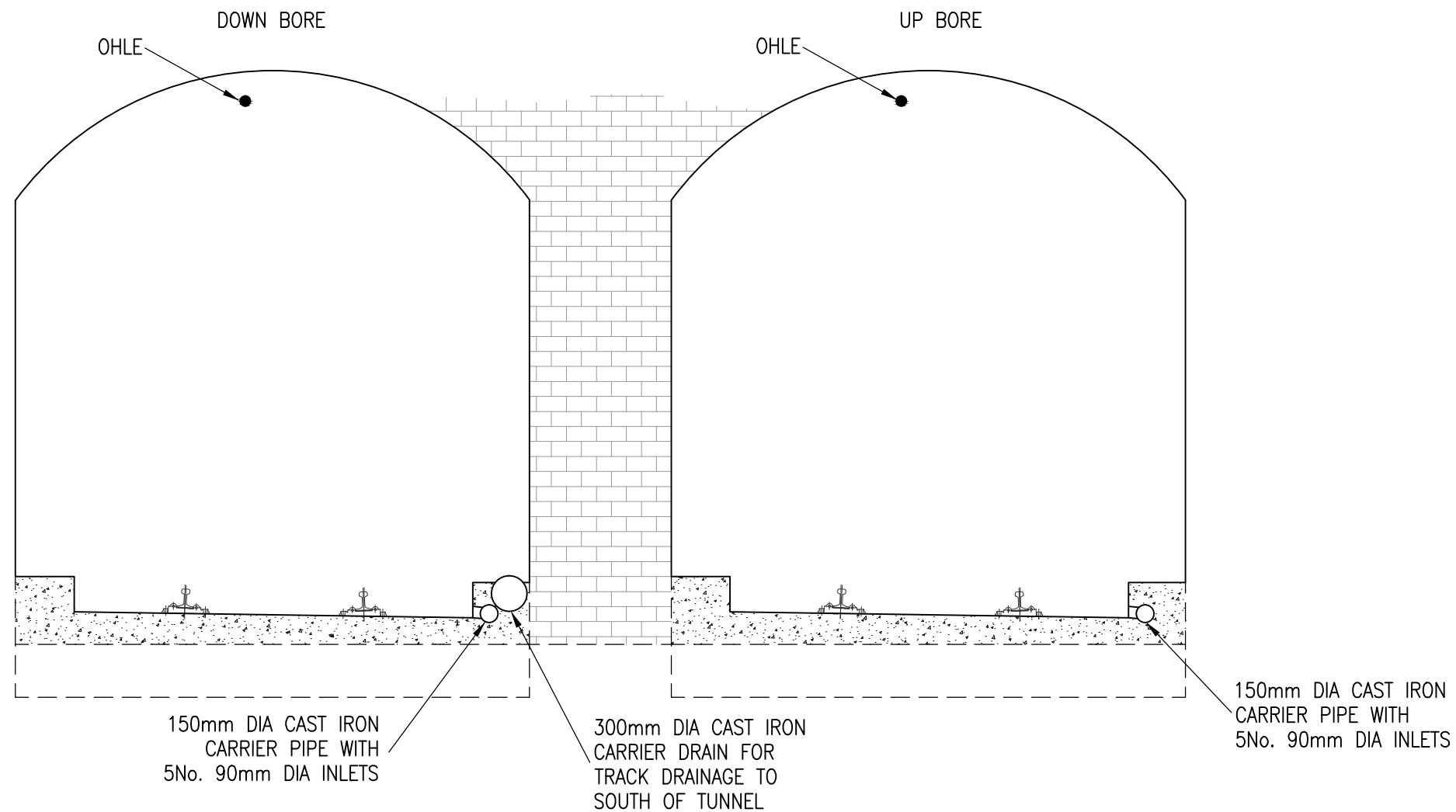


Do not scale from this drawing.		
SAFETY HEALTH AND ENVIRONMENTAL INFORMATION		
IN ADDITION TO THE HAZARD/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING RISKS AND INFORMATION.		
RISKS LISTED HERE ARE NOT EXHAUSTIVE. REFER TO DESIGN ASSESSMENT FORM NO. DAF 001, 002 AND 003.		
CONSTRUCTION		
<ul style="list-style-type: none"> • NETWORK RAIL SITE • CONFINED SPACE • INTERFACE WITH PUBLIC • ROCKFALL 	<ul style="list-style-type: none"> • PRESENCE OF SERVICES • DUST, VIBRATION AND NOISE • WORK AT HEIGHT • MANUAL HANDLING/ LIFTING 	
DEMOLITION		
FOR INFORMATION RELATING TO USE, CLEANING AND MAINTENANCE SEE THE HEALTH AND SAFETY FILE		
IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROVED METHOD STATEMENT.		
NOTES:		
<ol style="list-style-type: none"> 1. ALL DIMENSIONS IN MILLIMETRES. 2. ALL WORKS SHALL BE IN ACCORDANCE WITH NETWORK RAIL STANDARDS. 3. PIPE SIZES FROM AMCO INSPECTION 10th AUGUST 2014. 4. ALL TRACK AND TUNNEL DRAINAGE SHOWN INDICATIVELY AND ALL DETAILS TO BE CONFIRMED BY DETAILED DRAINAGE INSPECTION INCLUDING CCTV SURVEY INSPECTION. 		
Rev.	Date	Description
FAIRHURST		Client:
225 Bath Street GLASGOW G2 4GZ		NetworkRail
Tel: 0141 204 8800 Fax: 0141 204 8801		Working in Partnership
		AMCO rail
Project Title:		
BCDP-S/082		
2015/16 TUNNEL REPAIRS – DESIGN		
DALMUIR TUNNELS YKR/T268/023		
Drawing Title:		
DRAINAGE REMEDIATION WORKS ASSUMED TUNNEL/TRACK DRAINAGE		
Scale at A3:	Status:	
1:1000	FORM 001	
Drawn:	Checked:	Approved:
KAB	RM	ARB
Date:	Date:	Date:
10/09/14	26/09/14	30/09/14
Drawing No.:	Revision:	
103589/YKR/T268/023/2001	-	



TYPICAL TUNNEL CROSS SECTION
(SCALE 1:50)

Do not scale from this drawing.

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

IN ADDITION TO THE HAZARD/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING RISKS AND INFORMATION.

RISKS LISTED HERE ARE NOT EXHAUSTIVE. REFER TO DESIGN ASSESSMENT FORM NO. DAF 001, 002 AND 003.

CONSTRUCTION

- NETWORK RAIL SITE
- PRESENCE OF SERVICES
- CONFINED SPACE
- DUST, VIBRATION AND NOISE
- INTERFACE WITH PUBLIC
- WORK AT HEIGHT
- ROCKFALL
- MANUAL HANDLING/ LIFTING

DEMOLITION

FOR INFORMATION RELATING TO USE, CLEANING AND MAINTENANCE SEE THE HEALTH AND SAFETY FILE

IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROVED METHOD STATEMENT.

NOTES:

1. ALL DIMENSIONS IN MILLIMETRES.
2. ALL WORKS SHALL BE IN ACCORDANCE WITH NETWORK RAIL STANDARDS.
3. PIPE SIZES AND NUMBER OF CONNECTIONS FROM AMCO INSPECTION OF 10th AUGUST 2014.



Rev.	Date	Description	Drawn	Chkd.	Appd.

FAIRHURST

225 Bath Street
GLASGOW
G2 4GZ

Tel: 0141 204 8800
Fax: 0141 204 8801

Client:



Working in Partnership



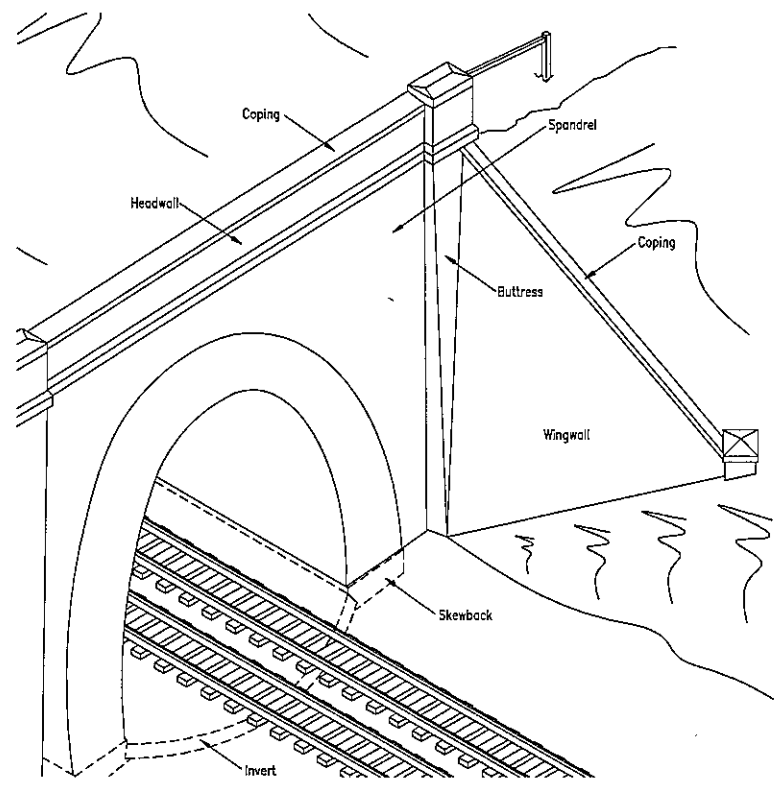
Project Title:
BCDP-S/082
2015/16 TUNNEL REPAIRS – DESIGN

DALMUIR TUNNELS YKR/T268/023

Drawing Title:
DRAINAGE REMEDIATION WORKS
TYPICAL TUNNEL CROSS SECTION

Scale at A3: 1:50	Status: FORM 001	
Drawn: KAB	Checked: RM	Approved: ARB
Date: 10/09/14	Date: 26/09/14	Date: 30/09/14

Drawing No.: 103589/YKR/T268/023/2002	Revision: -
---	----------------



Typical Tunnel Portal Arrangement

Specification

a) This specification supersedes sections 150 & 153 brickwork and masonry repairs of the Network Rail standard specification, NR/L3/CIV/140.

Bricks

b) Within the tunnel new brickwork shall be constructed from bricks with strength and size to match existing. In addition at portals and other brickwork on display new brickwork should aesthetically match existing. The use of compatible reclaimed examples is encouraged. The use of perforated bricks is prohibited. N.B. Existing brickwork often consists of imperial dimensioned bricks.

c) Each tunnel patch repair should include a dated brick clearly showing the year of repair.

d) To prevent frost damage, no brick shall be laid in air temperatures < 4°C unless otherwise instructed by the employers representative. Frost damaged brickwork shall be removed and replaced. New bricks shall be category F2 & S2 to BS EN 771-1

Stone Masonry

e) Wherever possible sound stone shall be re-used. Stone shall be accurately cut and dressed to the dimensions and style of finish required. It shall be seasoned and devoid of flaws. Core shall be taken to avoid staining during installation by coating the exposed surface in plaster or stone dust.

Brick and Stone Masonry

f) Cutting away of existing masonry shall not disturb the surrounding masonry which shall be supported or shored as required.

Mortar

g) Mortar used for repairs should match the strength of existing; generally class M6 (a) or M4 (a) lime mortar in accordance with BS EN 1996-1-1. Cement for mortar shall be "Portland" complying with BS EN 197-1. Lime shall be high calcium lime, semi-hydraulic lime or magnesium lime complying with BS EN 459-1. Sand shall comply with BS EN 13139 and shall be washed sand or natural-crushed rock. It shall not be of a marine source. Water shall not contain impurities & be tested in accordance with BS EN 1008. Batched mixes shall be used up within 2 hours of mixing.

Loggins

p) The integrity of the brickwork surrounding the repair area is maintained using "retentioning loggins" supported with folding wedges on the centring ribs. This defines the spacing for the "construction loggins". Loggins are placed parallel to the brick course and secured in place with timber packing and folding wedges.

This form of centring is only suitable for recessing repair area in the lower haunches and crown of minimal area and within which the exerted forces are considered negligible by the employers representative (in correspondence with the designer). See drawing NR/CIV/SD/524.

q) Preformed and jointed steel ribs shall be used in the upper haunches and crown when a more robust centring arrangement is required. See drawing NR/CIV/SD/523.

Holes

r) The arch barrel thickness may be estimated by measuring the number of rings on the portal face. However trial drilling must be used to determine the overall brickwork thickness where this is required for the repair. Holes to be fully grouted on completion.

s) All holes shall be drilled out and flushed clear of all dust and debris. Each hole must be monitored to prevent excessive grout "take" leading to leakage into the track ballast or filling of cavities within the structure.

t) Pinning and stitching bars shall be stainless steel or GFRP. Stainless steel bars to be high yield deformed reinforcing bar (grade 304 or 316) complying with BS 5744 in steel types 304531 or 316533. GFRP bars to have a density of 2270-2500kg/m³, tensile strength >1800N/mm² and ultimate tensile strain <2.0%. The half pitch between points of entry shall range between 250mm (min.) to 500mm (max.) depending on conditions and severity of defect in accordance with drawing NR/CIV/SD/525.

u) Bar and hole diameters shall be:

Usage	Nominal Bar #	Nominal Hole #
Cross pinning at new facing or patch repairs	12	16
Stitching cracks	16 or 20	20 or 25
Cross pinning for grouting at arch rings	16 or 20	20 or 25
Voussair stitching	16	20

Grout for filling voids within lining thickness

v) The method of grouting shall ensure that the grout permeates into the brickwork/masonry but minimises leakage. Consideration must be given to the type of grout used for purpose e.g. wet or dry conditions / size of void etc. Grouting operations shall be stopped if the amount of grout take exceeds that anticipated to prevent leakage. If leakage is anticipated, a thixotropic stabiliser may be used.

h) Where water ingress or other defects prevent the use of lime mortar as described above, proprietary products should be used. These should have the following properties:

- low strength, typically fa, cube 4-20N/mm²
- highly thixotropic
- early initial set
- similar modulus to lime mortar
- shrinkage compensated
- easy to use and handle on site
- minimal toxicity

Percolating water must be dealt with by redirecting through drainage channels and weep holes before attempting the repair.

i) Where mortar is removed by pressure water jetting, any wetting agents added to the water shall be low foaming and biodegradable. Prior to recommencing pointing, defective mortar to perpend and bed joints shall be raked out to a minimum 25mm. For open joints with a depth of > 50mm the following options should be considered: if the remaining mortar is sound and the bricks are stable they should be carefully re-pointed. If bricks are unstable then the area should be re-cased. Re-pointing shall be carried out with the brickwork in a damp condition by wetting the raked out joints. All prepared joints shall be free of vegetation and other mineral deposits. Pointing shall be carried out while the mortar is still green. All joints to be 10mm thick (max), flush pointed, cut and struck. All mortar to match the existing in colour. Where joints of negligible mortar exist ("pencil joints"), every effort must be made to match the existing course.

Ties

j) The preferred solution is that each arch ring shall be bonded back to the previous using stainless steel anchor ties. Ties to be installed as work proceeds in a diamond pattern with a nominal pitch of 400x400mm. The edge of the cut brickwork shall be prepared so that new brickwork can be tooled into the existing. Ties may be mechanical or resin fixed.

k) An alternative to stainless steel anchor ties is to use header bonding. See drawing ref: NR/CIV/SD/522.

l) Header bonding shall only be used in tunnel linings where the number of rings forming the lining exceeds four. The method of header bonding the existing rings or lining requires the cutting out of an additional block window into the backing / next ring. These block bonded windows shall be nominally 400mm x 400mm and occur at 1000 - 1200mm centres and in plan be staggered between adjacent vertical patches or repair. The edge of the cut brickwork opening shall be prepared so that new brickwork can be tooled into the existing.

m) Where header bonding is preferred for re-casing it shall only be carried out between the second and third ring, otherwise brick ties should be installed. In all instances the finished face bond shall match the existing.

n) Header bonding must only be carried out by persons with proven experience of such work and only under the guidance of the employers representative.

Formwork centring

o) Typical formwork comprises flat bar steel rib centring matching the profile of the arch and secured by anchors driven into the second or third ring depending on the number of rings to be re-cased.

Grouting of voids

w) For stabilising the defective brickwork and providing continuous mass to the arch barrel the grout shall be as follows:

Cementitious grout with low heat of hydration and low plastic shrinkage, high resistance to sulphate and other chemical attack and be capable of developing the performance specified when large volumes of water are present.

Compressive strength fa, cube

Age (days):	3	7	28
N/mm ² :	5	7	11

Setting times

Initial set:	15 mins
Final set:	1 hour

Any accelerator used shall be chloride free.

Anchor grout and resins for stitching & pinning

x) Grout shall be a mixture of cement, graded aggregate, flow and anti-shrink additives giving a pumpable grout. Where a proprietary anchoring method is used, the initial and final setting time shall be compatible with the manufacturers instructions.

y) For bonding of pinning bars into masonry the grout shall be as follows:

Cementitious, non-shrink thixotropic grout with low heat of hydration, high resistance to sulphate and other chemical attack and be capable of developing the performance specified when large volumes of water are present.

Grout to have a typical strength fa, cube of 40N/mm² at 28 days (23N/mm² at 1 day).

Setting times

Initial set:	15 mins
Final set:	1 hour

Any accelerator used shall be chloride free.

z) Alternatively a resin of equivalent strength may be used.

Temporary works

aa) Temporary works details and notes on this and related drawings are indicative only and are meant for guidance. For each particular project, the contractor must satisfy himself and the employers representative that all temporary works are correctly designed for the expected loading conditions and that gauging requirements are fully satisfied whenever track is open to traffic with temporary works in place. The temporary works, design, drawings and form C are to be produced in accordance with network rail company standard NR/SP/CIV/003.

ab) The location of the temporary works must be checked to ensure gauging clearances are not compromised. Exceptionally where clearances are tight and loads negligible (e.g. self weight of new brickwork only) then plywood with appropriate anchors may be used. The contractor shall include details of their proposals in their method statements.

NOTES

General

- The existing bonding of the brick elements shall be retained unless it is noticed to be incorrect. In such cases the employers representative should be informed and advice sought.
- All terminology is based on that typically used to describe tunnel defects.
- The use of snapped headers is forbidden. Any instances found in existing brickwork are to be collated to the attention of the employers representative.
- If repairs are to be carried out near to any fixings such as down pipes, cable attachments, OHLE attachments, then accepted detailed method statements shall be required prior to work taking place. In the case of OHLE attachments, the employers representative shall contact the OHLE representative from the maintaining organisation to arrange necessary expertise and support.
- Re-casing of tunnels (intrados) is restricted to a maximum base dimension of 1 metre or 5 bricks at a time. It is permissible to carry out this on a hit and miss basis in tunnels, therefore at any one time there may be more than 1 no. recasing of 1m width going on at the same time. Consideration must be given to ensure that all brickwork taken out is replaced in the same possession/shift.
- Re-casing of walls must be restricted to 1m wide panels at a time and must not extend beyond 1m in height in line with general building practice. Again, this may be done on a hit and miss basis with the approval of the employers representative. All brickwork taken out must be replaced in the same possession/shift.

Installation Guidance

Refer to reference drawings.

Design Assumptions

Refer to reference drawings.

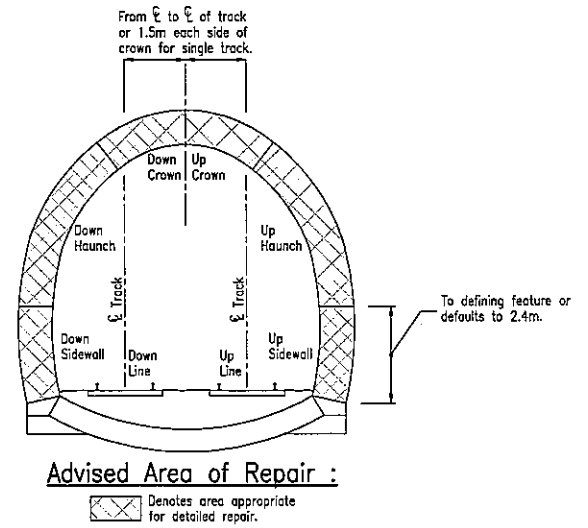
Risk Assessment

See table 1. Note that a specific risk assessment must be prepared for each site.

Schedule of Drawings	
Drawing No.	Title
NR/CIV/SD/520	Specification for the works
NR/CIV/SD/521	Standard brickwork bonds
NR/CIV/SD/522	Re-casing of defective brickwork in tunnel linings greater than 4 rings with header bonding between rings
NR/CIV/SD/523	Re-casing of defective brickwork tunnel linings up to 4 rings
NR/CIV/SD/524	Single ring re-casing of defective brickwork in tunnel linings up to 4 rings
NR/CIV/SD/525	Tunnel lining cross pinning and grouting
NR/CIV/SD/526	Stitching of cracks between spandrel/voussairs and tunnel lining
NR/CIV/SD/527	Stitching of cracks
NR/CIV/SD/528	Stitching of transverse cracks in brickwork
NR/CIV/SD/529	Spot replacement of bricks
NR/CIV/SD/530	Typical centering arrangements
NR/CIV/SD/531	Re-casing jack arches in cut and cover tunnels
NR/CIV/SD/532	Stone Masonry refurbishment
NR/CIV/SD/533	Re-casing vertical walls
NR/CIV/SD/540	Sprayed concrete patch repair to walls
NR/CIV/SD/541	Sprayed concrete patch repair to crown/haunches

Safety, Health & Environment Risk Assessment		
RISK	Stage	Mitigating measures
Working at height.	C	Ensure all access equipment is properly erected and founded on firm level footing.
Contact with OHLE.	C	Ensure correct procedure is followed for isolations.
Wall mounted services and lighting.	C	Specific method statement and risk assessment to identify and detail protection to all services including OHLE.
Falling items when working over live railway.	C	Ensure any open vehicle or pedestrian routes are fully protected.
Compromising gauging requirements with temporary works.	D/C	Full gauging check to be carried out prior to planning temporary works. temporary works to be drawn to scale against clearance requirements. form C required.
Discovering instability in brickwork.	D/C	Ensure competent personnel are on site who are able to assess brickwork quality.
Use of chemical resin and grout to affix ties.	C	COSHH information to be available on site. Brief operatives on use. Ensure suitable contingency in case of spillage.
Blow out of brickwork or induced instability of brickwork panels caused by excessive grout injection.	D/C	Use competent personnel. Method statement or specific specification to include guidance on grouting pressures. Consideration to be given to the provision of temporary support to potentially unstable panels.
Failure of temporary works.	D/C	All structural temporary works to use form C design process. Accurate assessment of loads to be supported and supporting fixings (e.g. no. of rings to be supported by lagging and depth of fixing to reach sound ring).
Vehicle fumes and dust.	C	Ensure adequate ventilation and appropriate monitoring.

Note : C=Construction, D=Design, O=Operation



Advised Area of Repair :

A	22.07.09	FIRST ISSUE	NLJ	PH
Rev	Date	Description of revision	Design'd	C'kd

Network Rail

Network Rail Infrastructure Ltd,
 Registered office: Kings Place,
 80 York Way, London N1 5AG

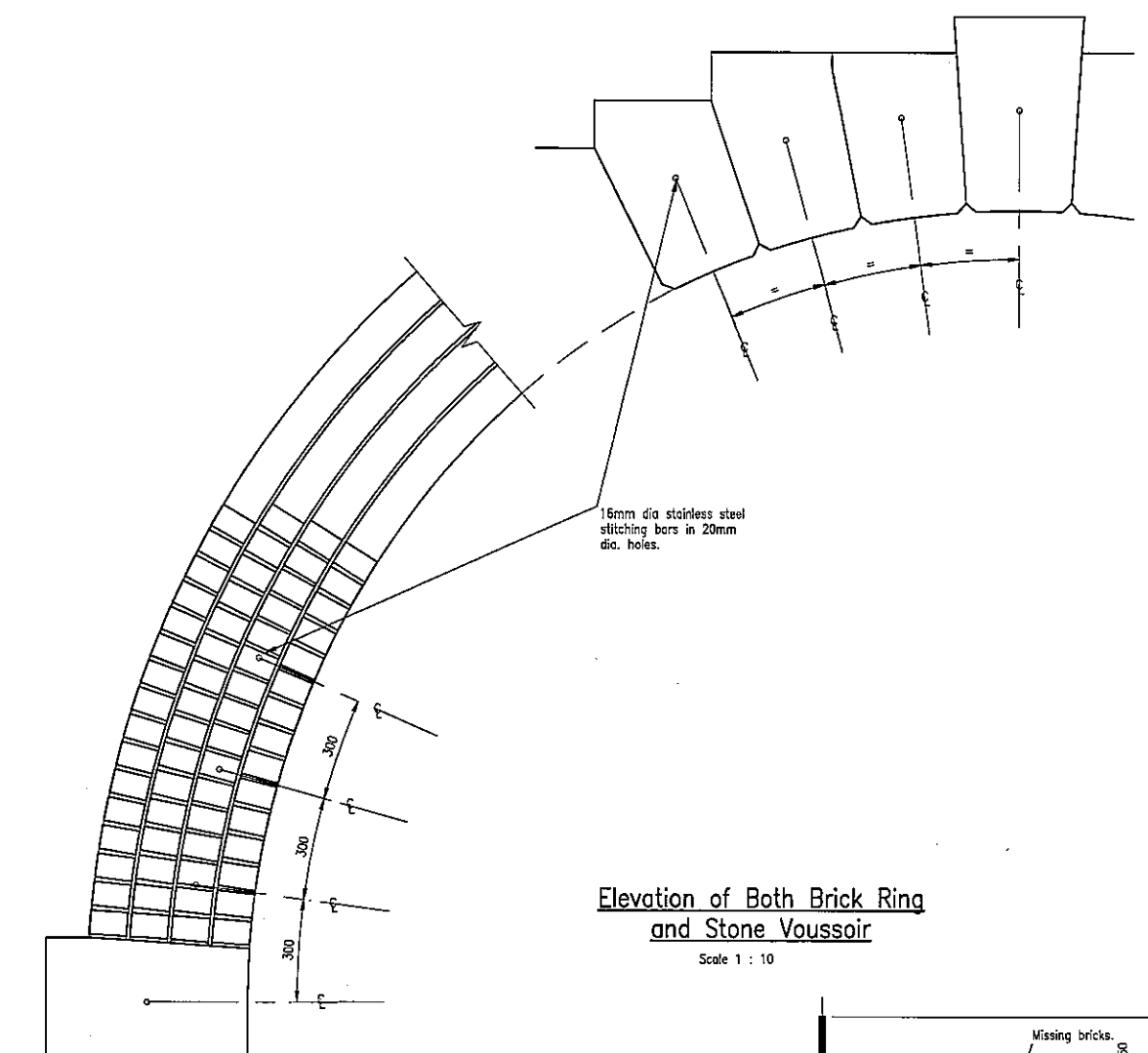
Approved	P.Clark	Senior Prog. Engineering Manager	PC	22.07.09
Name	Position	Signature	Date	

Master copy with original signatures held by Network Rail HQ
 CIVIL ENGINEERING STANDARD DESIGN
 © COPYRIGHT NETWORK RAIL 2009

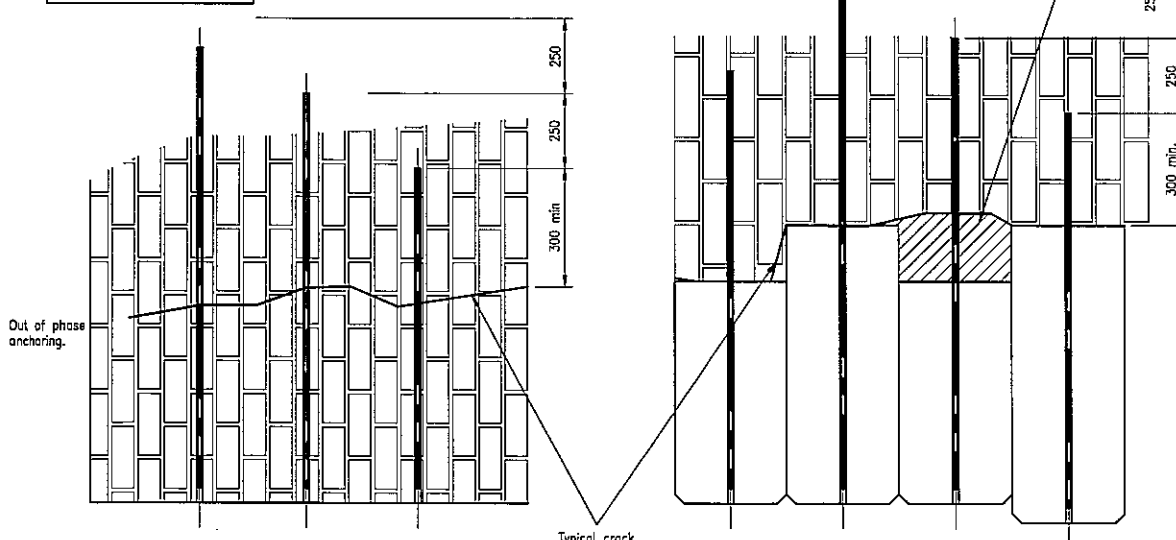
**TUNNEL LINING MAINTENANCE
 REPAIR - STANDARD DRAWINGS**

**SPECIFICATION
 FOR THE WORKS**

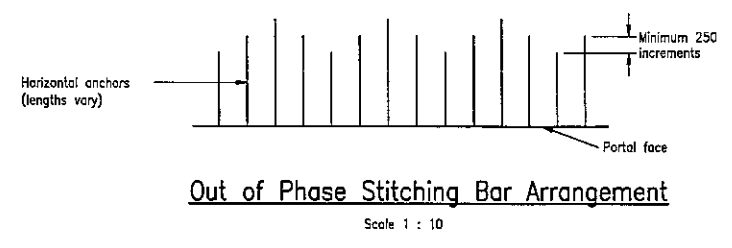
Scale	NOT TO SCALE
Drawing Number	NR/CIV/SD/520
REL.	A



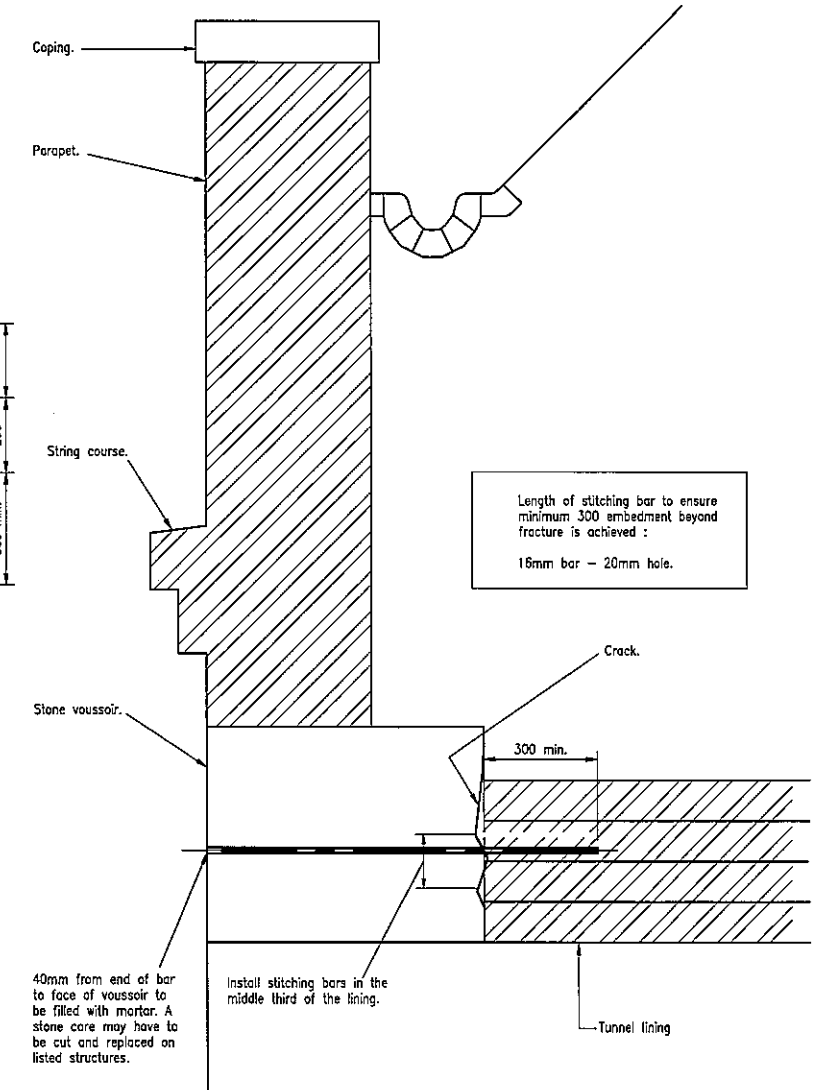
Elevation of Both Brick Ring and Stone Voussoir
Scale 1 : 10



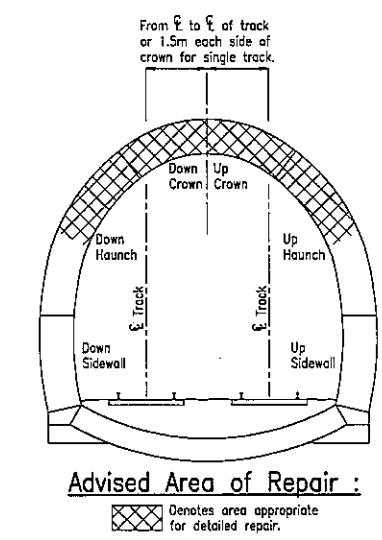
Reflected Plan of Lining Showing Offset Out of Phase Stitching
Scale 1 : 10



Out of Phase Stitching Bar Arrangement
Scale 1 : 10



Stitching System for Typical Longitudinal Crack Between Voussoirs and Arch Barrel
Scale 1 : 10



Advised Area of Repair :
Denotes area appropriate for detailed repair.

- Installation Guidance**
- Stitching bar positions to be marked out and drilled with rotary/rock drilling equipment. Stitching bars or anchors shall be installed horizontally through the voussoirs and tunnel lining, parallel to the springing. The level of the bar shall be approximately equidistant from the intrados and extrados of the arch barrel. Hole diameter to be drilled with a tolerance of 0 to + 5%.
 - Holes shall, wherever reasonably practicable, be formed through bricks or masonry units as applicable and not through joints or where damage to new brickwork or bonding may occur. Holes to be flushed clear of all dirt and debris, and any sharp protrusions removed.
 - Grout to be injected into the anchor hole at a pressure recommended by the supplier/manufacturer. The grout shall have a low heat of hydration and low plastic shrinkage, with a high resistance to sulphate and/or other chemical attack.
 - Insert the anchor bars into the holes ensuring that when fully inserted, a clearance of 40mm from the face of the arch is maintained.
 - Remove any surplus grout from drilled hole and face of structure. Point up any remaining holes with mortar to match the existing structure. Crack to be pointed up & grouted on completion.
 - The contractor is at liberty to propose alternative methods and/materials for carrying out the works, in a separate project specific Form A/B submission.
- General**
- The contractor shall provide a work package plan with details of the cracks to be injected, the procedure for cleaning out cracks, the injection process and proposed materials to be used ensuring no damage occurs to the existing structure. Crack injection using proprietary systems shall be in accordance with the manufacturers recommendations. Mortar or sealing compounds used to seal the face of the crack shall have achieved sufficient strength before injection commences. The choice of mortar, sealing compound and injection material shall take into account the crack width, depth, presence of water and compatibility with the 'parent' material.
 - The cause of the crack must be investigated. The length of embedment of 300mm minimum is for a shear failure only. This will not be sufficient for a tension failure mechanism which must be supported by a project specific form A/B submission.

NOTES

General

- Length of adjacent anchors to be varied to prevent a new longitudinal crack forming, by producing an elongated 's'-shaped 'out of phase' offset line on plan as shown.

Specification

Minimum anchor length beyond typical crack to be 300mm.

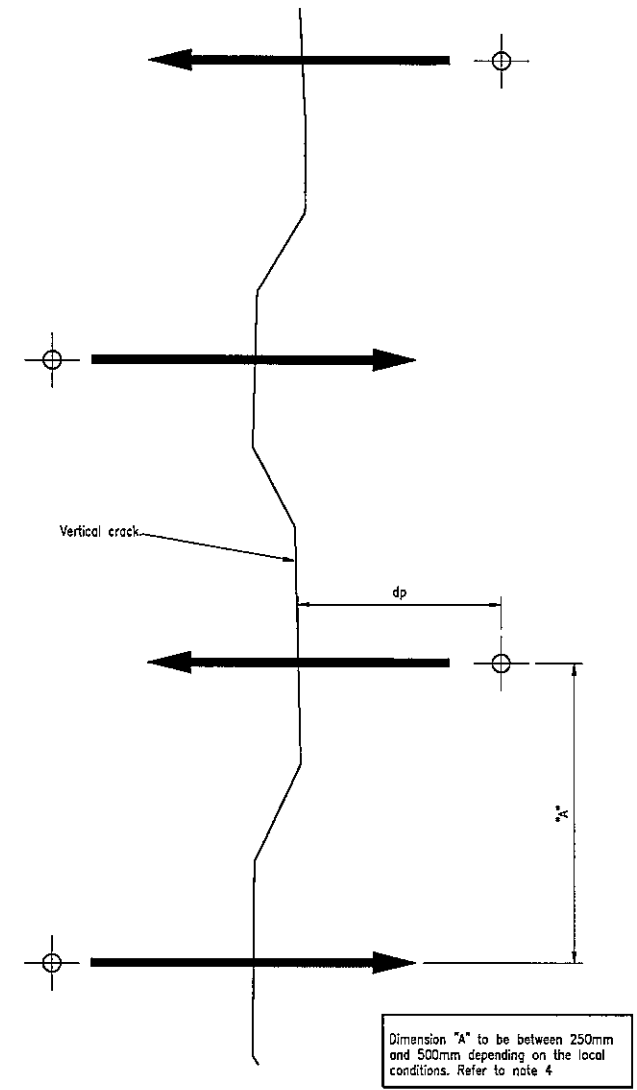
Design Assumptions

None.

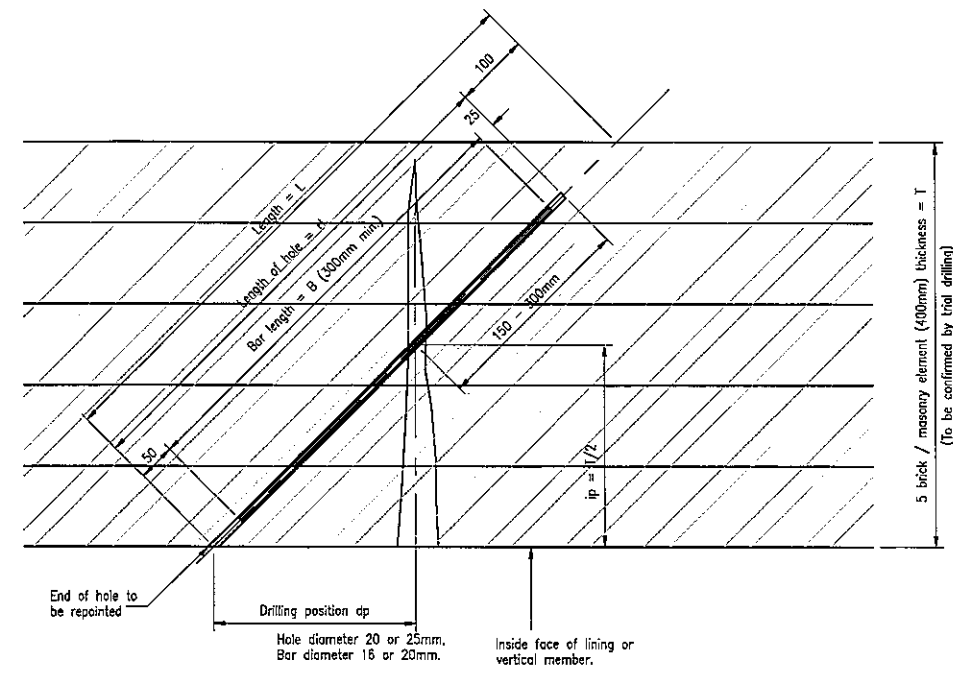
Risk Assessment

Refer to drawing NR/CIV/SD/520.

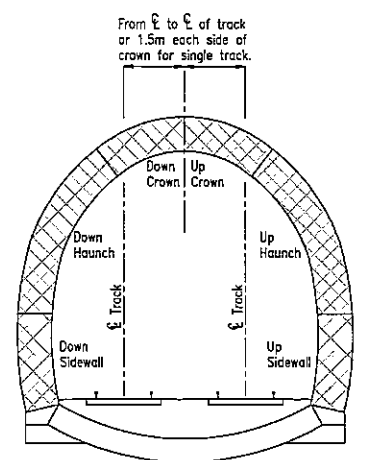
A	22.07.09	FIRST ISSUE	NLJ	PH
Rev	Date	Description of revision	Design'd	C'kd
Network Rail				
Network Rail Infrastructure Ltd, Registered office: Kings Place, 90 York Way, London N1 9AG				
Approved	P.Clark	Senior Prog. Engineering Manager	PC	22.07.09
Name		Position	Signature	Date
Master copy with original signatures held by Network Rail HQ CIVIL ENGINEERING STANDARD DESIGN © COPYRIGHT NETWORK RAIL 2009				
TUNNEL LINING MAINTENANCE REPAIR - STANDARD DRAWINGS				
STITCHING OF CRACKS BETWEEN BRICK SPANDREL/VOUSSOIR AND TUNNEL LINING				
Scale	AS SHOWN			
Drawing Number	NR/CIV/SD/526			REV. A



Spacing of Stitching Bars Along Length of Typical Crack
Scale 1 : 5

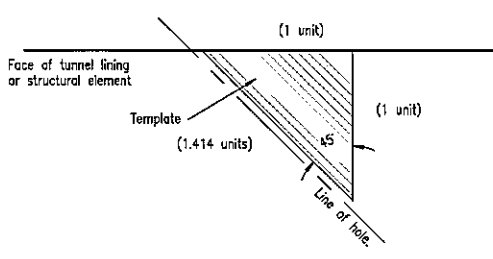


Typical Section at 45° Cross Stitching of Cracks
Scale 1 : 5



Advised Area of Repair :
Denotes area appropriate for detailed repair.

Note : to ensure the correct drilling angle is maintained during installation of the bars a template should be used. This should be cut to give the required drilling angle.



Typical 45° Template
Scale 1 : 10

Table 1

Thickness of element T	Drilled length of holes and bars including position and intersection point.		
	45°		
Rings	Hole H mm	Bar B mm	dp T/2 mm
230 (2)	225	150	215
350 (3)	395	320	175
470 (4)	565	490	235
590 (5)	734	659	295
710 (6)	904	829	355

(See note 3)

The figures in italics fail to reach desired values but may be used with employers representative's agreement. Ring thickness based on 110mm wide bricks. Brick dimensions may vary.

- Design Assumptions**
- To determine the fracture stitching arrangement a number of factors need to be established.
 - Location: Thickness (T) of lining to be drilled and stitched. Drilling angle of 45° from the face.
 - Drilling angle of 45° from the face. Thickness to be stitched; check that when the bar is in position that it extends a minimum 150mm beyond the fracture, the optimum length being 300mm. This does not prevent greater lengths being installed if required as directed by the employers representative. The minimum length is 300mm.
 - Location: refer to contract drawing or inspection report. Type: refer to inspection report.
 - Thickness (T) of tunnel lining must be established by trial drilling.
- Calculation of bar lengths, hole depths and drilling positions**
- Depending on the type of fracture under repair the position of the intersection point (ip) must be considered. The most desirable position for intersecting the crack is midway through the break, therefore the angle of entry must be 45°.
 - Shear cracks = T/2; desired repair at midway in break.
 - To ensure that the (ip) is no less than 125mm from the face of the intrados it must anchor into at least the second ring or course. Having determined the drilling position, the minimum bar length must be 300mm.
 - The spacing or half pitch (A) of bars measured longitudinally along the crack shall be uniform throughout the length, this will be proportional to the distance (ip) nominally between 250mm and 500mm. See note 4.
 - For both brick & stone masonry approximately 500mm each side of the crack must be cleaned using a high pressure waterjet.
 - The crack and any poor mortar joints within the cleaned area to be raked out to a min depth of 25mm or sound material which ever is greater and re-pointed by hand or an approved mechanical method. Joints to be fully mortared up and struck flush.
 - Pointing to be allowed to obtain sufficient strength prior to the grouting. This being carried out after the stitching process.
- Installation Guidance**
- Holes shall be drilled, flushed clear of all dust and debris and wherever reasonably practicable, be formed through bricks or masonry units as applicable and not through joints.
 - Details of tolerances with respect to hole diameter, length and deviation, the method of monitoring hole accuracy and any corrective action shall be included in the method statement.
 - The grout to be injected at a pressure and consistency that will ensure the grout travels and permeates into the brickwork without immediately running out. Minimise excessive leakage. Give due consideration to the condition of the brickwork and not cause 'blow-out'. Closely monitor grout 'take' to minimise leakage.
 - Whilst grout is still 'green' re-drill the holes. Inject the anchor grout into the hole, insert the stitching bars in the same holes. Secure with a temporary timber bung to prevent grout loss. Remove bung after set period and point up with mortar.

- NOTES**
- General
- This drawing shall be used where cross stitching & grouting is to be undertaken for cracks that exist in all elements of brickwork.
 - Where brickwork in the vicinity of the crack requires replacing refer to drawing NR/CIV/SD/529.
 - Table 1 at the foot of the drawing is a guide for the required depths needed to ensure an adequate repair. Although the values in italics for 2 & 3 indicate insufficient anchorage length, generally such thin linings would not be found other than in culverts and due to restricted access it would be impracticable to carry out such repairs.
 - The dimension between bar centres shall be specified in the project specific Form B and /or agreed work scope.

Specification
Refer to design assumptions and specification on drawing NR/CIV/SD/520.

Risk Assessment
Refer to drawing NR/CIV/SD/520.

A	22.07.09	FIRST ISSUE	NLJ	PH
Rev	Date	Description of revision	Design'd	C'kd



Network Rail Infrastructure Ltd,
Registered office: Kings Place,
90 York Way, London N1 9AG

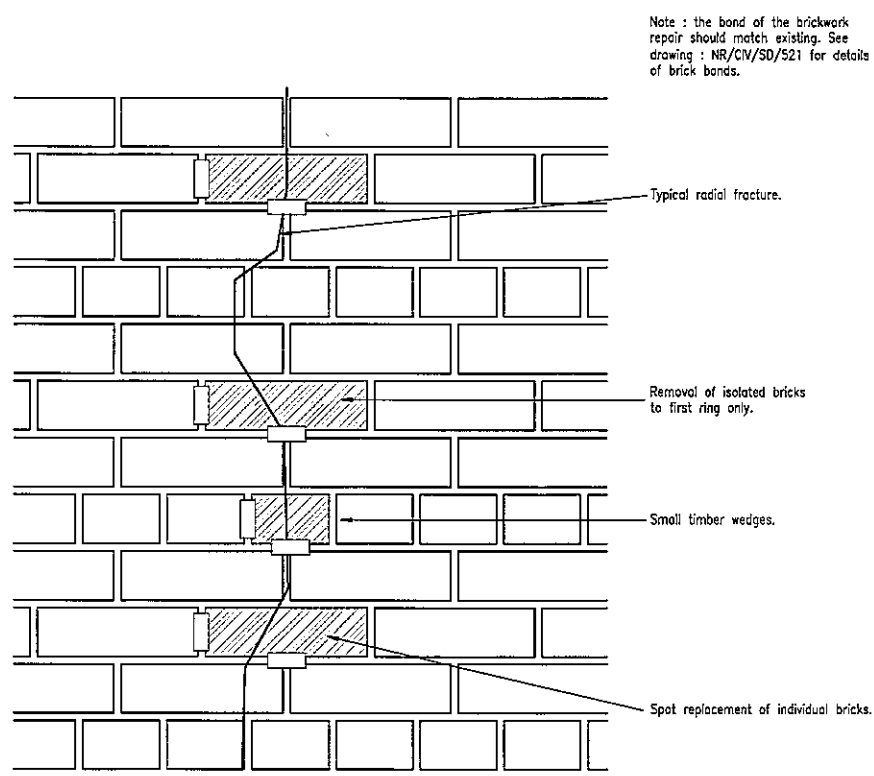
Approved	P.Clark	Senior Engineering Manager	PC	22.07.09
Name	Position	Signature	Date	

Master copy with original signatures held by Network Rail HQ
CIVIL ENGINEERING STANDARD DESIGN

© COPYRIGHT NETWORK RAIL 2009
TUNNEL LINING MAINTENANCE REPAIR – STANDARD DRAWINGS

STITCHING OF CRACKS

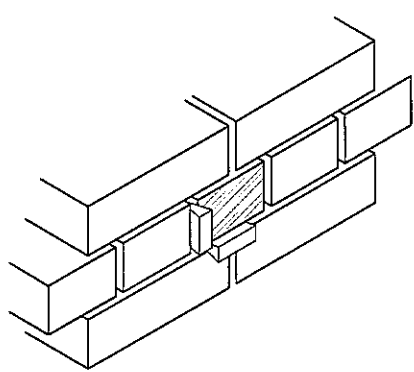
Scale	AS SHOWN
Drawing Number	NR/CIV/SD/527
REV.	A



Note : the bond of the brickwork repair should match existing. See drawing : NR/CIV/SD/521 for details of brick bonds.

Elevation Spot Replacement of Bricks in English Bond

Scale 1 : 5

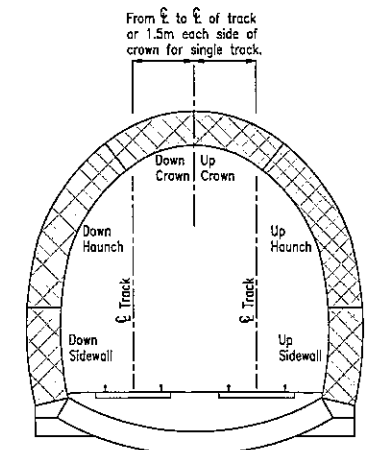


Isometric View Showing Timber Wedges Used to Secure Spot Replacement of Bricks

Not to scale

- Installation Guidance**
- a) Bricks to be replaced along length of crack wherever a full break has occurred. This will be at the discretion of the employers representative.
 - b) The surrounding brickwork shall be wetted firstly before re-pointing is carried out. The crack and any poor mortar joints within the cleared area to be raked out to a min depth of 25mm/sound material. All prepared joints shall be free of vegetation and other mineral deposits.
 - c) Pointing shall be carried out while the mortar is still green either by hand pointed or by any approved mechanical method. Joints to be flush pointed cut and struck to match existing depending on location. All mortar to match the existing in colour. Where joints of negligible mortar exist ("pencil joints"), every effort must be made to match the existing, course for course.
 - d) Wedges are to be removed after 7 days and pointing completed.

- NOTES**
- General**
1. Individual bricks are to be replaced depending on the condition of brickwork and the length of crack.
 2. The extent of repair will be decided by the employers representative on site.
 3. Generally small isolated areas of repair would not necessitate the need for formwork support. Small wedges securing the perpendicular and bed joints should suffice until striking up of the joints can be achieved.
 4. Wedges are intended to support the repair in the temporary case only.
- Specification**
- Refer to drawing NR/CIV/SD/520.
- Risk Assessment**
- Refer to drawing NR/CIV/SD/520.



Advised Area of Repair :

Denotes area appropriate for detailed repair.

A	22.07.09	FIRST ISSUE	NLJ	PH
---	----------	-------------	-----	----

Rev	Date	Description of revision	Design'd	C'kd

Approved	P.Clark	Senior Prog. Engineering Manager	PC	22.07.09
----------	---------	----------------------------------	----	----------

Master copy with original signatures held by Network Rail HQ
 CIVIL ENGINEERING STANDARD DESIGN
 © COPYRIGHT NETWORK RAIL 2009

TUNNEL LINING MAINTENANCE REPAIR – STANDARD DRAWINGS

SPOT REPLACEMENT OF BRICKS

Scale	AS SHOWN	REV.
Drawing Number	NR/CIV/SD/529	A