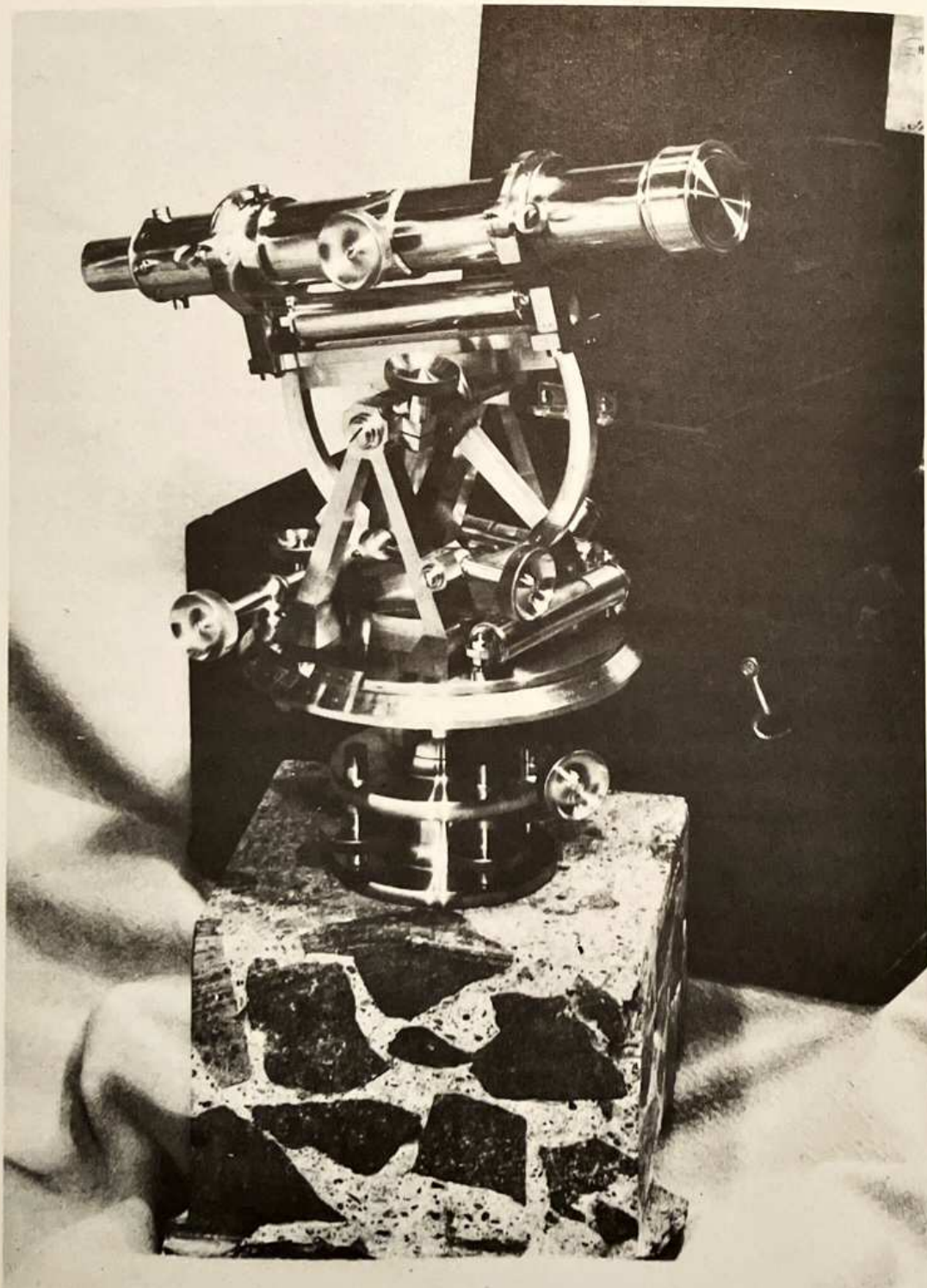


EARLY USES OF CONCRETE IN EDINBURGH ROADS

*Catalogue of the Edinburgh exhibit
at the Centennial Exhibition of the
Institution of Municipal Engineers
Brighton 20-22 June 1972*



The device on the cover was used on the stationery of the City Road Surveyor over 50 years ago and probably as early as 1878.



See Exhibits 17 and 20

The Institution of Municipal Engineers
Centennial Exhibition

Brighton

June 20th--22nd, 1972

A Catalogue of the Exhibit

EARLY USES OF CONCRETE IN EDINBURGH ROADS

which includes a selection of

Surveying Instruments and an Eidograph
in use c. 1872

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City Engineer and Master of Works
Edinburgh.

June 1972.

FOREWORD

It is perhaps not a very common occurrence for a Municipal Engineer's Department to have any appreciable historical material either documentary or otherwise which is of general interest outside any particular town concerned. The city of Edinburgh is perhaps better endowed than other towns in that there is a considerable quantity of this material carefully preserved in the City Archives and in the City Library.

It is fortunate for all concerned that Mr. Paxton, a Principal Assistant Engineer in my Department, is extremely interested in historical matters relating to all fields of British Civil Engineering, and a deep debt of gratitude is owed to him for spending so much of his own time on research into this exhibit. I should also like to express my thanks to all who have contributed to the exhibit, in particular, the City Librarian for loaning the display cases and the Director of the Royal Scottish Museum for preparing the theodolites and supplying the photograph used for the frontispiece of this catalogue.

The part dealing with the use of concrete for road construction clearly demonstrates that the Victorian road engineers in Edinburgh were extremely competent men with a flair for originality, and also shows that modern road construction techniques are by no means the product of the present century, but have their origins very early in the 19th century.

The quality of the Portland Cement produced such a long time ago, in common with many other manufactured materials of that age, was obviously very high indeed. Likewise the abilities of the engineers, who had the courage of their convictions and engaged in pioneering work which has stood the test of time in a most remarkable manner.

F.R. Dinnis

26th May, 1972.

INTRODUCTION

The occasion of the centenary of the Institution affords an appropriate opportunity for reflection on some aspects of the work of our predecessors during the last century. One of the more utilitarian and potentially significant facets of the work of the Victorian local authority engineer was his application of improved "Portland" cement to concrete in town roads, both as a foundation and top surface. This is the main theme of the Edinburgh exhibit.

The modern practice of using hydraulic cement to bind materials in carriageway construction developed progressively, albeit spasmodically, from its first significant usage in the foundation of Telford's 1½ mile improvement of the Holyhead Road at Highgate Archway in 1828-9, to its extensive use today. At the present time some 25% of all major roads under construction have a concrete running surface and a further 25% have cemented material within the structure of the pavement. A necessary preliminary to this development, particularly in the last century, was a considerable improvement in the quality of cement from the naturally occurring water-limes and "Roman" cements widely used before the Great Exhibition of 1851.

The first four exhibits relate to Dean Bridge, Edinburgh, in the carriageway of which Thomas Telford intended to use concrete in 1829. The building of this famous bridge, for which Telford was the engineer, commenced in October 1829 and was completed by the summer of 1832 at a cost of £18,556. The bridge comprises four spans of 90 feet and has a total length of 447 feet. The surface of the carriageway is 106 feet above the bed of the Water of Leith. Today, the bridge, which is still virtually as built, is the responsibility of the City Engineer and carries over 6,000,000 vehicles per annum. Unusual design features are the hollow spandrels and piers which were adopted to reduce weight on the foundations and to facilitate inspection. The asciticious or outer arches give the upper bridge structure a pleasing appearance of slenderness.

During mid-Victorian times water-bound macadam roads were in vogue nationally and in many instances had replaced earlier sett causeways. This "macadamizing" of roads did not prove a success. Although macadamized roads were satisfactory when newly laid, they were troublesome and expensive to maintain and much of their great mileage throughout the country was in a dusty, uneven and often dangerous state. Several decades were to pass before tar, tarmacadam and asphalt were generally applied to

road construction. In 1870, one contemporary observer of the London scene, a civil engineer, wrote graphically of*the miseries of macadamized streets.... Vehicles rush through a sea of mud and slush, bespattering passer-by and defacing the adjoining houses and shops, the very foot-pavements are bestrewed with mud. In dry weather, when the streets are watered to allay the dust and prevent the surface breaking up, almost the same inconveniences are experienced; so that, as a general rule, the streets in a large town are almost always in a muddy condition*

Forward thinking engineers and surveyors regarded the shortcomings of macadamized roads as a challenge and important pioneering work on improving carriageway construction was carried out in Edinburgh as early as 1866, with the experimental application of Portland cement concrete to both sett causeway foundations and carriageway top surfaces. Areas of each type of construction measuring 750 sq.yds. were laid down in the heavily-trafficked carriageway of George IV Bridge. The work was executed by the City Road Trust of Edinburgh to the directions of Joseph Mitchell, a leading Scottish road engineer and former pupil and disciple of Telford. Both the experimental sections of road were successful and Mitchell published an account of his new mode of construction, the second edition of which is on display in the case. Although his concept of smooth, hard, dust-free concrete carriageway surfaces, facilitating traction and with low maintenance costs, was not realised nationally until comparatively recent years (he would have approved of the modern concrete motorways!), Mitchell did live to see the widespread adoption of sett causeways founded on Portland cement concrete, a practice undoubtedly encouraged and influenced by his own efforts. In the 1870's, tramways were widely adopted in city streets and on this subject also Mitchell's views appear to have been ahead of their time. He wrote of tramways, *I fear that they are wholly inapplicable to the narrow and overcrowded thoroughfares of London, where, among other inconveniences, they will seriously impede access to our shops and warehouses . He considered that they would interfere with the practical working of traffic by forcing the general travelling on the remaining space on each side....The object of a tramway is to furnish a smooth and equable surface for the traction of vehicles. I think a well-made concrete road will effect that purpose more thoroughly. It will not obstruct traffic in any part of the thoroughfare. The traction is half that now required on the best macadamized road on a dry day. It is free from mud and dust in all weathers. And, if necessary, it may be washed with the water-hose every morning, thereby purifying and refreshing the air in our thoroughfares....J.M....16th April, 1870 .*

Mitchell's section of concrete carriageway at George IV Bridge can be

considered the first successful length of major concrete road in modern Britain. Three years after its construction, the Chairman of the City Road Trust, Jas. Peddie, W.S., referred to its continuing good state despite some uneven "joinings". He commented that the road *is as good today as it was when first laid, excepting at one or two spots which can easily be repaired; and I do not think it has lost above a quarter of an inch by friction over the general surface. Its freedom from dust in summer, and from mire in Winter is a great recommendation to it, and carriages running over it produce no more noise than over a well-macadamized road in perfect order. Its original cost is not more than causeway with Ratho stone....and I am satisfied it will last double the time....some device will, I doubt, not be found for lessening the trouble in getting at gas and water pipes and drains....* He urged the Board and the new Surveyor Mr. Proudfoot to carry out further trials of Mitchell's concrete. In fact, the road lasted nearly 40 years and influenced the construction of many concrete roads in the Edinburgh area. From about 1873 until 1910, concrete carriageway totalling 5½ miles in length was laid in over 100 Edinburgh and Leith streets. These streets were, however, of a lightly-trafficked residential character and to place this figure in context, it should be mentioned that during the same period about ten times this mileage of sett causeway had been laid, much of it on tramway routes and founded on Portland cement concrete. The method of forming the concrete in some of the early concrete roads differs from Mitchell's mode as published, in that the open-graded whinstone aggregate was grouted in situ and not physically mixed up thoroughly with the other ingredients so that every individual stone was saturated with the cement liquid. The specimen on display in the case has been cut from a grouted concrete road of this type. The engineer responsible for the construction of this particular road and many of the other early concrete roads in Edinburgh was David C. Proudfoot, Surveyor to the City Road Trust from 1869 to 1878 and City Road Surveyor from 1878 to 1906.

During and after the Great War, with the successful and rapidly increasing use of tar as an economical road binding material, the practice of constructing new concrete roads and sett causeways virtually ceased and it is necessary to move a few miles to the north of Edinburgh for a further development in concrete road technology. This occurred in 1916, with the construction at Canmore Street, Dunfermline, of one of the earliest reinforced concrete carriageways in Britain. In general, Edinburgh's early concrete roads have lasted very well, requiring only minimal maintenance and even as late as 1950 their length totalled 5.92 miles. With the increasing traffic of recent years some cracking of the concrete occurred and although it became necessary to overlay many of the earlier carriageways with asphalt, they still continue to give useful service.

costs it can be seen that the causeway of Aberdeen granite laid on 3" of concrete cost 18.94 shillings per sq.yd. (note the decimals!) and the 6" deep concrete carriageway 8.047 shillings per sq.yd.

7. **JOSEPH MITCHELL ADVOCATES CONCRETE ROADS NATIONALLY.**
Enlarged facsimile of the title page of Joseph Mitchell's pamphlet setting forth his *New mode of constructing the surface of streets...* published in London in 1870, together with his *Instructions for making a concrete road*. It is clear from Mitchell's *Instructions* that he was advocating a concrete road in the true sense that it is understood today and not a cement-grouted macadam. Mitchell's pamphlet appears to have been the first publication of importance advocating the construction of concrete roads.

The original pamphlet forms exhibit 16.

8. **TARDY PROGRESS AT GEORGE IV BRIDGE IN 1866.**
Photograph of part of a page from the Edinburgh Evening Courant for August 21st 1866. It appears from exhibit 6 that work on Mitchell's construction commenced on arrival of the cement early in June. There seems to be a dearth of press comment on this utilitarian project during its construction and what little there was scarcely constitutes a bouquet for the Surveyor and Engineer!

By courtesy of J.W. Cockburn, F.L.A., City Librarian, Edinburgh.

9. **VICTORIAN TRAFFIC IN PRINCES STREET, EDINBURGH**
Contemporary photograph of the East End of Princes Street c.1880. Shortly before the taking of this photograph the tramways and setts in Princes Street had been relaid on a 9" foundation of Portland cement concrete under the superintendence of D.C. Proudfoot, City Road Surveyor.

Copyright E.R. Yerbury & Son, Edinburgh.

10. **NORTH BRIDGE, EDINBURGH IN 1885.**
Contemporary photograph of North Bridge from Register House, Princes Street, in 1885. The present North Bridge and North British Hotel, two well-known Edinburgh landmarks, were built towards close of the next decade.

Copyright E.R. Yerbury & Son, Edinburgh.

11. **CARRIAGEWAY CONSTRUCTION FOR MAJOR ROADS IN 1895.**
Contemporary illustrations of Class 1 and Class II sett causeways founded on cement concrete. By 1895 most large towns had many miles of this type of construction on their main roads.

Illustrations in H.P. Boulnois's text-book "The Construction of Carriageways....1895"

12. **SETT LAYING IN LEITH c.1905**
Contemporary photograph of a large labour force sett-laying to tramways at the foot of Leith Walk early in the present century.

By courtesy of J.W. Cockburn, F.L.A., City Librarian, Edinburgh.

13. **GILLESPIE CRESCENT—AN 1873 CONCRETE ROAD TODAY.**
Colour photograph of one of Edinburgh's earliest surviving concrete roads, Gillespie Crescent, constructed in 1873, as it appears today. Although the carriageway was surfaced with a thin layer of asphalt some years ago, a small area of the concrete can still be seen at the entrance to the Crescent.
14. **BLACKWOOD CRESCENT AFTER 82 YEARS TRAFFIC WEAR.**
Concrete Quarterly No.24, March 1955, article *Early Concrete Roads in Edinburgh*. The photograph shows Blackwood Crescent, another early concrete road constructed in 1873, as it appeared in 1955. It has subsequently been overlain with asphalt, but some idea of the very low maintenance costs of these roads can be gauged from the fact that the total cost of maintaining Blackwood Crescent from 1873 until 1920 was only £40!

Lent by Peter Russell, B.Sc., F.I.C.E., F.I.Struct.E., M.Inst.H.E., of the Cement and Concrete Association.
15. **DEAN BRIDGE—ORIGINAL TELFORD DRAWING OF 1829.**
Original pen and ink drawing depicting four sections of the bridge. Dated from London on 8th May 1829 and signed Thos. Telford. See note on exhibit 1.

Measures 722 x 552 mm.

Lent by B. Annabel, Dip.Arch (Leics), A.R.I.B.A., F.R.I.A.S., City Architect, Edinburgh.
16. **MITCHELL'S PAMPHLET ON CONCRETE ROADS, 1870.**
The second edition of Mitchell's pamphlet advocating concrete roads and published in 1870. See note on exhibit 7.
17. **SPECIMEN OF EARLY GROUTED CONCRETE, 1878.**
This specimen cube has been cut recently from West Arthur Place, Edinburgh, constructed in 1878.

The concrete was formed on a blinded and rolled stone bottoming 6" thick as follows:- A 4½" thick layer of 1½" whin road metal was spread uniformly over the bottoming and grouted with a mixture of fine gravel riddled out of Fisherrow gravel and Robin & Co's best (Portland Cement). The cement used was to be capable of sustaining a tensile strain of 600 lbs. on the superficial area of 2¼" of the standard test block after being immersed 7 days in water. The grout was mixed in a patent steam mixing machine and then spread, beaten and "equalised" into the road surface "in a most careful and tradesmanlike manner".

Illustrated in the frontispiece.
18. **SPECIFICATION FOR CONSTRUCTION OF WEST ARTHUR PLACE IN 1878.**
Part of the original specification relating to exhibit 17. The Contractor was supplied with a concrete mixing machine for which he had to pay the Road Trust £1.10/- per day. Note the particular emphasis on workmanship...*as the whole after-strength and durability of the carriageway depends much on this part of the contract.*

19. **THEODOLITE BY T. DUNN c.1870.**
5'' cradle theodolite made by T. Dunn of Edinburgh c.1870. Used by the City Road Surveyor's staff.

20. **THEODOLITE BY ADIE & SON c.1870.**
5'' cradle theodolite in brass made by Adie & Son of Edinburgh c.1870. Used by the Burgh Engineer's staff. Note the signature of John Cooper on the label in the box lid.

Illustrated in the frontispiece.

21. **THEODOLITE BOX FOR EXHIBIT 19.**
Box for exhibit 19 with brass plate on lid inscribed—"City of Edinburgh Roads Department, 1883".

22. **DUMPY LEVEL BY BRYSON c.1855**
Dumpy level in polished brass made by James Bryson of Edinburgh c.1855

23. **EIDOGRAPH BY ADIE & SON c.1860.**
Eidograph in polished brass made by Adie & Son of Edinburgh c.1860.

The eidograph was used for accurately reproducing drawings and enlargements or reductions of drawings. It was invented by Professor Wallace of Edinburgh in 1821 and used fairly widely for over a century.

24. **CITY ENGINEER'S BATON OF OFFICE**
Wooden Baton measuring 115 x 14 mm.dia. with ornamental silver devices at each end for impressing the Corporation and Royal Arms into wax seals. The Baton is also embellished with an ornamental centre band in silver which is inscribed "CITY ROAD SURVEYOR". The hall marks date the Baton at 1909.

