Supplementary Information

The following information is associated with Network Rail Standard: **NR/CIV/SD/101**Rev A

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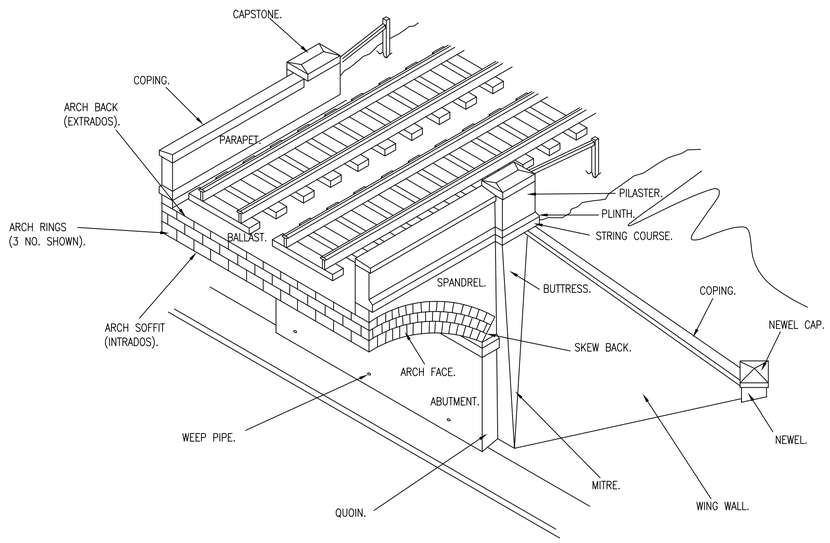
DRAWING No. NR/CIV/SD/101



RAIL OVER ROAD UNDERBRIDGE IS SHOWN ABOVE WITH 3 ARCH RINGS

NOT TO SCALE

SCHEDULE OF DRAWINGS

DRAWING NO.	TITLE
NR/CIV/SD/101	SPECIFICATION FOR THE WORKS
NR/CIV/SD/102	STANDARD BRICKWORK BONDS
NR/CIV/SD/103	RECASING OF DEFECTIVE BRICKWORK IN ARCHES AND TUNNEL LININGS GREATER THAN 4 RINGS WITH BLOCK BONDING BETWEEN RINGS
NR/CIV/SD/104	RECASING OF DEFECTIVE BRICKWORK IN ARCHES AND TUNNEL LININGS UP TO 4 RINGS.
NR/CIV/SD/105	SINGLE RING RECASING OF DEFECTIVE BRICKWORK IN ARCHES AND TUNNEL LININGS UP TO 4 RINGS.
NR/CIV/SD/106	BRICK ARCH RING AND TUNNEL LINING CROSS PINNING AND GROUTING SYSTEM.
NR/CIV/SD/107	STITCHING OF LONGITUDINAL CRACKS IN ARCHES AND TUNNEL LINING BETWEEN SPANDREL/VOUSSOIRS AND ARCH BARREL.
NR/CIV/SD/108	STITCHING OF ROTATIONAL CRACKS.
NR/CIV/SD/109	STITCHING OF SHEAR CRACKS.
NR/CIV/SD/110	STITCHING OF LONGITUDINAL CRACKS IN BRICK
NR/CIV/SD/111	SPOT REPLACEMENT OF BRICKS.
NR/CIV/SD/112	TEMPORARY WORKS ARRANGEMENTS.
NR/CIV/SD/113	RE-CASING JACK ARCHES.
NR/CIV/SD/114	TEMPORARY WORKS ARRANGEMENTS USING SHORING FOR LIVE LOAD CONDITIONS.
NR/CIV/SD/115	MASONRY REFURBISHMENT.
NR/CIV/SD/116	RECASING VERTICAL WALLS.

TABLE 1

SAFETY, HEALTH & ENVIRONMENT RISK ASSESSMENT

DESIGNERS' NOTE – CDM REG. 13(2)(b)

THE FOLLOWING ARE SIGNIFICANT HAZARDS WHICH MIGHT AFFECT THE HEALTH AND SAFETY OF THOSE UNDERTAKING THE WORKS OUTLINED IN THIS SET OF DRAWINGS ON RAILWAY STRUCTURES OR THOSE AFFECTED BY THESE ACTIVITIES. A SITE SPECIFIC RISK ASSESSMENT SHOULD ALWAYS BE UNDERTAKEN PRIOR TO COMMENCING ANY OF THE WORKS DESCRIBED ON SITE.

IT IS ASSUMED THAT A COMPETENT CONTRACTOR IS AWARE OF THE RISKS ASSOCIATED WITH GENERAL CONSTRUCTION ACTIVITIES UNDERTAKEN WITHIN THE RAILWAY ENVIROMENT.

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 ASSESMENT TO IDENTIFY AND DETAIL PROTECTION TO ALL SERVICES INCLUDING OHLE.
FALLING ITEMS WHEN WORKING OVER PUBLIC HIGHWAY.	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 COMPETANT PERSONEL 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 PERSONEL. 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).

NOTE : C=CONSTRUCTION, D=DESIGN, O=OPERATION

SPECIFICATION

a) THIS SPECIFICATION SUPERSEDES SECTIONS 150 & 153 BRICKWORK AND MASONRY REPAIRS OF THE NETWORK RAIL STANDARD SPECIFICATION.

BRICKS

b) NEW ARCH RING BRICKWORK SHALL BE CONSTRUCTED FROM BRICKS WITH STRENGTH, SIZE AND AESTHETIC CHARACTERISTICS TO MATCH EXISTING. THE USE OF COMPATIBLE RECLAIMED EXAMPLES IS ENCOURAGED. N.B. EXISTING BRICKWORK OFTEN CONSISTS OF IMPERIAL DIMENSIONED BRICKS.

c) 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.

MASONRY

d) 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. CARE SHALL BE TAKEN TO AVOID STAINING DURING INSTALLATION BY COATING THE EXPOSED SURFACE IN PLASTER OR STONE DUST.

e) CUTTING AWAY OF EXISTING MASONRY SHALL NOT DISTURB THE SURROUNDING MASONRY WHICH SHALL BE SUPPORTED OR SHORED AS REQUIRED.

MORTAR

f) MORTAR USED FOR RE-CASING SHALL BE AS FOLLOWS:- 1: 1/4: 4 CEMENT/LIME/SAND WITH THE ADDITION OF AN APPROVED AIR ENTRAINING AGENT TO ENHANCE FROST RESISTANCE.
CEMENT FOR MORTAR SHALL BE "PORTLAND" COMPLYING WITH BS 12.
LIME SHALL BE HIGH CALCIUM LIME, SEMI-HYDRAULIC LIME OR MAGNESIUM LIME COMPLYING WITH BS EN 459-1.
SAND SHALL COMPLY WITH BS EN 1313 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.

g) WHERE WATER INGRESS OR OTHER DEFECTS PREVENT THE USE OF LIME MORTAR AS DESCRIBED ABOVE, PROPRIETARY PRODUCTS SHOULD BE USED. THE PROPERTIES OF THESE PRODUCTS SHOULD BE COMPATIBLE WITH THE LIME MORTAR. PERCOLATING WATER MUST BE DEALT WITH BY REDIRECTING THROUGH DRAINAGE CHANNELS AND WEEP HOLES BEFORE ATTEMPTING THE REPAIR.

h) 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 PERPENDS 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

i) EACH ARCH RING SHALL BE BONDED BACK TO THE PREVIOUS USING STAINLESS STEEL FISHTAIL 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 TOOTHED INTO THE EXISTING. TIES MAY ALSO BE RESIN FIXED.

j) AN ALTERNATIVE TO STAINLESS STEEL FISH TAIL TIES IS TO USE BLOCK BONDING. SEE DRAWING REF: NR/CIV/SD/103.

FORMWORK CENTRING

k) 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.

LAGGING

l) THE INTEGRITY OF THE BRICKWORK SURROUNDING THE REPAIR AREA IS MAINTAINED USING "RETENTIONING LAGGINGS" SUPPORTED WITH FOLDING WEDGES ON THE CENTRING RIBS. THIS DEFINES THE SPACING FOR THE "CONSTRUCTION LAGGINGS". LAGGINGS 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 RECASING 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 CORRESPONDANCE WITH THE DESIGNER).
SEE DRAWING NR/CIV/SD/105.

m) 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/104.

HOLES

n) WHEREVER REASONABLY PRACTICAL THE ARCH BARREL THICKNESS SHALL BE DETERMINED BY MEASURING THE NUMBER OF RINGS ON THE ARCH FACE. TRIAL DRILLING SHALL ONLY BE COMPLETED WITH THE AGREEMENT OF THE EMPLOYERS REPRESENTATIVE. THIS WILL BE USED TO DETERMINE THE OVERALL BRICKWORK THICKNESS TO BE GROUTED AND THE BACKFILL TYPE.

o) UNLESS OTHERWISE SPECIFIED HOLES MUST NOT PENETRATE THE ARCH EXTRADOS TO PREVENT DAMAGE TO THE WATERPROOFING AND GROUT CONTAMINATION OF THE BALLAST ABOVE. THEREFORE ALL HOLES SHALL STOP 100mm (MIN.) SHORT OF THE ARCH EXTRADOS.

p) 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.

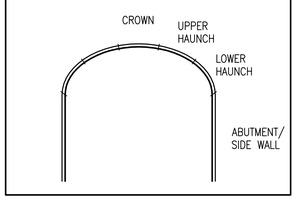
q) PINNING AND STITCHING BARS SHALL BE STAINLESS STEEL HIGH YIELD DEFORMED REINFORCING BAR (GRADE 304 OR 316) COMPLYING WITH BS 6744 IN STEEL TYPES 304S31 OR 316S33.
THE HALF PITCH BETWEEN POINTS OF ENTRY SHALL RANGE BETWEEN 250mm (MIN.) TO 500mm (MAX.) DEPENDING ON CONDITIONS AND SEVERITY OF DEFECT IN ACCORDANCE WITH DRAWING NR/CIV/SD/107.

r) IN ALL CIRCUMSTANCES EXCEPT LONGITUDINAL FRACTURING OF VOUSSOIRS THE BAR DIAMETER
SHALL BE: 6mm
HOLE DIAMETER: 10mm
FOR VOUSSOIR STITCHING THE BAR DIAMETER
SHALL BE: 10mm
HOLE CLEARANCE: 16mm

GROUT FOR FILLING VOIDS

s) 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.

ADVISED AREA OF REPAIR :



AREA APPROPRIATE FOR DETAILED REPAIR IS SHOWN BY HEAVY LINE.

GROUTING OF VOIDS

t) 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

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 FOR STITCHING & PINNING

u) 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.

v) FOR BONDING OF PINNING BARS INTO BRICKWORK / MASONRY THE GROUT SHALL BE AS FOLLOWS:

w) 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 OF $40N/mm^2$ AT 28 DAYS ($23N/mm^2$ AT 1 DAY).

SETTING TIMES

INITIAL SET: 15 MINS
FINAL SET: 1 HOUR

ANY ACCELERATOR USED SHALL BE CHLORIDE FREE.

BLOCK BONDING

x) BLOCK BONDING SHALL ONLY BE USED IN TUNNEL LININGS AND ONLY WHERE THE NUMBER OF RINGS FORMING THE LINING EXCEEDS FOUR.
THE METHOD OF BLOCK 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 TOOTHED INTO THE EXISTING.

y) WHERE BLOCK 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.

z) BLOCK BONDING MUST ONLY BE CARRIED OUT BY PERSONS WITH PROVEN EXPERIENCE OF SUCH WORK AND ONLY UNDER THE GUIDANCE OF THE EMPLOYERS REPRESENTATIVE.

aa) AN ALTERNATIVE TO BLOCK BONDING IS TO USE STAINLESS STEEL FISH TAIL TIES. SEE DRAWING REF: NR/CIV/SD/104.

TEMPORARY WORKS

ab) 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.

ac) ALL RECASING WORK WHICH REQUIRES TEMPORARY WORKS TO BE CONSTRUCTED MUST NOT BE CARRIED OUT UNDER LIVE LOAD CRITERIA. FURTHERMORE, 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

1. 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.

2. ALL TERMINOLOGY IS BASED ON THAT TYPICALLY USED TO DESCRIBE BRIDGE DEFECTS NOT TUNNEL DEFECTS.

3. THE USE OF SNAPPED HEADERS IS FORBIDDEN. ANY INSTANCES FOUND IN EXISTING BRICKWORK ARE TO BE CALLED TO THE ATTENTION OF THE EMPLOYERS REPRESENTATIVE.

4. 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.

5. RECASING OF ARCHES AND TUNNELS (INTRADOS) IS RESTRICTED TO A MAXIMUM BASE DIMENSION OF 1 METRE OR 5 BRICKS AT A TIME. IT IS PERMISSABLE TO CARRY OUT THIS ON A HIT AND MISS BASIS IN LARGE ARCHES, BRIDGES AND 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.

6. RECASING 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 ASSESSEMENT MUST BE PREPARED FOR EACH SITE.

Rev	Date	Description of revision	Design'd	C'kd
A	22.06.06	FIRST ISSUE-NR APPROVED	RMA	NGAY
P3	17.03.06	REVISED FORM B.	RMA	NGAY
P2	31.01.06	FORM B ISSUE.	RMA	NGAY
P1	13.01.06	PRELIMINARY DRAFT	RMA	NGAY

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Authorised	K. TEAGER	Director of Civil Engineering	KT	08.06.06

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BRICK AND MASONRY REPAIR STANDARD DRAWINGS

SPECIFICATION FOR THE WORKS

Scale: NOT TO SCALE

Drawing Number: NR/CIV/SD/101 REV. A

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