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Bridges still need natural stone

The requirements of standardisation and speedy construction can be met by the modern stone industry

'Despite the technical revolution that has occurred in bridge building . . . there is still a place for natural stone cladding and formwork . . .' These words appeared in a memorandum submitted by the British Stone Federation four years ago to the Ministry of Transport. It is therefore gratifying to learn that natural stone has been incorporated in at least two new major river bridges and in many of the bridges that traverse a section of the M5 motorway.

On the modern motorway, with two or more bridges to every mile, speed of construction is a very important consideration. The contractor's bridge building programme has to keep pace with highly mechanised earth-moving and road-making operations, and the bridge designer is impelled to exploit the fastest as well as the latest techniques and methods of construction. To a large extent the overall shape and proportions of road bridges are of course dictated also by modern traffic requirements. Some degree of standardisation of bridge types must be accepted in the interests of efficiency and economy, and consequently there is less scope than previously for variety in design.

For all these reasons traditional forms of masonry construction associated with bridgework over the centuries are in some danger of falling into disuse. But, given discrimination and a little ingenuity on the part of the designer, this tendency is by no means inevitable, as can be seen from the bridges that traverse an attractive part of M5 (Bristol to Birmingham); this twenty-eight mile stretch will connect with the Ross Spur and extend northwards from trunk route A38 at Brockeridge Common, near Tewkesbury, to Lydiate Ash, near the outskirts of Birmingham.

With the support of the Ministry of Transport, the Worcestershire County Council have given a great deal of thought to the problem of blending new bridges with their surroundings. The need to avoid monotonous repetition of bridge types was recognised early in the design stages, and further variety and interest has been created by using different facing materials in character with the local scene. For instance, at the southern end of the route, in the neighbourhood of the Cotswolds, limestone quarried in Tetbury has been selected for facing the abutments and piers of a number of bridges; around Worcester, including the two bridges at Warndon junction (see photograph), the richer Doulting Stone has been used; while farther north, towards Bromsgrove, Pink Hollington stone has been chosen to harmonise with the local soft red sandstone and subsoil.

The stonework has been specially designed to allow for its attachment, by means of metal channels and ties, to the structural concrete after the latter has been cast. This procedure avoids any risk of delay to the contractor's erection programme and allows the bridge superstructure to be completed and brought into use for site traffic. As a further precaution against delay, provisional orders for the stonework were placed in advance of the contract so as to allow the suppliers reasonable time to organise and guarantee delivery of the quantities required.

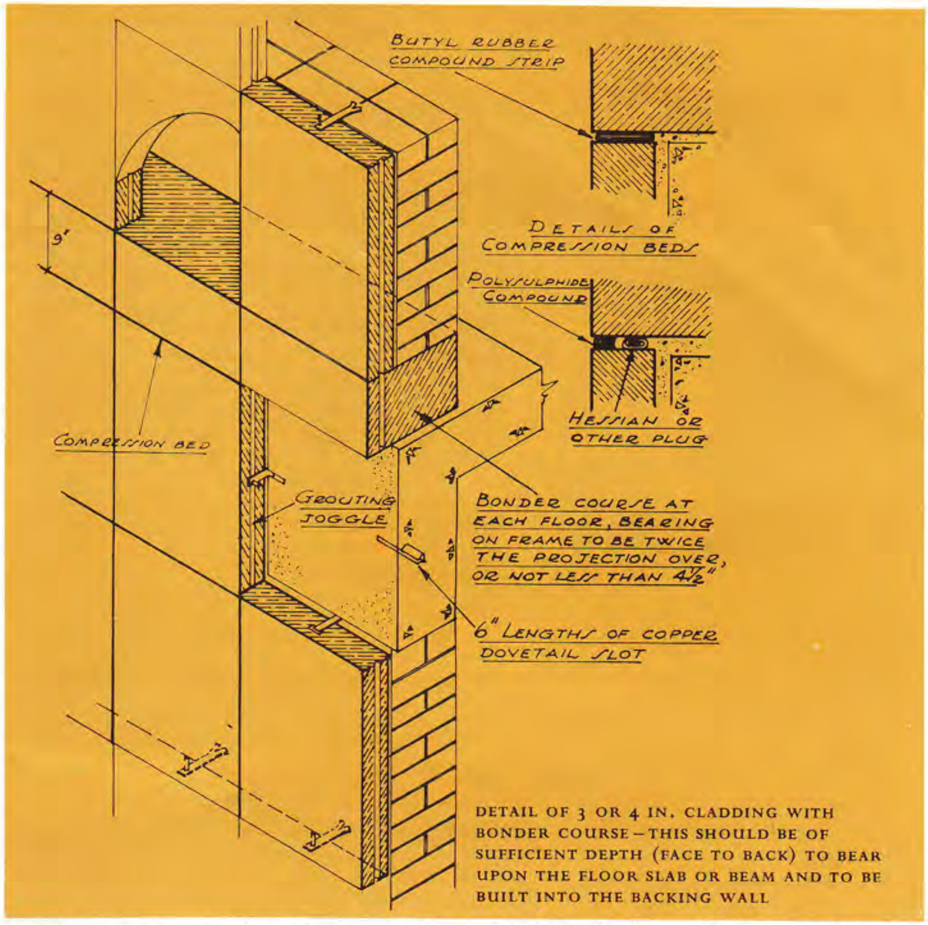
When prices are required for ashlar or masonry for bridgework, etc., it is essential that full information and drawings should be given to the firms tendering. This will enable all firms to quote on a similar basis, and none will be encouraged to put in high prices to cover details which may not be apparent in the original bill of quantities or specification.

The scheme, now nearing completion, is being carried out by the Worcestershire County Council as agents for the Ministry of Transport. The entire works, including sixty-seven bridges, are being constructed to designs prepared in the office of the County Surveyor and Bridgemaster,

ONE OF A PAIR OF BRIDGES AT WARNDON JUNCTION ON THE SECTION OF M5 THAT SKIRTS WORCESTER. IT IS CLAD WITH DOULTING STONE

Guide to Cladding*

3. Mortars, grouting and waterproofing



DETAIL OF 3 OR 4 IN. CLADDING WITH BONDER COURSE – THIS SHOULD BE OF SUFFICIENT DEPTH (FACE TO BACK) TO BEAR UPON THE FLOOR SLAB OR BEAM AND TO BE BUILT INTO THE BACKING WALL

Mortars

The correct composition of mortar for different types of cladding is important to ensure: (a) that it will not contribute, by reason of its hardness, to spalling or cracking of the cladding slabs when under pressure due to movements in the structure; (b) that it will not shrink and thus allow water and moisture to percolate through the cladding joints; (c) that its colour and texture blend with the cladding material; (d) that the aggregates used are clean and free from discolouring elements.

There are many differing specifications for mortars and it is outside the scope of this Code of Practice to recommend particular 'mixes'. Many architects and most masonry contractors specify mixes which have proved satisfactory over the years and, provided these meet the general requirements outlined in(a), (b), (c), and (d), they can be used with confidence.

Grouting at the back of cladding

Generally, thin cladding of granite, marble, and slate is not grouted solid at the back. It is normally fixed against dabs of mortar and the cavity between the back and the face of the supporting wall is left void. Care must be taken to ensure that all joints are properly filled so that water cannot find its way through to the cavity. This water would collect at each floor level and cause dampness, efflorescence, and staining.

If thin cladding is fixed with open joints, or weep holes are left at each floor level, any water that percolates through to the cavity can run out. In such cases it is necessary to provide a metal flashing at each floor level to carry the water clear of the wall.

With thicker cladding it is recommended that the cavity be filled solid with cement/sand compo., sufficiently fluid to fill the cavity completely.

Voids behind fascia or head and string courses which normally occur at floor levels should be treated similarly. The vertical joints of the cladding should be grouted with a fairly strong mixture – say, 2 of aggregate to 1 of cement.

The mortices and pockets provided for metal fixings should be filled with neat cement grout in a fairly liquid form.

Waterproofing the back of cladding

This is a subject on which opinions are much divided. The case for waterproofing is that it prevents absorption by the cladding of moisture from the backing. This moisture contains soluble salts which, if allowed to penetrate to the front face of the cladding material, results in discolouration. In theory this is sound, but in practice, under normal building conditions, it is not possible to ensure a completely sealed back face to the cladding, and any weak places allow moisture to escape in concentrated form. Materials such as granite and slate, due to their low coefficient of absorption, are generally not affected by moisture from supporting walls.

Marble is usually fixed clear of the supporting walls; in most cases it is also treated on the back face with shellac or other non-absorbent coatings; it is usually fixed to walls which have had time to dry out. Marble is therefore not, to any marked extent, subject to problems arising from the absorption of moisture.

Limestone and sandstone on the other hand, when used as an external cladding, are fixed against newly cast concrete or fresh brickwork. Because of their higher coefficient of absorption they may 'soak up' moisture which can result in temporary discolouration of the face. In practically all cases this discolouration will disappear as the moisture evaporates and the stone dries out.

Saturation by rain during the course of construction, and more particularly by water running over the edge of floor slabs directly on to the backs of the cladding, is a serious cause of discolouration. Protection against rain can quite readily be provided by tarpaulins or polythene sheeting attached to the scaffolding; against water from the floor slab by building a brick on edge kerb around the perimeter of the slab. Steps should be taken to drain water collected on floor slabs, because continually saturated concrete adjacent to external walls results inevitably in ugly discolouration of the cladding. If care is taken to minimise saturation of the cladding, trouble from discolouration will be greatly reduced.

Coating the backs of the cladding slabs with a bituminous paint or other protective membrane has not proved to offer a complete remedy against absorption. Where the cladding is fixed to concrete or other preformed backing members, and the backs of individual cladding slabs have been treated before fixing, it is still not possible to seal the joints, i.e. on the back, after fixing. Moisture from the backing member and water trapped behind the cladding finds its way through the joints in concentrated form. This results in brown staining on the face of the cladding around the joints.

Even where it is possible to seal off the whole of the back of the cladding, including the joints, effectively during fixing, there can be no guarantee that hair cracks in the joints will not develop during the course of construction and so allow moisture from the backing to seep through. If the back of the cladding is left untreated, absorption is evenly distributed over the whole area of contact with backing members, and consequently evaporation is speeded up and there is less likelihood of patchy discolouration.

There appears to be little merit in treating the face of the backing wall with a waterproof coating. Although this may restrain moisture in the backing wall from being absorbed by the cladding, it tends to accelerate absorption, by the cladding, of water trapped between the cladding and the backing wall. When left untreated the backing wall itself will absorb the water and help towards a more natural absorption and evaporation.

The provision of regular overhanging courses with generous throats helps considerably in reducing unsightly surface staining. Any surface likely to collect rainwater should have a steep weathering to assist the water to cascade off, rather than trickle over the edge and carry dirt down the face of the cladding. Flush sills, copings, and similar members are not recommended, but when they are used they should have steep weatherings as mentioned above.

The provision of an efficient damp-proof course beneath the coping of parapets will practically eliminate discolouration of the parapet wall.

*An extract from the new *Code of Practice* for fixing stone, granite, marble, and slate slabbing to structural frames. Obtainable from the British Stone Federation 141 Streatham High Road, London SW16

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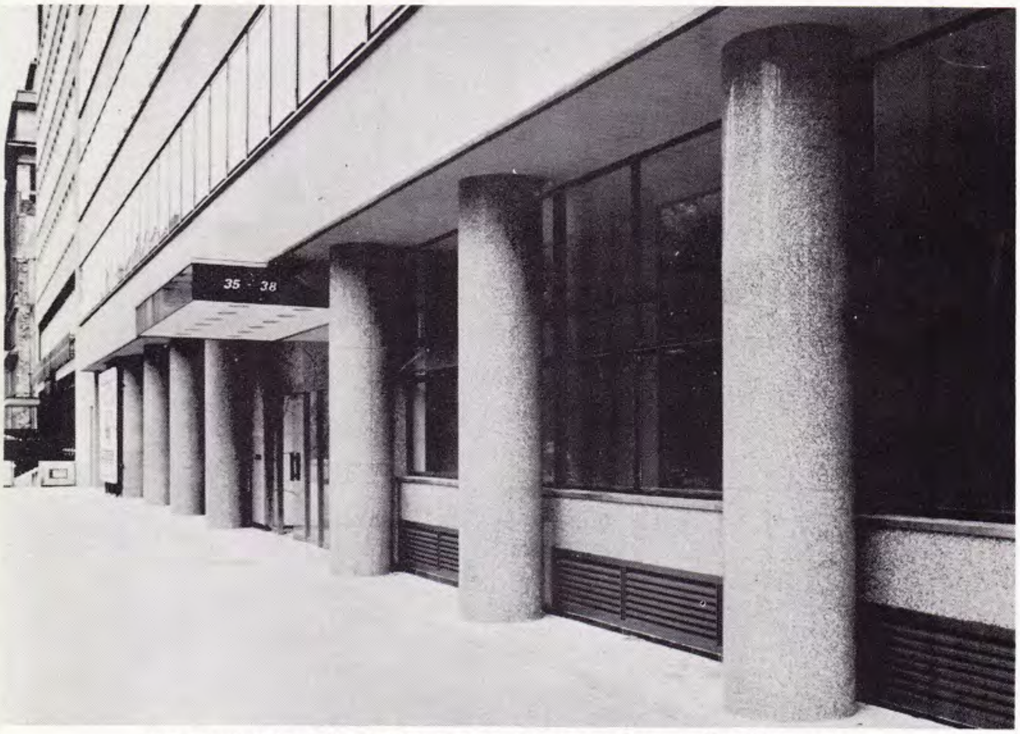


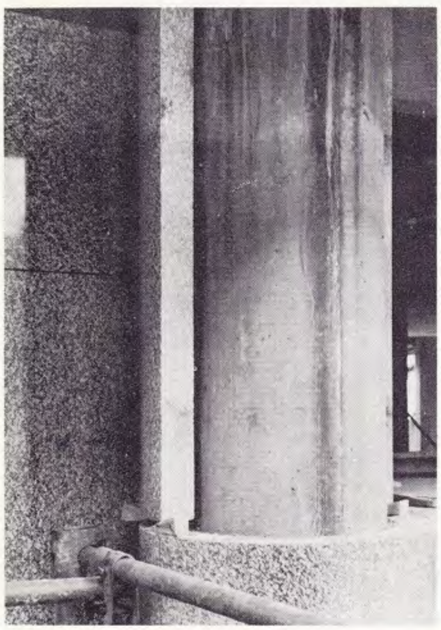
THE COLUMNS AT 35-8 PORTMAN SQUARE, ENCASED IN CORNISH TOR DOWN GRANITE
ARCHITECTS: RONALD WARD & PARTNERS

of approximately 1 ft. 5 in. diameter, leaving a wall thickness of $3\frac{1}{2}$ in.

Finally, to enable the casings to be fitted around the structural column, each pipe-like section was carefully sawn into two halves which were erected at site with a nominal clearance of $\frac{1}{2}$ in. between the granite and the concrete. The two halves were securely joined together with bronze cramps and the interstice filled solid with cement mortar.

The great advantage of this method of production is a smoothly circular column of meticulous accuracy and with a minimum of joints.

THERE IS A NOMINAL CLEARANCE OF $\frac{1}{2}$ IN. BETWEEN THE GRANITE AND THE CONCRETE COLUMN



INSERTING WEDGES PRIOR TO SPLITTING AN OUTSIZE BLOCK OF PORTLAND STONE

Location of principal quarries throughout the British Isles

Wellfield and Waterholes York Sandstone

SOURCE Wellfield and Waterholes Quarries, Huddersfield, Yorkshire.

GEOLOGY Millstone grit York sandstone of the Carboniferous System.

COLOUR Wellfield Mottled – light brown shading pleasantly to grey with blue traces. Waterholes Grit – light brown.

CHARACTERISTICS Very durable, fine grain, smooth even texture, with occasional granular quartz nodules; both stones are free working, harden on exposure to air, will take sharp arrises and are suitable for carving; they are both unaffected by atmospheric pollution and undamaged by frost action.

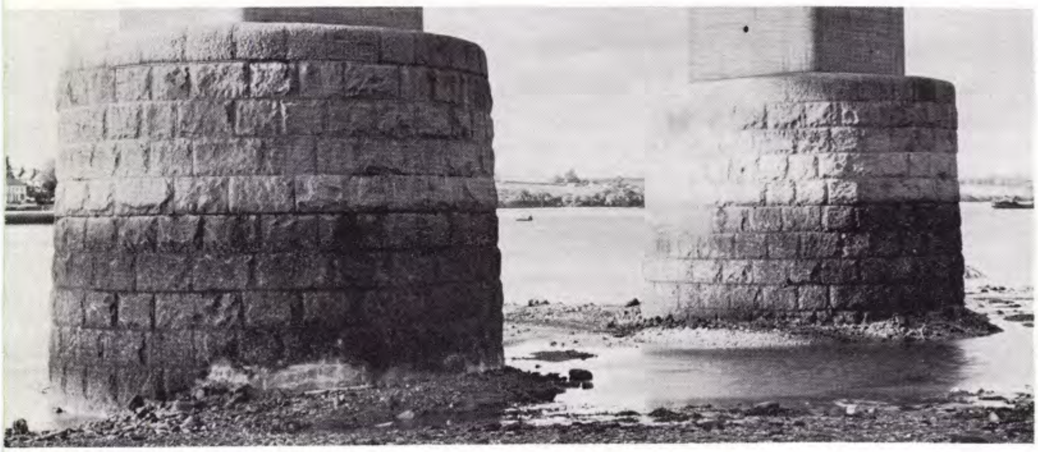
AVAILABILITY Ample reserves of block stone are held to meet normal delivery requirements.

SIZES No restrictions on superficial size. Horizontal bedding up to 21 in. for quantity: edge bedding up to 21 in. wide with heights as required. Face bedding as required.

FINISHES Both stones lend themselves to a variety of finishes, including frame-sawn, fine-rubbed, split-faced, rock-faced, and punched.

PHYSICAL PROPERTIES Weight: 150 lb./cu. ft.
Crushing strength: 705 tons/sq. ft.
Porosity (per cent): 9.0.
Saturation coefficient: 0.90.

WHERE USED *Architectural:* Manchester Free Trade Hall; Pontefract Municipal Offices; Newcastle's New Civic Buildings; Oldham Civic Centre; Brotherton Library at Leeds University; W.R.C.C. Staff Club and offices; Keighley Technical College; Burnley Technical College.
Engineering: Doncaster North Bridge; Salmesbury Bridge, Preston by-pass; Leeming by-pass, six bridges; New Forth Bridge, approach roads; various works for Manchester, Fyle, Leeds, and other water boards.
Steps, pavings, landscape walls, etc: Oban Cathedral; Coventry Cathedral; York Minster; St. Paul's Cathedral; Universities of Birmingham, Leeds, Sheffield, and London.



ROCK-FACED ASHLAR IN CORNISH DE LANK GRANITE AROUND THE PIERS OF THE NEW BRIDGE ACROSS THE TAMAR

Mr W. R. Thomson, M.I.C.E., M.I.MUN.E., F.INST.H.E. The contractors are A. Monk & Co. Ltd. of Warrington; sub-contractors, C. Bryant & Son Ltd.

Natural stone still plays an important part in river bridges. The two photographs convey the massive strength of the rock-faced ashlar around the piers supporting the towers of the new bridge crossing the Tamar, linking Devon with Cornwall – St Budeaux to Saltash. Each course of Cornish De Lank granite is uniform in height to the required radii, the 2 ft. 6 in. lower courses gradually reducing as they are built up – in random lengths with a minimum of 2 ft. × 6–9 in. on bed stretchers, with 15 in. bed headers. The faces are battered and there is a joint allowance of $\frac{3}{4}$ in. Altogether 9,000 cu. ft. of granite were used. This £1½-million bridge was completed in 1962 and opened by the Queen Mother; it was constructed by Cleveland Bridge and Engineering Co. Ltd, Darlington – Mott, Hay & Anderson, London, being the consulting engineers.

De Lank granite is also being supplied to John Howard and Co. Ltd, London (in consortium with Associated Bridge Builders Ltd, Chepstow), for the £11-million Severn Bridge whose 3,240 ft. main span will link Aust with Chepstow. Granite totalling 6,500 cu. ft. will be used for the copings to the piers – apex stones, cutwaters, and straight copings. The consulting engineers are again Mott, Hay & Anderson, in conjunction with Freeman, Fox & Partners. The bridge was architecturally designed by Sir Percy Thomas & Son, Cardiff.

Circular columns in Cornish granite

OFFICES recently completed at 35–8 Por man Square, London, provide an examp of the craft of granite turning which now all too rare. Twelve external structur columns are clad in polished Cornish granite fro pavement to first-floor level. Approximately 1 ft. high, with an outside diameter of 2 ft., eac column is clad in three courses with two ston per course.

The blocks, to make 4 ft. × 2 ft. × 2 ft., we quarried at the Tor Down Quarry, St Brewar Cornwall. The turning, however, is undertake by specialist firms in Aberdeen who for ma decades have made this branch of the grani industry their own. To save transport costs, t blocks were scappled at the quarry roughly ci cular to 2 ft. 1 in. diameter. The process of lath polishing produces an exceptionally fine glos and the full character of the stone reveals itsel

These circular column casings are very ofte gutted out to accommodate the structural R.C column by dividing the circular section (usuall into four pieces), sawing perpendicularly into th backs and clearing the resulting webs by hand. I this case, to avoid possible difficulties in co struction due to irregularities in the inner surfac of the granite and to keep the number of joints t the minimum, it was decided to hollow out th column by boring. This was done with a core dri

FIXING THE PIPE-LIKE SECTIONS OF GRANITE AROUND THE STRUCTURAL COLUMN