# SERIES 2400
# BRICKWORK, BLOCKWORK AND STONEWORK

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# BRICKWORK, BLOCKWORK AND STONEWORK

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## 2401 Cement

**1** Cement shall be one of the following:

(i) (05/05) Portland cement conforming to BS EN 197-1;

(ii) (05/05) Masonry cement conforming to BS EN 413-1;

(iii) (05/05) Sulfate-resisting Portland cement conforming to BS 4027 where described in Appendix 24/1.

## 2402 Aggregates

**1** (05/05) Fine aggregate shall conform to BS EN 13139.

## 2403 Water

**1** (11/03) If water for the Works is not available from a water company's supply, the Contractor shall ensure that the water complies with the guidance given in BS EN 1008. The sulfate content of the water shall be tested in accordance with Test No. 1 in TRL Report 447. The water shall not be used if the sulfate content exceeds 1.4 g of sulfate (as $SO_4$) per litre. Water from the sea or tidal rivers shall not be used.

## 2404 Mortar

(05/05) **Mortar Work Other Than Unreinforced Masonry Arch Bridges**

**1** Cement mortar for brickwork, blockwork and stonework shall be mixed in the proportions given in Table 24/1 according to the mortar designation described in Appendix 24/1.

**2** (11/03) The chloride ion content of the mortar determined in accordance with BS EN 1744-1 shall not exceed 0.3% of the mass of cement for mortar made with Portland cement and 0.2% for mortar made with sulfate-resisting Portland cement. Calcium chloride or admixtures containing calcium chloride shall not be used.

**3** (05/05) For work in which cement mortars of designation (ii) or (iii) as defined in BS 5628-3 are required, the Contractor shall select the appropriate mortar from one of the mixes for the designation given in Table 24/1. If the work is to be carried out in frosty weather and the bricks are wet when laid, then a cement sand mortar with an air entraining plasticiser shall be used. Admixtures shall conform to BS EN 934-3 and any additional performance requirements stated in Appendix 24/1 and shall not contain calcium chloride.

**TABLE 24/1: Mortar Proportions by Volume**

| Mortar designation | Cement: lime: sand | Masonry cement: sand | Cement: sand with plasticiser |
|---|---|---|---|
| (i) | 1:0 to 1/4:3 | - | - |
| (ii) | 1:½:4 to 4½ | 1:2½ to 3½ | 1:3 to 4 |
| (iii) | 1:1:5 to 6 | 1:4½ | 1:5 to 6 |

**4** (05/05) The inclusion of lime in mortar designation (i) is optional. The proportions of lime given in Table 24/1 are for lime putty conforming to BS EN 459-1. If the lime is measured as the dry hydrate, the amount may be increased up to 1.5 volumes for each volume of lime putty. Where a range of sand contents is given in Table 24/1, the higher shall be used for sand that is well graded and the lower for coarse or uniformly fine sand.

**5** Mortar shall be mixed thoroughly either by hand or mechanically until its colour and consistency are uniform. The constituent materials shall be accurately gauged, allowance being made for bulking of sand. Mortar shall be made in small quantities only as and when required. Mortar which has begun to set or which has been mixed for a period of more than one hour in the case of a mortar designation (i) or more than two hours in the case of other designations shall be discarded.

**6** (05/06) A set of mortar prisms shall be made for each type of mortar designated to be used and shall be tested in accordance with sub-Clause 2417.9.

## 2405 Lime Mortar

**1** (05/05) Lime mortar shall consist of one part by volume of hydrated lime conforming to BS EN 459-1 to 2.5 parts by volume of sand.



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## 2406 (05/05) Masonry Units (Bricks)

(05/08) **Brick Work Other than Unreinforced Masonry Arch Bridges**

**1** (05/05) Clay masonry units (bricks) shall conform to the particular requirements of BS EN 771-1 as described in Appendix 24/1. The determination of sulfate content for the soluble salt content test shall be in accordance with Test No. 2 in TRL Report 447.

**2** (05/08) Calcium silicate bricks (sand lime and flint lime) shall comply with BS EN 771-2.

**3** (05/08) Bricks beneath frames for chambers and gullies, and for the construction of brick chambers, shall, unless otherwise described in Appendix 24/1, be HD type Class B clay engineering bricks conforming to BS EN 771-1 and the performance characteristics given in Table 24/2:

**TABLE 24/2:** (05/05) **Performance Characteristic Requirements**

| Performance characteristic | Reference | Clay engineering bricks |
|---|---|---|
| | | Class B |
| Compressive strength (N/mm²) | BS EN 772-1 | ≥ 75 |
| Water absorption (% by mass) and also when used as DPC units<br>and<br>Net dry density (kg/m³) | BS EN 772-7<br><br>and<br>BS EN 772-13 | ≤ 7,0 (and DPC2)<br><br>and<br>≥ 2100 |
| Freeze/thaw resistance category | BS EN 772-1 | F2 |
| Active soluble salts content category | BS EN 772-5 | S2 |

or concrete bricks or blocks conforming to BS EN 771-3 and BS EN 772-2 having an average crushing strength value of not less than 20 N/mm² when used for surface water drainage, or special purpose concrete bricks having a minimum cement content of 350 kg/m3 when used for foul drainage.

## 2407 Blocks

**1** (05/08) Concrete blocks shall comply with the particular requirements of BS EN 771-3 and BS EN 772-2 as described in Appendix 24/1.

## 2408 Reconstructed Stone

**1** (05/08) Reconstructed stone shall be used only in blockwork and shall comply with BS EN 771-5 and any particular requirements described in Appendix 24/1.

## 2409 Natural Stone

**1** Building stone shall be of the type and quality described in Appendix 24/1.

## 2410 Reinforcement

**1** (11/03) Wire or fabric, laid between brickwork or blockwork shall be stainless steel to BS EN 10088-1, designation 1.4301, 1.4401 or 1.4436, softened condition, excluding free machining specifications.

**2** (05/05) Steel bars laid between brickwork or blockwork shall be stainless steel to BS 6744, designation 1,4301 or 1,4436, softened condition, excluding free machining specifications.

## 2411 Anchorages, Dowels, Fixings and Ties

**1** (05/05) Anchorages, dowels, fixings and ties shall be stainless steel designation 1.4301, 1.4401 or 1.4436, softened condition, excluding free machining specifications, complying with the requirements given in the British Standards listed in Table 24/3.

**TABLE 24/3:** (05/06) **Austenitic Stainless Steel**

| Form | Standard to be complied with |
|---|---|
| Strip | BS EN 10029, BS EN 10048, BS EN 10051, BS EN 10258, BS EN 10259 |
| Rod | BS EN 10088-1 |
| Bar | BS 6744 |
| Tube | BS EN 10296-2 |
| Wire | BS EN 10088-3 |

## 2412 Brickwork and Blockwork

**1** Brickwork and blockwork shall be laid on a full bed of mortar and bonded as described in Appendix 24/1. Single frogged bricks shall be laid with the frog uppermost. Perpends between bricks and blocks shall be filled with mortar before the next mortar bed is laid. Whole bricks and blocks shall be used except where it is necessary to cut closers.

**2** Brickwork and blockwork shall be built uniformly. Corners and other advanced work shall be stepped back and not raised above the general level more than

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900 mm. Courses shall be kept horizontal and matching perpends shall be in vertical alignment.

**3** Unless stated in Appendix 24/1, overhand work shall not be permitted.

**4** Bed-joint reinforcement shall have a 15 mm minimum of mortar cover to each masonry face. It shall not be laid dry on a bed face, but shall be embedded within the mortar bed thickness.

**5** Where pointing is required in Appendix 24/1 the joint shall be raked out to a depth of 12 mm and after the completion of the entire facework, pointed in mortar as described in Appendix 24/1.

**6** Where jointing is required in Appendix 24/1 it shall be done as the work proceeds to the finish described in Appendix 24/1.

## 2413 Stonework

### General

**1** Except where otherwise described in Appendix 24/1, the length of any stone shall not exceed three times its height. The breadth on the bed shall be not less than 150 mm, nor greater than three-quarters of the thickness of the wall.

**2** All stratified stone possessing bedding planes shall be laid with its natural bed as nearly as possible at right angles to the direction of load. In the case of arch rings, the natural bed shall be radial.

**3** Facework quoins shall be built to a height not exceeding 900 mm in advance of the main body of the work and adjacent walling stepped down on either side.

**4** Stone facework between the quoins shall then be built to a height not exceeding 450 mm above the backing which shall then be brought up level with the completed facework. At no time shall the backing be built up higher than the facework.

**5** Except for dry rubble walling, all joints shall be sufficiently thick to prevent stone-to-stone contact and shall be completely filled with mortar.

### Ashlar

**6** All stones shall be dressed to accurate planes on the beds and joints, and they shall be fair and neatly or fine tooled on the face as described in Appendix 24/1.

### Block-in-course

**7** Beds and joints shall be squared and dressed for a distance of at least 225 mm from the exposed face. Bond stones shall form not less than one sixth of the area of the exposed face and shall extend at least 900 mm into the wall or for the full thickness of the wall if the latter is less than 900 mm. Unless described in Appendix 24/1 as tooled or worked, the exposed face of all stone shall be blocked and left rough. Arrises shall be dressed square at all beds and joints.

### Squared Random Rubble Coursed and Uncoursed

**8** All stones shall be truly squared and dressed on the beds and joints for a distance of at least 125 mm from the exposed face. Bond stones shall be provided at the rate of not less than one to every square metre of exposed face, and shall measure not less than 150 mm x 150 mm on the face, and not less than 450 mm or the full thickness of the wall if the latter is less than 450 mm. Sneck stones shall be not less than 75 mm in any dimension. Vertical joints shall not include more than three consecutive stones, and the horizontal lapping of the stones shall be not less than 100 mm.

### Random Rubble Coursed and Uncoursed

**9** All stones shall be carefully set with a bond stone provided at the rate of not less than one to every square metre of exposed face. Bond stones shall measure not less than 150 mm x 150 mm on the exposed face, and not less than 450 mm in length or the full thickness of the wall if the latter is less than 450 mm unless otherwise described in Appendix 24/1. For coursed work the joints shall be levelled as described in Appendix 24/1 and the backing flushed up in mortar.

### Dry Rubble

**10** Dry rubble stonework shall be constructed generally to the requirements of uncoursed random rubble stonework, as specified in sub-Clause 9 of this Clause but without mortar. All stones shall be carefully shaped to obtain a close fit at all beds and joints, any interstices between the stones being filled with selected stone chippings or spalls. The exposed tops or copings of dry rubble walls shall be formed as shown on the Drawings.

### Special Stonework Including Quoins, Copings, Plinths, Voussoirs etc

**11** Special stonework shall consist of selected stones dressed to the shapes and dimensions, and where required their faces worked, all as shown on the Drawings.

## 2414 Cold Weather Working

**1** (05/05) No bricks, blocks or stones shall be laid when the air temperature in the shade is below 3°C unless precautions are taken either in accordance with

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BS 5628-3 or to ensure that all materials when used are free from snow, ice and frost.

## 2415 Protection of New Work

**1** Immediately after laying and for 3 days thereafter, brickwork, blockwork and stonework shall be protected against the harmful effects of weather. The upper surface of newly laid brickwork, blockwork and stonework shall be protected against rain as the work proceeds until such time as the work is completed and the upper damp-course, coping or other finishing feature is laid.

**2** (11/03) All visible brickwork, blockwork and stonework and any surface below such work which is visible at the completion of the Works, shall be clean and free from damage and spillage. All purpose-made open joints shall be free from debris of any description.

## 2416 Brick, Block and Stone Facework Fixed to Concrete

**1** Any loose material shall be removed from the concrete, and its surface washed with clean water before any bricks, blocks or masonry is laid.

**2** The portion of the stainless steel fixing projecting from the concrete shall be completely embedded in the mortar of the facework and shall be kept back a minimum of 30 mm from the face of the brickwork and blockwork or 40 mm from the face of the masonry.

**3** The cavity between brick and block facework and the concrete shall be completely filled as the work proceeds with mortar of the same mix as that specified for the facework.

**4** (05/05) The variation in depth, front to back of stones for natural stone facework shall not exceed that described in Appendix 24/1 and the space between the facework and the backing shall be completely filled as the work proceeds with concrete strength class C12/15 and a maximum aggregate size of 10 mm conforming to Series 1700.

## (05/05) Brick and Other Works for Unreinforced Masonry Arch Bridges

## 2417 (05/05) Unreinforced Masonry Arch Bridges

### General

**1** The masonry and associated work requirements for unreinforced masonry arch bridges shall conform to this Series.

### Brick Work

**2** (05/08) Unless otherwise described in Appendix 24/1, masonry units (bricks) shall be HD type Class A or Class B clay engineering bricks conforming to the particular requirements of BS EN 771-1 and the performance characteristics given in Table 24/4. The determination of sulfate content for the soluble salt content test shall be in accordance with Test No. 2 in TRL Report 447.

**TABLE 24/4:** (05/06) **Performance Characteristic Requirements**

| Performance characteristic | Reference | Clay engineering bricks | |
|---|---|---|---|
| | | Class A | Class B |
| Compressive strength ($N/mm^2$) | BS EN 772-1 | ≥ 125 | ≥ 75 |
| Water absorption (% by mass) and also when used as DPC units<br>and<br>Net dry density ($kg/m^3$) | BS EN 772-7<br><br>and<br>BS EN 772-13 | ≤ 4,5 (and DPC1)<br><br>and<br>≥ 2200 | ≤ 7,0 (and DPC2)<br><br>and<br>≥ 2100 |
| Freeze/thaw resistance category | BS EN 772-1 | F2 | F2 |
| Active soluble salts content category | BS EN 772-5 | S2 | S2 |

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**3** (05/08) Concrete bricks and blocks shall conform to BS EN 771-3 and BS EN 772-2 having an average crushing strength value of not less than 30 N/mm² and a minimum cement content of 350 kg/m3.

**4** Natural stone shall conform to BS 5628-3 and shall be selected on the basis of proven durability and weather resistance as described in Appendix 24/1.

**5** (05/08) Reconstructed stone shall conform to BS EN 771-5 and the requirements stated in Appendix 24/1.

**6** Calcium silicate units shall not be permitted for use in unreinforced masonry arch bridge construction.

### Mortar Work

**7** Mortar shall be in accordance with Clause 2404 and the following.

**8** (05/06) Mortar designation shall be in accordance with Table 24/5. Materials and mix proportions shall be in accordance with sub-Clauses 2404.1 to 2404.6, and 2417.10, as appropriate.

**TABLE 24/5:** (05/06) **Mortar Designation**

| Location/Element | Mortar Designation |
|---|---|
| Below a level of 150mm above finished ground level | (i) or (ii) |
| Above a level of 150mm above finished ground level<br>- Abutments, spandrel/wing walls, piers & parapets<br>- Arch rings | (ii) or (iii) (iii) |

**9** (05/06) A set of mortar prisms shall be made for each type of mortar designation used on each arch structure. The mortar used shall be representative of the mortar used in the structure. The prisms shall be made and tested for compressive strength in accordance with BS EN 1015-11. Each set comprises three prisms each divided in two to give six individual tests. The mean of the six tests shall be within the limits shown in Table 24/6:

**TABLE 24/6:** (05/06) **Mortar Compressive Strengths**

| Mortar designation | 28-day mean compressive strength in N/mm² | |
|---|---|---|
| | Minimum | Maximum |
| (i) | 9.9 | 11.5 |
| (ii) | 4.1 | 4.7 |
| (iii) | 2.3 | 2.6 |

**10** In cases, such as where an existing arch with lime mortar is being widened or where additional tolerance of movement is considered desirable, lime mortar may be used. In such cases the mortar shall comply with the recommendations of 'Best Practice Guide for Hydraulic Lime Mortar for Stone, Brick and Block Masonry'.

### WORKMANSHIP FOR BRICKWORK, BLOCKWORK AND STONEWORK

**11** Workmanship shall be in accordance with Clauses 2412, 2413, 2414 and 2415 and Annex A of BS 5628-3.

**12** Forms of bonding in which the rings of masonry are jointed by mortar alone, as with concentric rings in stretcher bond, shall not be used unless stated in Appendix 24/1.

**13** Clay bricks shall not be used within 14 days of firing.

**14** Masonry in an arch ring shall be flush jointed.

**15** Exposed surfaces of masonry shall be regular, clean and have an acceptable appearance.

**16** Finished surfaces of buried masonry to be waterproofed shall have no abrupt irregularities greater than 3 mm.

**17** Masonry shall not be subjected to loading, including its own weight, within 28 days of construction which will induce a stress exceeding 1/3 of its strength at the time of loading.

**18** Removal of centring to the arch ring shall only take place after the material has gained sufficient strength. The centring shall not be removed until at least 7 days after completion of the arch ring.

### Waterproofing

**19** Unless otherwise described in Appendix 24/1, the waterproofing system shall be a permitted system conforming to Clauses 2003 and 2005.

### Protection of Waterproofing

**20** Waterproofing systems shall be protected with a single leaf of masonry or in-situ concrete when unbound materials are used as a permeable backing.

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**21** Waterproofing systems with a permeable backing of porous no fines concrete or precast hollow concrete blocks in accordance with sub-Clauses 513.1(ii) and (iii) shall require no further protection.

**Permeable Backing to Structures**

**22** Permeable backing to spandrel/wing walls and abutments shall comply with Clause 513. Where foamed concrete fill to Clause 1043 is used, sub-Clause 513.2 shall apply.

**23** Where Class 6N or 6P fill is used, permeable backing to the arch ring shall be a granular material or porous no-fines concrete in accordance with Clause 513.1.

**24** Where Class 7A, 7B or foamed concrete fill is used, permeable backing to the arch ring shall conform to sub-Clause 513.2.

**Fill**

**25** Fill shall be Class 6N, 6P, 7A or 7B conforming to Clause 610 or foamed concrete conforming to Clause 1043.

**26** Fill shall be placed and compacted in accordance with Clause 610.

**27** Plant for compaction of material within 1 metre, or within one fifth of the span if greater, of the arch ring shall conform to sub-Clause 623.10.

**28** For bridges carrying public highways, a minimum depth of fill of 300 mm shall be provided between the crown of the arch and the underside of the pavement as described in Appendix 24/1.

**29** Unless otherwise described in Appendix 24/1, fill shall be drained by a 150 mm minimum diameter pipe with rodding facilities provided at springing. Drainage pipes and rodding facilities shall conform to Series 500.

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