coupled and connected to a hydraulic pump.
3. The distance between the centrelines at each side of the temporary cable bands is recorded.
4. Once a final check of erection alignment has been made the jacks are pressurised.
5. **During the Test no personnel must occupy the area directly behind the Macalloy bars under tension. In order to increase safety additional nuts shall be provided to restrain the bars to the temporary cables bands should a break occur.**
6. The pressure in the jacks is raised in steps in accordance with M&T Drg. No. 1.301 and the pressure recorded at each stage.
7. The distances between the centrelines of the temporary cable bands are recorded after each increase in load.
8. After each step the Bridgemaster shall inspect the main cable and wrapping for any cracking in the paint or movements of the temporary cable bands. Note: Deflection of the neoprene protective wrap, between the main cable and the temporary cable band, may result in a total deflection of approximately 2mm between the temporary cable bands.
9. When the maximum force, 680kN (320kN per jack) is reached the nuts are tightened and locked and the force is kept on the temporary cable bands for 1 hour. The distances are to be recorded at the start and the finish of this 1 hour period.
10. If no cracks in the paint or movement of the wrapping wire of the main cable or temporary cable bands are visible in the Test then the load capacity of the temporary cable bands is acceptable for a hanger replacement.
11. If cracks appear or movement of the wrapping wire or temporary cable bands is apparent then the Bridgemaster shall be consulted for further instruction. If such damage occurs the Test will be stopped and a temporary waterproof bandage applied to the main cable until a permanent repair procedure is developed by the Bridgemaster.

12. Erection of Anchor Beam for Temporary Hangers at Top Chord

Erection and certification for use of the access scaffold under the top chord (see Section 5) shall be complete prior to commencing this operation.

The anchor beam and other required materials are to be transported to the required location by Hiab lorry, subject to the restrictions on footway loading.

The tools and equipment required include: Hiab lorry, lever hoist, 2 soft slings and web lashing, access scaffold

The anchor beams shall be erected symmetrically around the top chord as shown on M&T Drg. No. 1.201. There shall be one anchor beam erected on each side of the existing hanger at 1360 mm from centre line of the existing hanger. The anchor beam is shown in detail on M&T Drg. Nos. 1.320, 1.321 and 1.322.

Erection of the anchor beams shall take place without supporting the beam on the access scaffolding.

Sequence of operation:

1. The anchor beam is lifted by the Hiab Crane, which is operated from the footpath, with soft slings so that it hangs vertically. The lower end of the beam is to be anchored by a guide rope that passes between the footpath and the top chord, under the top chord and returns around the top chord between the top chord and the carriageway. The guide rope shall be attached to a lever hoist which in turn is anchored to the footpath parapet.
2. The anchor beam is lowered at the carriageway side of the top chord until the leading end is below the underside of the top chord box girder. The lower end of the anchor beam is then raised by the lever hoist into its final position under the top chord, (see Figure 12.1).
3. To ensure good contact is achieved between the anchor beam and the top chord 5mm thick aluminium packers are placed between the contact surfaces. Aluminium material shall be A1 99, 5 F7 (DIN)/ 1B (BS) or similar approved. These packers may be considered re-usable subject to a minimum residual thickness on 3mm after previous use and the approval of the Bridgemaster.
4. Two M24 screws are used to ensure the anchor beam is positioned symmetrically on the top chord.
5. Once symmetrical erection of the anchor beam is achieved and confirmed the anchor beam is secured in place by web lashing, (see Figure 12.2).
6. Web lashing is attached to the eyeholes on the anchor beam and installed over the top chord, with edge protection to prevent damage to the web lashing or top chord paint, and tightened to secure the anchor beam in place.
7. Steps 1 to 6 inclusive are repeated for the second anchor beam.

12. Erection of Anchor Beam for Temporary Hangers at Top Chord, cont'd.

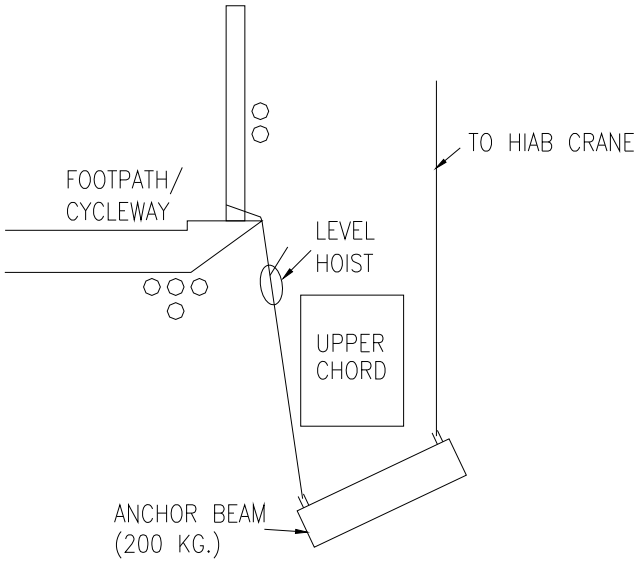

Figure 12. 1 Erection of Anchor Beam

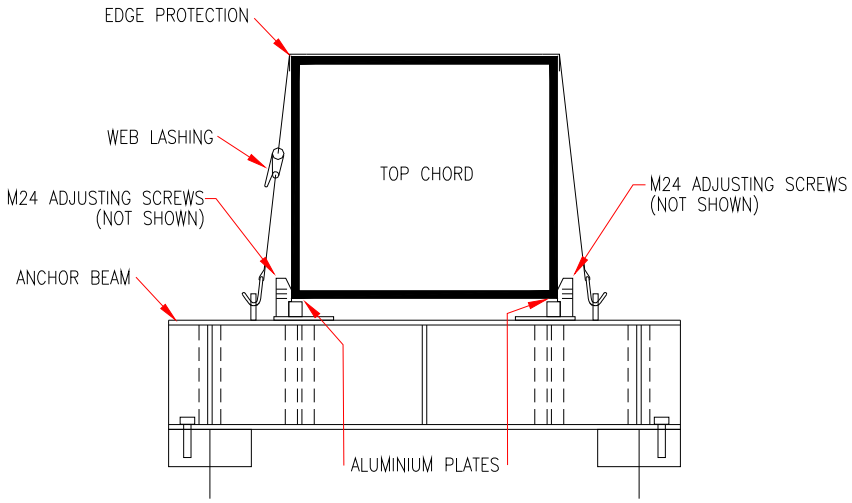

Figure 12.2 Anchor Beam - secured with web lashing

13. Pre-assembly, Installation and Operation of Temporary Hangers (VSL Strands)

Pre-assembly of the Temporary Hanger VSL strands is carried out on the footway/cyclepath.

Reference should be made to following VSL documents:

1. Forth Road Bridge U.K.
   Temporary Hangers

   Technical Information
   Edition 2-Sfr

   Lyssach, March 1999

   Pages 1 to 8

2. Forth Road Bridge U.K.
   Temporary Hangers

   Operation Manual
   VSL (Switzerland) Ltd

   Lyssach, March 1999.Sfr

3. OPERATING AND MAINTENANCE INSTRUCTIONS FOR THE COMPRESSION FITTING EQUIPMENT

   Lyssach, 22 June 1988
   PD/msr – edition 2

These documents are attached to this replacement procedure in Appendix A.

14. Erection of Temporary Hangers (VSL Strands)

The Working Platform must be in position and secured to the main cable by the temporary cable bands prior to commencing this operation.

Assembly of the temporary hangers shall be complete prior to commencing this operation (see Section 13).

The tools and equipment required include: Tirak winch (1te), soft slings (2te), snatch blocks (2te), Shackles (2te), safety line (10.2mm dia x 100m breaking load 8te) safety blockstop, soft sling (5.te), shackles (5te), specialist abseilers

Sequence of operation:

1. Pre-assembly of the strands is complete
2. The Tirak winch is secured at the top of the main tower. Not sure if this is viable for hangers at a distance from tower??????
3. The wire from the Tirak winch is lead down from the top of the tower via snatch blocks and manually brought down the main cable to the working platform
4. A 10.2 mm dia safety line and an 8mm dia guide line are hand carried down the main cable to the working platform.
5. The guide line and the safety line are anchored at the working platform and then extended from the working platform to the footpath level by abseilers.
6. The 10.2mm dia. safety line is connected to the main cable using a 5te soft sling. The other end of the safety line is connected to the top chord using a soft sling, tirfor and rope clamp, with the slack removed from the safety line.
7. The top end of the guide line is connected to the hook of the Tirak winch line
8. The Tirak Winch hook is lowered to the footpath level controlled by the guide line. (and connected to the safety line?????)
9. The safety Blockstop is installed on the safety line.
10. The safety Blockstop is connected to the first temporary hanger.
11. The hook from the Tirak winch is also connected to the first temporary hanger.
12. The first two temporary hangers erected should be connected at the lower end of the working platform.
13. The first temporary hanger is lifted to the working platform by the Tirak winch while secured to the safety line by the blockstop, see Figure 13.1. The guide line shall also remain connected to the Tirak hook during this lifting operation.
14. The temporary hanger strand is connected to the hydraulic cylinder on the working platform according to VSL Drg. No. T5215.1. (Seems light on method)
15. The Tirak hook and blockstop are released from the temporary hanger once installed in the hydraulic cylinder and lowered to the footpath attached to the guide line for the next hanger erection.
16. The three remaining temporary hangers are erected following steps 10 to 15.
17. What do we do with safety line and guide lines in interim

14. Erection of Temporary Hangers (VSL Strands), cont'd

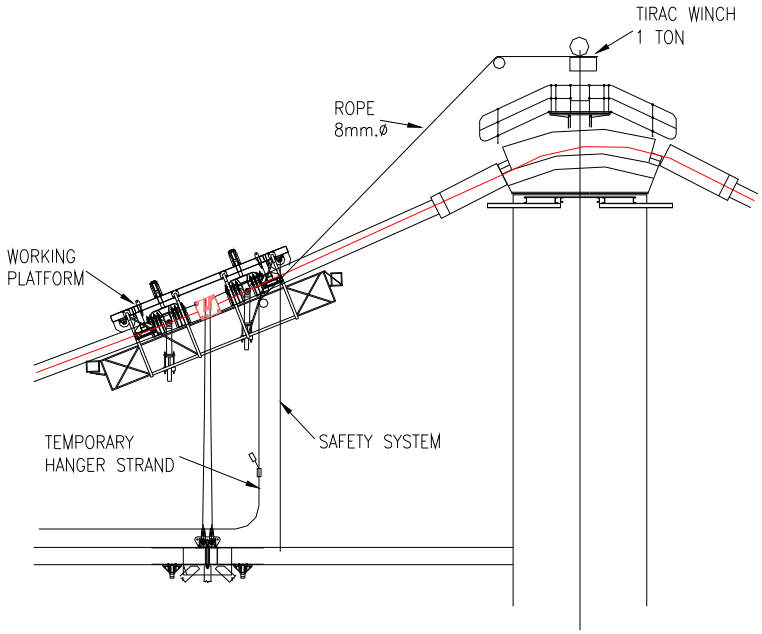

Figure 14. 1: Erection of Temporary Hanger

15. Attachment of Temporary Hangers to Anchor Beam

The erection of the temporary hangers to the working platform should be complete prior to commencing this operation.

The tools and equipment required include: Soft slings, pulley, hand tool cable cutter VSL hydraulic equipment.

Sequence of operation:

1. The VSL hydraulic cylinder pistons at the working platform are lowered full stroke (700mm) and then raised 100mm.
2. The temporary hangers are cut 700mm below the soffit of the anchor beam.
3. The plastic coating on the VSL strands is stripped for approximately 1.0m from the bottom of the strands.
4. The VSL strand guide is fitted on the temporary hangers.
5. Each hanger and strand guide is fitted to the anchor beam and the bolted connection tightened.
6. The VSL strand anchors are then mounted on the temporary hangers and bolted to the anchor beam. The bolted connection is tightened.
7. Mount the cable grip and lever hoist to the temporary hanger above the strand guide and tension the temporary hanger as much as possible with the lever hoist.
8. Mount the end covers on the VSL anchors and tighten completely to activate the wedge locks. See Figure 15.1.
9. Once all four hangers have been attached as above, steps 1 to 8 inclusive, the temporary hanger system is ready for use.

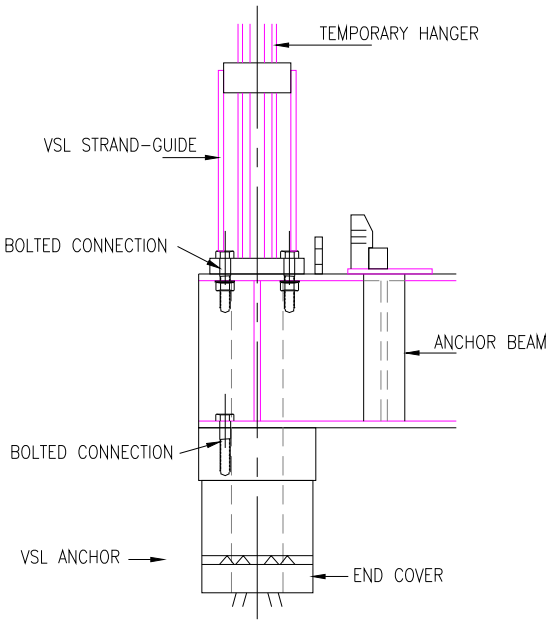

Figure 15.1 : Attachment to Anchor Beam

16. Erection of Access Cradle

The cradle is a working basket which is connected to the main cable at the hanger location where the hanger is to be replaced.

During use as a lift it is guided by the temporary hangers.

The cradle has a load capacity of 200 kg, or 2 persons, and will be used as access to the working platform.

The cradle will also be used to de-mount and re-install hanger spacer units.

Erection or cradle will be done by a specialist subcontractor (ALPS).
Operation and maintains manual to be supplied by ALPS.

For further details see:
Doc. No. 1.706: Work Instruction, Erection of cradle.

17. Dismantling of Spacer Units

The erection and testing of the access cradle shall be completed prior to commencing this operation. (see Section 16)

The tools and equipment required include: Cradle, hand tools with safety lines.

Sequence of operation:

1. Two workers will travel from the footpath level to the spacer unit(s) using the access cradle. (for operation instructions refer to Section 16).
2. On arrival at the spacer unit a safety bag shall be attached to the hangers below the spacer unit to catch any falling objects.
3. All necessary working tools will be secured with safety lines.
4. Hand tools will be used to dismantle the spacer units and all parts shall be collected and stored in a secure bag until the cradle returns to the footpath.(refer to drawing number 33111/AB/14 for details of the spacer unit(s)
5. **NOTE: there are many small parts, washers, nuts, and liners, and nothing can be allowed to fall from the cradle during this operation to remove the spacer units.**
6. On return to the footpath all parts are to be taken to the compound and stored for re-use.

18. Erection of Temporary Jacking System on Hangers

The general arrangement of the temporary jacking system on the hangers, is shown on M&T Drg No. 1.712.

The temporary jacking system consists of:	M&T Drg Nos.
Small Beam	1.702
Big Beam, Type 1	1.703
Clamp	1.705
8 nos. hydraulic jacks (Tentec), 50.0 tones, stroke 333 mm, pressure 689 bar	1.710
Miscellaneous base and connection plates	1.706
Bracket Beam, Pin and Macalloy Bars, nuts and washers	1.716

Refer to the above noted drawings for the layout and details of the operations and equipment described below.

The tools and equipment required include: Hiab, soft slings, lever hoist, hand tools, hydraulic power packs on drip trays on footpath

Sequence of operation:

1. The clamps and bushings are installed on the hanger ropes on top of sockets. Use the 46 mm dia. bushings for the main span and the 55 mm dia. bushings for the side spans.
2. The two Bracket Beams are installed on the anchor brackets and connected using the Pins
3. The four Macalloy Bars are installed and four nuts and washers on the four Macalloy bars are levelled, at a height approximately 50 mm under the just installed clamps on the hanger ropes.
4. The two Big Beams, Type 1, are installed on the Macalloy bars.
5. The Small Beams with hydraulic jacks mounted on them are installed.
6. Support for the hydraulic jacks and stay-plates 1 and 2 are mounted.
7. The upper Macalloy bar nuts and washers are installed.
8. The temporary jacking system is adjusted into the correct position and the alignment is checked.
9. All bolted connections are tightened firmly.
10. **The pressure relief valves on the power pack shall be adjusted to 503 bar, corresponding to approximately 73 tons in each hanger. The valve is then sealed. The adjustment can be done without the hoses connected.**
11. The temporary jacking system is connected to the pump unit. Configuration of the hydraulic system for the temporary jacking system will be with all 8 jacks coupled, to ensure equal load in the hanger ropes.
12. When the system has been checked for alignment and approved by the Bridgemaster the system is ready for use.

19. Load Transfer from Existing Hangers to Temporary Hangers, and Monitoring of Loads and Displacements

Before the load transfer from the existing hangers to the temporary hangers, the temporary hangers and temporary jacking system have to be ready for use (see Sections 14, 15 and 18), as confirmed by the Bridgemaster.

The tools and equipment required include: Temporary jacking system and temporary hanger system.

The first time the hydraulic system is used, the pressure relief valve on the power pack shall be adjusted. The valve is then sealed. The adjustment can be done without the hoses connected,

In this Section the following names are used: (see Figure 19.1)

The **A-system** is the temporary hanger system (VSL)
The **B-system** is the temporary jacking system (Tentec).

Adjustment for the A-system:
360 bar, corresponds to approximately 73 t in each VSL cylinder.

Adjustment for the B-system:
503 bar, corresponds to approximately 36.5 t in each Tentec cylinder.
(~ 73 t in one hanger rope).

Hydraulic Diagram for:
A-system, see M&T Drg. No. 1.330 and,
B-system, see M&T Drg. No. 1.730

Sequence of operation:

1. The pressure in the B-system is raised to:

   Side span: 420 bar, corresponding to a force F=61 tons in each hanger.

   Main span:340 bar, corresponding to a force F=49 tons in each hanger.

   Or such lower load at which the pins and bushings in the hanger rope sockets become loose. This load shall be recorded.

2. The pressure in A-system is raised to:

   Side Span: 230 bar, corresponding to a force F= 47.5 tons in each VSL Cylinder

   Main Span:230 bar, corresponding to a force F= 40.0 tons in each VSL Cylinder

Or such lower load equivalent to the load recorded under step 1 above or at which the pins and bushings in the hanger rope sockets become loose, where this has not occurred under step 1 above. This load shall be recorded.

As the pressure in the A-system is raised the nut on the threaded safety bars will be rotated to keep the distance between nut and safety yoke on VSL-jacks, at approximately 10 mm. This is to ensure that if a failure of the hydraulic system were to occur during load transfer, damage to the existing structure will not occur.

3. The pins are now removed from the hanger rope sockets using hand tools, with the location and part identification numbers recorded prior to removal. All parts removed shall be stored in secure bags, which shall be suitably identified, and these shall be removed to the compound and stored for re-use.

4. The pressure in the B-system shall then be released which shall result in an increase in the load in the A-system. **The pressure in the A-system shall be monitored continuously to ensure that the pressure does not rise above 360 bar.**

5. Should the pressure in the A-system reach 360 bar before the pressure in the B-system is fully released the B-system shall be locked off and the pressure in the A-system released by 60 bar. The release of pressure from the B-system shall then recommence in accordance with step 4 until the B-system is fully released and there is no tension in the existing hangers.

6. Step 5 shall be repeated as necessary to ensure the pressure in the A-system does not rise above 360 bar.

7. The pressure in A-system is then reduced until the pressure is equal to the load recorded in step 1 or step 2 above. This will bring the bridge geometry back to the geometry before transferring the load. During this operation all the nuts on the threaded safety bars will be rotated in steps of 10 mm.

8. When the pressure in the A-system is equal to the load recorded in step 1 or 2, the threaded safety bars on the VSL-hydraulic jacks are tightened up to carry the load, and the pressure in the A-system is relieved.

9. The B-system, the temporary jacking system, is then removed and the operation to dismantle the existing hangers can begin.

Steps 2 to 9 must only be carried out during non-peak (traffic) hours

A load conversion between the A-system and the B-system is provided overleaf for guidance.

Load conversion between A-system and B-system

Pressure in A-system (bar)	Pressure in B-system (bar)	80% pressure in B-system (bar)	40% pressure in B-system (bar)	Total Load in (KN)	Total Load in (Ton)
20	29	23	11	160	16.3
40	57	46	23	320	32.6
60	86	69	34	480	48.9
80	115	92	46	640	65.2
100	143	115	57	800	81.5
120	172	138	69	960	97.8
140	201	161	80	1120	114.1
160	229	183	92	1280	130.4
180	258	206	103	1440	146.7
200	287	229	115	1599	163.0
220	315	252	126	1759	179.3
240	344	275	138	1919	195.7
260	373	298	149	2079	212.0
280	401	321	161	2239	228.3
300	430	344	172	2399	244.6
320	459	367	183	2559	260.9
340	487	390	195	2719	277.2
360	516	413	206	2879	293.5
380	545	436	218	3039	309.8
400	573	459	229	3199	326.1
420	602	482	241	3359	342.4
440	631	505	252	3519	358.7
460	659	527	264	3679	375.0
480	688	550	275	3839	391.3
500	717	573	287	3999	407.6
520	745	596	298	4159	423.9
540	774	619	310	4319	440.2
560	803	642	321	4478	456.5
580	831	665	333	4638	472.8
600	860	688	344	4798	489.1

A system
VSL Piston area for push
20420 mm2

4 No. Jacks
VSL Total Piston area for push
81680 mm2

B system
Tentec Piston area for push
7123 mm2

8 No. Jacks
Tentec Total Piston area for push
56984 mm2

19. Load Transfer from Existing Hangers to Temporary Hangers, and Monitoring of Loads and Displacements, cont'd

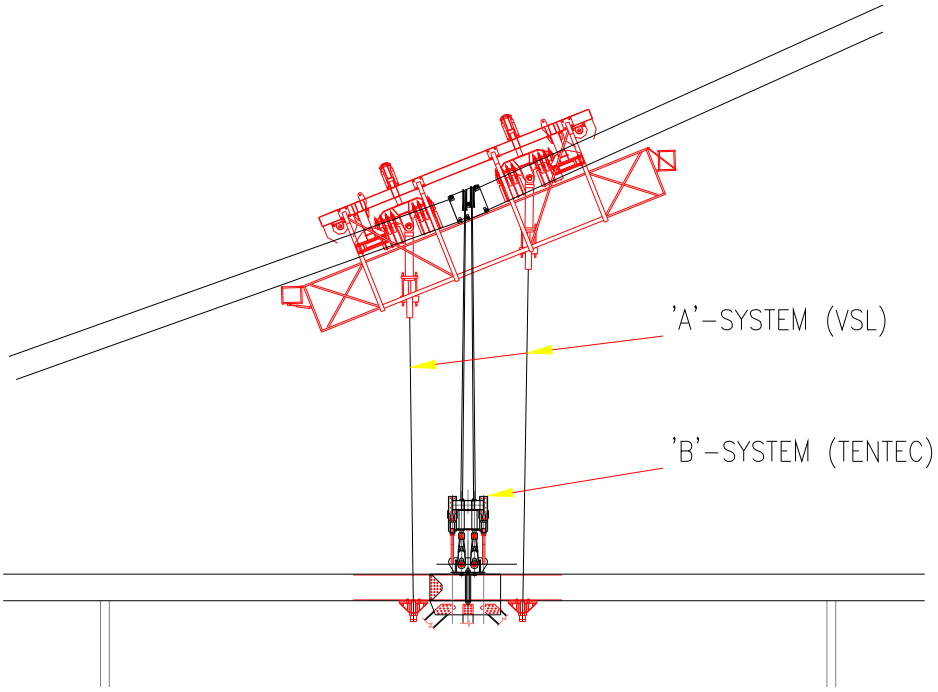

Figure 19. 1: Temporary Loading Transfer Systems

20. Cutting and Dismantling of Existing Hangers

The cutting and dismantling of the existing hangers can start, when the loads are transferred from the existing hangers to the temporary hangers.

The tools and equipment required include: Hand tools, hot air gun and the following:

The system to dismantle the existing hangers and to erect the new hangers is as shown on M&T Drg. No. 1.501, and consists of:

Circular roller track, unit AH
Air winch K6UAL, 13mm dia. wire and winch frame, unit BM
Snatch block frame, unit BN and BO
Cable Clamps
Cable Drawing Sleeves
Rigging Screws
Cable Car
Cable Cutter
Lever hoists
2 blockstops
10mm dia safety wire

The operation is carried out as described in the following steps from the working platform/cradle and the footway/cycle path level. Sketch details of the staged operation are provided in Drawing No. 33111/H&S/13/20 enclosed with this document and all references to Details in this section are to details shown on this drawing.

Prior to any cutting of a hanger rope the ends of the hanger will be secured to prevent unnecessary movement of the free end. The hanger ropes are secured by a 3 ton SWL pulley attached to the upper chord of the deck truss with soft slings and a cable clamp on the hanger ropes. In case of a storm the attachment shall allow a deflection of the end of the hanger of no more than approx. 3m.

Sequence of operation:

1. The snatch block frame, units BN and BO, and the Air Winch shall be erected and fastened to the top chord as shown on M&T Drg No 1.207.
2. A 10mm dia security wire shall be attached to the main cable using a 3 meter long 3 ton nylon sling connected with a 4.75 ton pin shackle and anchored at the top chord with similar connection.
3. Two blockstops shall be erected on the security wire, one upside down. The blockstop designated for upward movement must be installed above the other blockstop. The two blockstops shall be connected to each other with a short 5 ton steel sling (see Detail 2).
4. Where both hangers have to be removed the first existing hanger to be removed shall be the shorter one (i.e. the lowest).
5. Hand tools, and where necessary the hot air gun, shall be used to remove the existing Denso Tape protection which covers the hanger ropes over the cable

band grooves. The extent of removal of this protection material shall be dependent on whether both or only one hanger rope is to be replaced and therefore shall be determined and confirmed by the Bridgemaster.

6. Unless otherwise confirmed by the Bridgemaster the socket shall be cut from the existing hanger rope at a position determined by the Bridgemaster using a hydraulic cutter, prior to removal of the hanger rope. Cutting shall only be undertaken after the hanger rope is adequately secured against movement of the free ends.
7. The circular roller track unit AH is moved into position by use of the adjusting system as shown on M&T Drg No. 1.215.
8. Two clamps are connected to the existing hanger rope at 3.0m below the circular roller track, one on either side of the main cable. Access to connect the clamps is provided by the cradle. Pulleys are attached between these clamps and the circular roller track (see Detail 1).
9. The 13mm dia. wire from the Air winch K6UAL, is connected to the existing hanger by a cable drawing sleeve. (see paragraph 32 for connecting cable drawing sleeve to hanger rope)
10. A cable clamp is attached to the existing hanger above the cable drawing sleeve and this clamp is connected by a sling to the upper blockstop on the security wire, which prevents upward movement (see Detail 2).
11. A second cable clamp is attached to the 13mm dia wire from the air winch 2.4 metres below the cable drawing sleeve and this clamp is attached by a sling to the lower blockstop on the security wire, that prevents downward movement (see Detail 2).
12. By pulling the two pulleys the existing hanger is raised from the cable band groove and a loop is created in the existing hanger (see Detail 3).
13. The loop is laid in the circular roller track, unit AH.
14. A clamp is connected to the lowering end of the hanger rope at the footway level and this is attached to a pulley anchored to the top chord via unit BN (see Detail 4).
15. The two clamps and pulleys connected in step 8 are dismantled.
16. By use of pulley at the footpath level (step 14) and at the same time slackening away on the air winch, the existing hanger is pulled to the footpath and cut into pieces for transportation off the bridge. Cable ties should be attached on each side of the cutting points prior to cutting the existing rope with the hydraulic cutter.
17. The existing hanger is removed until the first cable clamp on the hanger connected to the security wire reaches the roller track.
18. A third cable clamp is attached to the existing hanger on the opposite side of the roller track, ie on the lowering side, and this is connected by a sling to the blockstop on the security wire that prevents downward movement (see Detail 5).
19. **After** completion of step 18, the first cable clamp which is at the roller track is detached from the hanger and the security wire.
20. The existing hanger is then lowered further until the second cable clamp reaches the roller track.
21. A fourth cable clamp is attached to the winch wire on the opposite side of the roller track, ie on the lowering side, and this is attached by a sling to the blockstop on the security wire that prevents upward movement (see Detail 6).

22. **After** completion of step 21, the second cable clamp which is at the roller track is detached from the hanger and the security wire (see Detail 7).
23. The existing hanger is then lowered further until it is completely removed.
24. The 13mm dia. wire rope from the air winch and the cable drawing sleeve are detached from the existing hanger at the footway level after removal of the existing hanger rope.
25. Where the second hanger is also to be replaced, the 13mm dia. wire rope is mounted through the two new snatch blocks and the end is fastened to the lower end of the 2nd existing hanger by use of the cable drawing sleeve.
26. Where the second existing hanger rope is to be replaced the operations 6 – 23 are repeated on the second existing hanger rope (see Detail 8).
27. After removal of the existing hanger rope(s) the 13mm dia. wire from the Air winch K6UAL is ready to be connected to the new hanger (see Detail 9).
28. The circular roller track is moved away from the cable band.
29. Now remedial works to the cable band can start.
30. The dismantled parts of the old hangers are transported from the bridge for storage until disposal.
31. **Max. loading on Pickup Trunk with Hiab-crane: 1.5 Ton.**

32. Connecting Cable Drawing Sleeve to Hanger (see Detail 10):
    a) Cut the existing socket from the existing hanger rope
    b) Remove all protective coatings to expose the bare steel wires for XXm from the cut end of the rope.
    c) Clean the exposed length of wire rope and allow to dry.
    d) Wrap the exposed length of wire rope in ‘Gaffa’ tape.
    e) Install the cable drawing sleeve over the ‘Gaffa’ tape.
    f) Secure the cable drawing sleeve onto the rope with ‘Gaffa’ tape and a steel strap at the end of the cable drawing sleeve.
    g) Secure the end of the ‘Gaffa’ tape with a minimum of 3 No. Clove hitch made from 3mm string.

21. Remedial Works to Existing Structure etc

To create satisfactory conditions for the surface treatment operations, necessary shielding will be mounted at the working place.

1. Cleaning of Cable Band Grooves

The tools and equipment required include: Hand tools, hot air gun

Sequence of operation:

1. The grooves of the cable band exposed after removal of the hanger(s) shall be thoroughly cleaned by scraping off existing mastic, Denso paste and other materials left in the cable band groove after removal of the existing hanger(s).

2. The cable band grooves shall be washed and abraded to provide sound clean paint or steel to the satisfaction and approval of the Bridgemaster.

2. Repair/Replacement of Joint Sealant in Cable Band Joint (As required)

The tools and equipment required include: Hand tools, hot air gun

Sequence of operation:

1. **Where determined as necessary by the Bridgemaster** the existing joint sealant in the upper joint between the two halves of the cable band shall be removed using hand tools. Suitable measures shall be employed to prevent debris or other items falling to the bridge below.
2. After removal of the existing sealant the surface of the joint shall be cleaned with JOINT CLEANER
3. PRIMER 4 shall then be applied on the surfaces with a brush. Allow primer to be touch dry (5 mins approx) before applying THIOFLEX ONE. Any joint not sealed in 24 hours must be re-primed.
4. Application temperature for PRIMER 4 is 5 to 50^{o}C and at least +3^{o}C above the dew point. (Heat the surfaces with a hot air gun to remove moisture from the surface then prime and seal before the surface has cooled to ensure dew point criteria is met)
5. Apply the sealant THIOFLEX ONE (cut nozzle at 45^{o})
6. Extrude the sealant firmly into the joint to ensure complete contact with joint faces. Application temperature 5 to 50^{o}C
7. Use a spatula wetted with diluted detergent solution to tool off.
8. DO NOT apply PRIMER 4 and THIOFLEX ONE when raining or snowing (without adequate protection).

3. Protection System for Cable Bands

The tools and equipment required include: Hand tools, hot air gun

The cable band grooves shall be cleaned in accordance with Section 21.1 and any joint repairs carried out in accordance with 21.2 prior applying the protection system.

Sequence of operation:

1. The cable band grooves shall be protected by application of a paint system equivalent to the existing protection system as approved by the Bridgemaster. The colour of the finish coat shall match the existing colour of the cable bands.

22. Erection of New Hangers

The remedial works to the existing structure (Section 21) must be finished before starting this operation. The new hangers must be transported from the storage area to the hanger position (see Section 6).

The erection of the new hangers is carried out by use of the winch arrangement mounted on the top chord, see M&T Drg. No. 1.501, the arrangement consists of:

Circular roller track, unit AH
Air winch K6UAL, Ø 13 mm wire and winch frame, unit BM
Snatch block frame, unit BN and BO
Rigging Screws
Cable Clamps
Cable Drawing Sleeves
Cable Car
Cable Reel Jacks
Soft slings
Hiab crane
Lever hoists
2 Block stops
10mm dia safety wire

The operation is carried out in following steps from the working platform/cradle and the footway/cycle path level. Sketch details of the staged operation are provided in Drawing No. 33111/H&S/13/22 enclosed with this document and all references to Details in this section are to details shown on this drawing.

Sequence of operation:

1. The circular roller track unit AH is cleaned of all grease paint or debris from the old hangers, by cloth and if necessary a drop of kerosene oil, and is moved into position by use of the adjusting system as shown on M&T Drg No. 1.215.
2. Where more than one hanger rope is being replaced start with the shortest hanger (the one lowest in the cable band) at each cable band. Verify the correct hanger rope has been brought from storage before continuing.
3. The 13mm dia. wire rope from the air winch, used to lower the old hangers, is connected to the new hanger, by use of:
   one Iron grip KK-M16
   one Iron grip BG-M16
   and soft slings
4. The 10mm dia security wire erected for the removal of the existing hangers (Section 20) is used again in the erection of the new hangers. Connection and use of the security wire shall be confirmed by inspection prior to re-use.
5. The connection of the two block stops to the security wire and to each other shall be checked and confirmed prior to use.

6. Approximately 2 m from the socket a clamp is fixed to the new hanger rope with a strop attached and the strop is secured to the new hanger rope towards the socket by cable ties, so the strop can be reached from the working platform when the socket arrives at that level, (see Detail 1). This is carried out at the footway level.
7. A cable clamp shall be attached to the winch wire just above the socket and this clamp is connected by a sling to the upper blockstop on the security wire, that controls upwards movement, (see Detail 2).
8. A second cable clamp is connected to the new hanger 2.5 metres below the socket and this clamp is connected by a sling to the lower blockstop on the security wire that controls downward movement, (see Detail 2).
9. The new hanger rope is pulled by the air winch to the level of the roller track. A rigger will monitor the hanger rope to ensure that it feeds off the transport reel correctly.
10. The new hanger is pulled up until the first cable clamp on the winch wire reaches the roller track.
11. A third cable clamp is attached to the winch wire on the opposite side of the roller track, ie on the lowering side, and this is connected by a sling to the block stop on the security wire that prevents downward movement, (see Detail 3).
12. **After** completion of step 11, the first cable clamp which is at the roller track is detached from the winch wire and the security wire.
13. When the socket is close to the circular roller track a pulley (Pulley A, Detail 4) is attached between the circular roller track and the strop provided in step 6.
14. A Eureka wire grip and a cable sling (14mm dia) are connected to the 13mm dia. wire and a pulley (Pulley B Detail 4) is attached between this and the remaining side of the circular roller track.
15. A third pulley (Pulley C, detail 4) is attached to the Transporter Unit (AA) to help carry the load of the new rope socket as this passes the circular roller track.
16. By pulling on Pulley A, from step 13, a loop on the winch wire can be made. The winch wire and the new rope socket can then be taken out of the circular roller track.
17. By pulling again on Pulley A, from step 13, and slackening on Pulley B, from step 14, the socket can pass the roller track, (see Detail 5).
18. The new hanger can then be laid in the circular roller track.
19. The new hanger is then lowered further until the second cable clamp reaches the roller track.
20. A fourth cable clamp is attached to the winch wire on the opposite side of the roller track, ie on the lowering side, and this is attached by a sling to the blockstop on the security wire that prevents upward movement.
21. **After** completion of step 20, the second cable clamp which is at the roller track is detached from the hanger and the security wire, (see Detail 6).
22. By slackening Pulley B, from step 14, the 13mm dia. wire rope will tighten up from the Eureka clamp to rope socket.
23. The Pulleys A, B and C, attached in steps 13, 14 and 15 and their respective clamps are dismantled. It may be necessary to disconnect Pulley B, from step 14, from the cradle. **Note: The clamps connecting the winch wire and new**

hanger to the blockstops on the safety wire shall not be disconnected, (see Detail 7).

24. The air winch can now pull the new hanger down until the sockets are aligned, (see Detail 8).

25. Special attention should be paid to the socket when it is leaving the cable drum, a guide rope will be fixed between the socket and the cable car or snatch block frame.

26. We are now ready to place the first new hanger in the cable band groove.

27. Protection works in accordance with Section 21 should be carried out prior to placing the new hanger on the permanent cable band.

28. The 13mm dia. wire from the air winch is disconnected, and is ready to pull the 2nd new hanger up if required.

29. A securing safety line shall be attached to both sockets of the new hanger and shall remain connected until the temporary jacking system is erected to secure the hangers. Once the securing line is attached to the new hanger sockets the cable clamps and connections to the security wire can be dismantled.

30. Attach two pulleys to the roller track, one either side, and connect these to two clamps attached to the new hanger rope, again one either side of the roller track, at a distance of approx 2.0 metres from the roller track. By using these two pulleys and clamps make a loop in the new hanger and lift it out of the circular roller track and on completion of the hanger protection works described in Section 24 place it in the cable band groove, (see Detail 9).

31. The new hangers will be placed with the “centre mark” of new hanger in the centreline for the main cable.

32. A check of the alignment of the new hanger rope and socket in relation to the anchorage bracket and of the marked line on the hanger rope are made. If any twist of the socket or rope in relation to anchorage bracket is present the new hanger must be lifted again and adjusted or just rotated to fit the marked line.

33. The two clamps and pulleys are dismantled from the new hanger after confirmation of acceptable alignment by the Bridgemaster.

34. The 13mm dia. wire from the air winch is connected to the 2nd new hanger, (see Detail 10).

35. The rest of the operation is the same as described from point 3 to 33.

36. The new hanger ropes are now ready for installation in the Anchorage Bracket, and erection of Temporary Jacking System can begin.

23. Erection of Temporary Jacking System on New Hangers

The erection of the new hangers on to the cable bands (Section 22) must be complete prior to commencing this operation

All procedures and the sequence of operations are as described for Erection of Temporary Jacking System on Hangers, refer to Section 18.

24. Protection System for New Hangers on Cable Bands, including Denso-tape and Mastic

During erection of new hangers and just before the new hangers are placed in the cable band the protection system to the new hangers is applied. The remedial works to the existing structure (Section 21) must be finished before starting this operation.

The tools and equipment required include: Hand tools, hot air gun

Sequence of operation:

1. Ensure all surfaces to be protected are free from rust, dust, old coating, grease and moisture.
2. Do not apply Primer, Paste, Mastic or Tapes if the temperature is below the dew point or if it is raining (without covering).
3. While the new hanger rope is supported just above the main cable apply a layer of Denso Paste (3 to 5mm thick) around the hanger rope with a brush from 490mm to 920 mm from the centre mark of the hanger rope.
4. Wrap 100 mm wide Denso Tape around the hanger rope (with approx. 55mm overlap) covering the Denso Paste. Wrap the hanger rope from 920mm up to 490 mm from the centre.
5. Apply a thin layer of Denso Primer D on the Denso Tape for the full length and allow the Primer to dry.
6. Wrap 150mm wide Denselt CA Tape around the hanger rope (with approx. 80mm overlap) covering the Denso Tape. Wrap from 910mm up to 590mm from the centre mark of the hanger rope. Use a hot air gun on the outer surface of the Denselt CA Tape to warm the overlap edges to seal the overlaps of the tape.
7. Apply a layer of Denso Paste (3 to 5mm thick) in each cable band groove by brush.
8. Place the hanger ropes in the cable band grooves and apply a layer of Denso paste (3 to 5mm thick) over the centre of the hanger rope (from Denso tape to Denso tape) with a brush.
9. **After** load transfer to the new hangers (see Section 25), place a 'sausage' of Densyl Mastic on each side of the hanger ropes in the cable band grooves over the full length of the grooves. The 'sausage' of mastic is pressed into the void between the hanger rope and the side of the cable band groove.
10. Apply 100mm wide Denso tape flat on the exposed surface of the hanger rope (from Denselt CA Tape to Denselt CA Tape). The two ends of the tape should overlap at the side of the cable band by 100mm.
11. Apply a thin layer of Denso Primer D over the Denso tape +25mm for both sides over the full length of the cable band grooves and allow the primer to dry.
12. Apply 200mm wide Denselt CA Tape flat on the exposed surface of the hanger rope covering the Denso tape and Denso Primer D. The two ends of the Denselt CA Tape should overlap at the side of the cable band by 150mm.
13. Use the hot air gun gently on the underside and surface of the Denselt CA Tape to warm the overlap edges to seal the overlaps of the tape.

See Figure 24.1 overleaf for sketch details of protection system.

24. Protection System for New Hangers on Cable Bands, including Denso-tape and Mastic, cont'd.

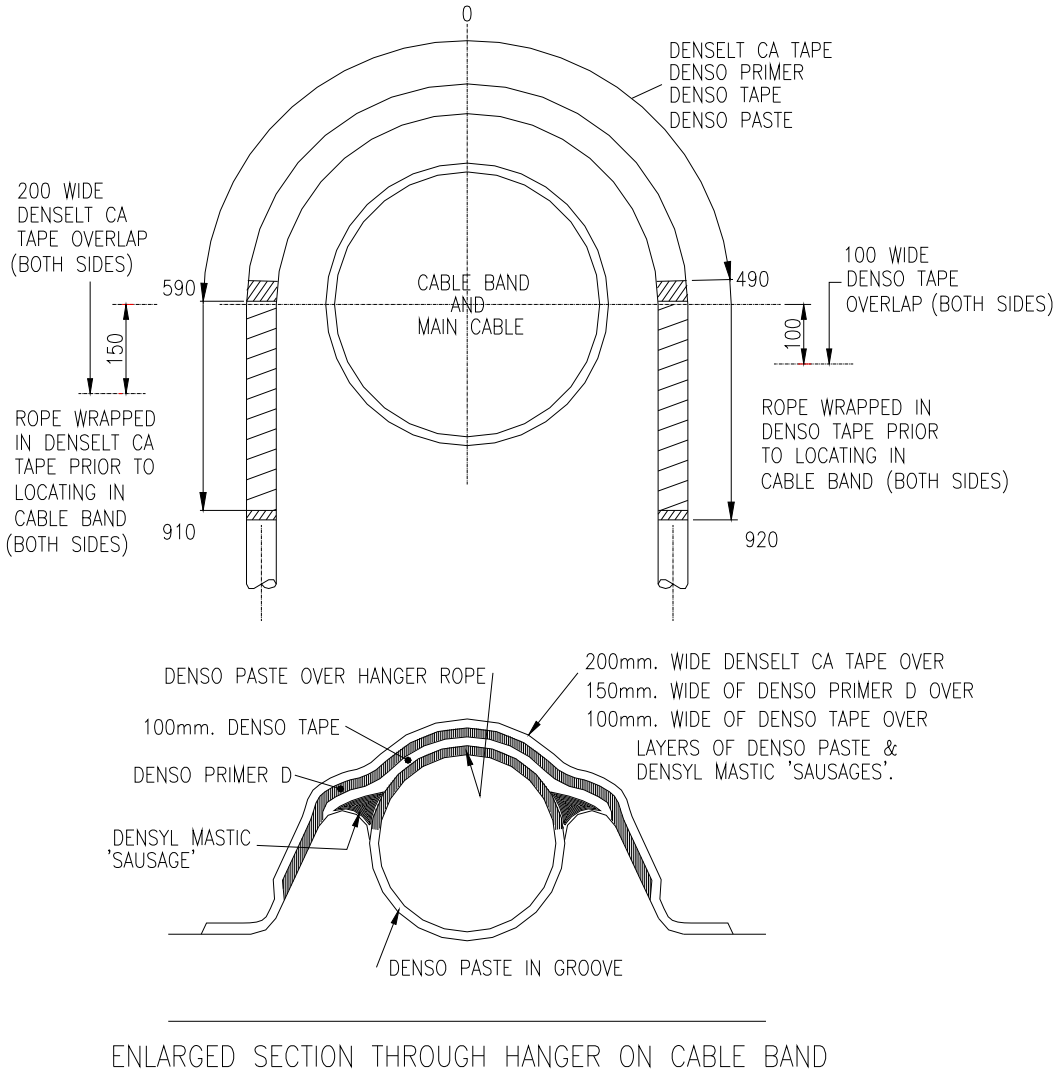

Figure 24.1 : Sketch Detail of Protection System on Cable Bands

25. Installation of New Hangers

Before transferring of load from the temporary hangers to the new hangers, the new hangers are erected and placed in the correct cable band (Sections 22 and 24) and the temporary jacking system (on the new hangers – Section 23) is installed and ready for use.

In this section the following names are used:
The **A-System** is the temporary hanger system (VSL).
The **B-System** is the temporary jacking system (Tentec).

The tools and equipment required include: Hand Tools, A-system, B-system

Sequence of operation:

1. On completion of the erection of the B-system the system is levelled and the pistons on the jacks are fully returned.
2. Clamps and guides are installed to prevent rotation of the hanger rope sockets during installation of the new hangers. Where necessary pulleys, soft slings and cow foot are also used for this purpose.
3. The pressure in A-system is raised, (jack is contracted) until all nuts on the threaded safety bars are free, gap = 1-2 mm.
4. The pressure is recorded and the pressure is converted to a force, using the conversion table provided in Section 19.
5. The distance between the centreline of the socket pin hole and the centreline of the corresponding anchor bracket pin hole is measured to confirm if the available stroke in the B-system shall be sufficient, distance 'H' on Figure 25.1.
6. If the distance measured in step 5 is less than 300mm proceed to step 9.
7. If the distance measured in step 5 is greater than 300mm the B-system should be pulled towards the top chord using 4 No. 1.5-3t chain hoists to reduce the distance to less than 300mm.
8. If the operation of step 7 does not reduce the distance between the socket hole and the anchor bracket hole to less than 300mm then the A-system should be operated to reduce the gap. The A-system should be pressurised until the gap is reduced to less than 300mm but **without exceeding** a maximum pressure of 200 bar in the main span or a maximum pressure of 260 bar in the side spans.
9. All 4 safety bar nuts on the A-system are tightened by hand.
10. All nuts on the B-system Macalloy bars are tightened and the chain hoists are dismantled.
11. The hydraulic pressure in the B-system is raised to approximately 100 bar.
12. Check that the hangers are placed correctly in the cable band and the socket fork is in correct position relative to the anchorage bracket on the top chord. Check the alignment of the rope and ensure there are no twists present in the ropes. If any twists are present in any of the ropes the operation must be suspended and procedures undertaken to dismantle the B-system and remove the twist in the rope, where necessary lifting the rope from the cable band groove.

13. Check clearance and alignment of Macalloy bars on the B-system and ensure they are bearing correctly and are clear of all other parts.

14. The hydraulic pressure in the B-System is raised until the force in the B-System is 80% of the force measured in point 4 above. (The pressure must not exceed 276 bar for the main span, and 327 bar for the side spans).

15. The pressure in the B-System is lowered to 40% of the force measured in point 4 above.

16. The pressure is raised again to 80% of the force mentioned in point 4 above.

17. The distance between the centreline of the socket pin hole on the hanger and top of top chord is measured and recorded to check for elongation of the hanger rope, distance 'X' on Figure 25.2.

18. Point 15, 16 and 17 are repeated 5 times.

19. The cyclic loading in point 18 is carried out until the stretch of the rope is removed as determined by the Bridgemaster and once this is achieved the ropes shall be kept under sufficient load to prevent the rope from relaxing.

20. When the cyclic loading requirement is fulfilled the load in the B-System is adjusted to fulfil the requirements in point 22.

21. By load transfer from the A system to the B system the highest pressure in the B system will be:

    Side span: $\mathbf{P_{transfer} = 47.5 * 689 / (2*50.0) = 327\ bar}$
    Main span: $\mathbf{P_{transfer} = 40.0 * 689 / (2*50.0) = 276\ bar}$

    NB. It is very important that the pressure in the B-system, is not higher than that given above as unloading of the A-system will introduce additional load in the B-system.

22. The distance 'X' between the hanger socket and the top chord is adjusted, in steps of 2 mm, until the sum of the four distances "X", between the Top Chord and centre of the hole in the hanger rope socket, are as near to **4 x 235 mm** as possible.
23. When the adjustment described in point 22 is complete all shut-off valves to the jacks in the B-system are closed.
24. Bushings for the rope sockets are then selected. Requirement: "best fit" (Bushing shown on Tensoteci Drg. nos. 02007 and 02008). Bushing type no. and distance is to be recorded for the individual locations.
25. **Ensure the Bushings selected for each side of an individual socket are the same type and that these are installed in the same orientation to avoid unsymmetrical loading of the Pin.**
26. Bushings, flanges and pin bolts are installed. If necessary the jacks on the individual hangers are adjusted, by a maximum distance of. 1-2 mm.

27. By use of the above described procedure an equal distribution of the hanger load between the four individual hanger ropes is ensured.
28. When installation of the new hangers to the top chord is finished, the load in the B-System is relieved slowly until the load is 0 (zero).
29. If the safety nuts in A-System are not free, the pressure in the VSL-jack is raised so the jack is contracted until all 4 nuts in the safety yokes are free, gap = 1-2 mm.
30. The nuts are lowered until the clearance between the nut and the safety yoke is approximately 100 mm.
31. The load in A-System is relieved slowly until the load in the temporary hanger system is 0 (zero).
32. Now the loads are transferred to the new hangers and the anchor brackets, and the operation is finished.
33. The B-System can now be dismantled and the anchorage of the A-system hangers dismantled also. Where no further hanger replacement is to be effected the working platform and temporary hangers are moved down the main cable for dismantling, (see Section 28).

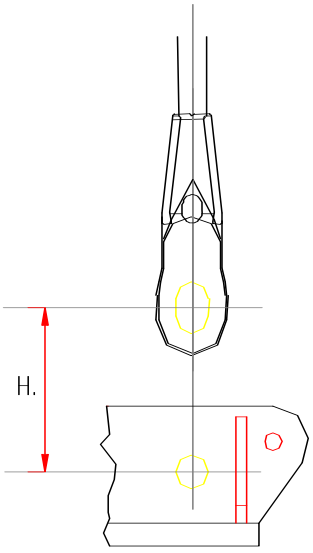

Figure 35.1

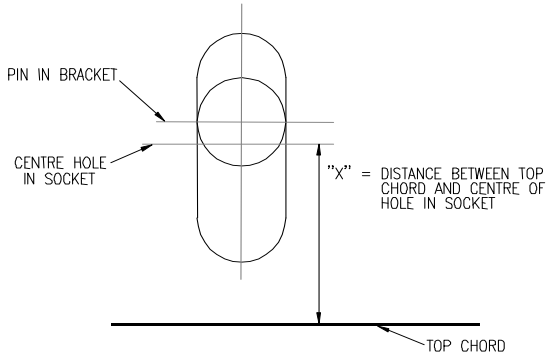

Figure 45.2

Protection to new hanger

26. Re-Installation of Hanger Spacer Units

The installation of the new hangers should be complete prior to re-installing the hanger spacer units.

The tools and equipment required include: Hand Tools, Cradle

Sequence of operation:

1. Two workers shall start from the top chord level and move up to the required position where the spacer unit is to be installed using the cradle. The distance shall be measured from the top of the hanger rope socket by a tape measure. The distances to each spacer unit are provided in step 7 below.
2. A small safety bag will be wrapped around the hanger below the connection point to catch any objects that may fall during the installation of the spacer unit.
3. All hand tools will be secured with safety lines to prevent dropped objects.
4. The spacer unit is detailed on Drg. Number 33111/AB/14.
5. The erectors should pay particular attention to the smaller parts; zinc liners, washers, nuts, etc.
6. The spacer units shall be erected on the hanger ropes and all connection tightened.
7. The distance to the spacer units from the top of the hanger rope socket shall be as follows:

Panel Points	Distance to Spacer Units (m)	
	First Spacer Unit	Second Spacer Unit
26, 26’	18.6	
28, 28’	21.2	
30, 30’	23.9	
32, 32’	26.8	
34, 34’	19.9	39.9
36, 36’	22.1	44.2
38, 38’	24.4	48.8
40, 40’	26.8	53.6
42, 42’	29.3	58.6
48, 48’	29.7	59.5
50, 50’	27.6	55.1
52, 52’	25.5	51.0
54, 54’	23.5	47.0
56, 56’	21.6	43.1
58, 58’	29.6	
60, 60’	27.0	
62, 62’	24.5	
64, 64’	22.1	
66, 66’	19.9	
68, 68’	17.7	

27. Moving of Equipment at Bridge Deck Level to New Hanger Position

The tools and equipment required include: Hand Tools, Hiab lorry/crane

Sequence of operation:

1. After installation of the new hangers all equipment at bridge deck level will be dismantled.
2. The temporary jacking system, cradle, winch and frame, temporary hanger anchors and all other equipment such as cable cutter, hydraulics, pumps etc. are loaded into the approved Pickup Truck with Hiab-crane, or equal, and transported along the footway to storage or next works location.

Max. loading on Pickup Truck with Hiab-crane: 1.5 Ton.

28. Moving of Working Platform on the Main Cable after installation of a New Hanger

The installation of new hangers shall be commenced at the highest relevant hanger position as determined by the Bridgemaster. Therefore the movement of the Working Platform following a hanger replacement shall be travelling down the main cable.

This operation shall only commence after completion of the installation of the new hanger.

The tools and equipment required include:

Hand Tools, Cradle, Working Platform, 3 nos. Tirfor TU – 32, each equipped with 65m of 16.3 mm dia. wire rope and safety hook

1 no. Pump station situated on the working platform at the end towards the pylon top. Operation of pump, reference is made to: Operation manual for Tirfor TU-32.

The moving system is located on top of the transport unit AA (working platform)

The operational weather criteria for this operation is a max. gust wind velocity of 15 m/sec at working level.

Sequence of operation:

1. During moving of the working platform all four VSL-jacks and temporary hangers will be fixed to the working platform at floor level, by use of web lashing, FKU 4000 or similar.
2. Install wedges at the cable band and secure with web lashing FKU 4000 or similar, (see Figure 9.1 in Section 9).
3. Install two Tirfor TU-32 wire ropes at the cable band of the hanger immediately higher than the new hanger location using soft slings and shackles, SWL of 6 tonnes. One sling and one shackle per wire rope. Protective timber, Azobe or equivalent, shall be installed and secured below the wire rope to prevent damage to the main cable wrapping wire to the approval of the Bridgemaster.
4. A third Tirfor TU-32 wire rope shall be installed at the next higher cable band above that used in step 3, using soft slings, shackles and timber in a similar manner.
5. These three Tirfor wires shall then be used to lower the working platform down the main cable.
6. Tighten the three Tirfor wires to provide support to the working platform.
7. Once confirmed by the Bridgemaster that the working platform is supported by the three Tirfor wires the temporary cable bands can be disassembled and securely stored on the floor of the working platform.
8. Secure the temporary hangers at footpath level.
9. Following confirmation of all parts being secured the Tirfor wires can be slackened to allow the working platform to roll down the main cable in a controlled manner

10. Just before leaving the cable band location at the new hanger the handstrand support frame is re-erected (see Section 29) and the wedges are dismantled and removed.
11. As the working platform approaches a lower cable band on the main cable the wedges are installed and secured as in step 2 above, and the handstrand support frame is dismantled temporarily (see Section 8).
12. As the working platform passes over the cable band the side wheels at the leading end of the platform should be retracted and be reset immediately after passing the cable band. This procedure should be repeated for the trailing end of the working platform**. Only one set of side wheels should be retracted at any one time.**
13. When the working platform reaches the first lower cable band position the temporary cable bands shall be connected to the main cable to secure the working platform. The procedure described in Section 7.4 for ensuring the main cable is clean and free from loose material and cleaned if necessary should be followed at each connection of the temporary cable bands.
15. After securing the working platform on the temporary cable bands the single Tirfor wire is relocated to the cable band position immediately higher than the working platform's current connection. Upon completion of the relocation of the Tirfor wire the temporary cable bands are released and the working platform can be lowered down to the next cable band.
16. As the working platform departs from a cable band the handstrand support frame is re-erected and the wedges removed for re-use at the next lower cable band.
17. On approach to the next lower cable band the procedure outlined in steps 11, 12, 13 and 14 are repeated to allow relocation of the two Tirfor wires, **one at a time**, to the hanger position immediately higher than the working platform's current position.
18. Steps 10, 11, 12, 13, 14, 15 and 16 are repeated until the working platform reaches the required hanger position to execute a hanger replacement or dismantling and removal of the working platform.
19. Should the hanger replacement be commenced at panel points 40, 42 48 or 50 the uppermost Tirfor anchorage point shall be the main cable on the opposite side of the tower saddle.
20. Once located over the required hanger position the temporary cable bands are used to secure the working platform. (see Section 9).
21. When moving the working platform below hanger positions at panel points 68 or 68' on the main span and 18 and 18' on the side spans the number of Tirfor wires required can be reduced to two, subject to the approval of the Bridgemaster.

29. Re-Installation of Handstrand Support Frames

With the new hangers installed and just before the working platform is moved to a new hanger location, the re-installation of handstrand support frame can be commenced.

The tools and equipment required include:

Hand Tools, Cradle, Working Platform, pulleys and slings.

Sequence of operation:

1. The working platform shall be moved down the main cable to a position where the wheel towards the main tower has just passed the cable band.
2. The handstrand support frame is retrieved from storage and brought to the hanger location along the footway.
3. The handstrand support frame is then transported in the cradle to the working platform and pulled onto the main cable by attaching slings to a pulley and also securing the frame with a guide rope.
4. The pulley and slings shall remain attached to the handstrand support frame until it is securely connected to the cable band.
5. All pulleys and slings and other loose equipment shall be secured to the working platform by safety lines during all operations to prevent falling objects.
6. The handstrand support frame is positioned over the cable band and the required number of packer plates is measured.
7. The handstrand support frame is then bolted to the cable band with the necessary packer plates installed to ensure a good fit and a spirit level is used to ensure the frame is fitted vertical. Once the erection is confirmed as complete the slings and pulleys are detached from the handstrand support frame.
8. Pullers and soft slings are then used to position the handstrand cable into the clamps at the top of the support frame and the clamps are fastened to secure the handstrand cable in place.
9. After final checking and adjustment all bolts and nuts are tightened.

30. Safety Precautions

All work on the Forth Road Bridge shall be undertaken in accordance with the Health and Safety Procedures of Forth Estuary Transport Authority.

In particluar:

All work shall be undertaken with respect for all public traffic.

At bridge deck level, all working locations shall be clearly marked with red cones and signs, telling which type of work is being performed.

In special cases, the Bridgemaster can ask for closure of the access road on one side of the bridge.

All men working on the main cable and under the bridge shall use safety harnesses and lines and wear adequate footwear.

When working at a height, all tools shall be secured by a line, or the working area shall be equipped with safety netting.

During installation of hangers all locations involved will be equipped with communications radio (walkie-talkie).