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Royal Bombay Sappers & Miners

Royal Bombay Sappers & Miners

THE Royal Bombay Sappers & Miners, now the Bombay Engineer Group, trace their descent from a company of Pioneer Lascars, raised by Major Laurence Nilson, Chief Engineer of the Bombay Presidency, in 1777.

In February 1820 the Governor-in-Council directed that the number of Engineer Lascars be increased to a complete company to be designated "Sappers & Miners". The Company was commanded by Captain Thomas Dickensen of the Bombay Engineers. This procedure followed the practice prevailing in the British Army until 1856 whereby units of the Corps of Royal Sappers and Miners were commanded by officers of the Corps of Royal Engineers and the soldiers and officers of the Engineer Arm belonged to different Corps. The raising of this Company marked the official origin of the Bombay Engineer Group.

In 1869 the Bombay Sappers & Miners occupied their present home at Kirkee where forty years later they built their own Officers' Mess. In 1903, when Lord Kitchener was Commander-in-Chief in India, their title was changed to 3rd Sappers & Miners, but the designation Bombay died hard. In recognition of outstanding services throughout the First World War the Royal title was bestowed upon them in 1921; two years later the designation 3rd was dropped and the Corps became the Royal Bombay Sappers & Miners.

For the provision of specialist units during the Second World War additional Groups of Indian Engineers were raised which had no connexion with the three long-established Corps of Sappers & Miners, although these provided a number of officers and NCOs for the Indian Engineer Groups.

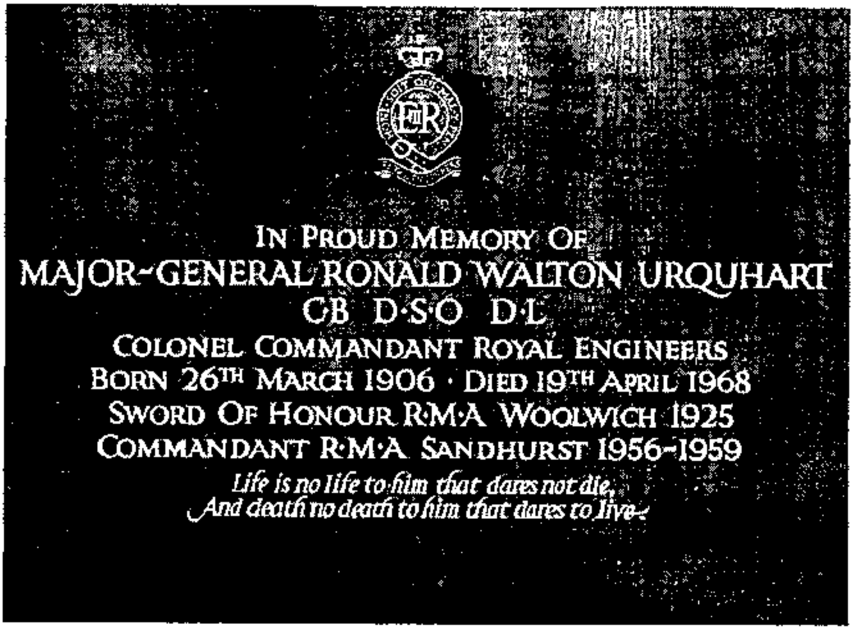
In 1946 the Royal title was bestowed upon the Indian Engineers, and at the same time it was decided that the three Corps of Sappers & Miners (Madras, Bengal and Bombay) should drop their time-honoured title of Sappers & Miners and become Groups. The Royal Bombay Sappers & Miners then became the Royal Bombay Group, Royal Indian Engineers. When India obtained her Independence and became a Republic the Royal title ceased to be used and the Corps assumed its present designation of Bombay Engineer Group.

British officers who had served in the Royal Bombay Sappers & Miners set up in the United Kingdom an Association to preserve the memories of days gone by and to maintain contact with their old Corps at Kirkee. To mark the 150th Anniversary of the official origin of the Corps members of the Association subscribed to a gift of silver consisting of a punch bowl, salver and ladle. The bowl bears the following inscription:

"*Presented to the Bombay Engineer Group by the friends and comrades of the Royal Bombay Sappers & Miners Officers' Association to mark the 150th anniversary of the Group, February 1970.*'

As it was not possible to arrange a personal presentation in Kirkee in February, a small ceremony took place at India House on 2 December 1969 at which the Chief Royal Engineer, General Sir Charles Jones, GCB, CBE, MC, himself an "ex-Royal Bo", accompanied by Brigadier H. P. Cavendish, CBE, DSO, Colonel P. A. Easton, OBE, and Mr C. W. Dennis, who served with the "Royal Bo's" during the Second World War, presented the salver to the High Commissioner for India, His Excellency Apa B. Pant, on behalf of all officers of the Association. In accepting this gift on behalf of the Bombay Engineer Group, His Excellency thanked General Sir Charles Jones for the gift and for the spirit and good wishes that went with it and promised to despatch it to India in time for the Anniversary Celebrations at Kirkee.

Memorial Tablet for Major-General R. W. Urquhart



On Sunday, 16 November 1969, as part of the Morning Service in the Royal Memorial Chapel, Sandhurst, a Memorial Tablet commemorating the late Major-General R. W. Urquhart, CB, DSO, DL, was unveiled by the Chief Royal Engineer, General Sir Charles Jones, GCB, CBE, MC, and dedicated by the Chaplain-General the Ven. Archdeacon J. R. Youens, CB, OBE, MC, QHC.

The Royal Military Academy Staff devised the Service with great care, and even thought of draping the Tablet with the Shop flag as well as a Sandhurst one, because General Urquhart had combined the distinction of winning the Sword of Honour at the Shop with being Commandant of Sandhurst.

The Tablet was subscribed to by General Urquhart's family and local subscribers in Gloucestershire, the surviving members of 14 YO Batch and Corps Funds.

After the Service visitors were entertained in the Indian Army Room, where the Staff had thoughtfully arranged for General Urquhart's former batman, gardener and other servants he had had at Sandhurst to be present, too.

The Applications for Concrete in Peace and War

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INTRODUCTION

TIME has always been, for the military civil engineer, a factor of prime importance. This is especially so during the construction phase of any operation, when the combination of operating under enemy fire and the immediate user requirement, make speed essential. The civilian Civil Engineer does not face the same environment and, in the past, time has been a factor of lesser importance. Since the war, however, this situation has changed. The biggest spender in the civil engineering and construction industry is undoubtedly the public sector and, once a Ministry decision is made to go ahead with a project, they require completion as soon as possible. Increased manpower costs, aggravated by SET, add to the need for a rapid financial turnover in relation to an employer's wage bill. These two factors have combined to produce a requirement in civil engineering in which progress has been made in those fields of research aimed at reducing construction times.

With this in mind, it is the aim of this paper to examine the developments in the use of concrete in relation to the present role of the Royal Engineers.

FIELDS OF APPLICATION

In the past concrete has been so slow in gaining strength that it has generally been unsuitable for use by combat military engineers. Changes in this factor will be discussed later, but concrete has still the disadvantage that it has a low strength weight ratio, and the use of concrete presents enormous logistic problems. It can be virtually eliminated as a material for use by *forward* engineer units in the context of operation in north-west Europe.

Nevertheless in the limited war context concrete still has the role it always has had in road construction to open up areas inaccessible to wheeled transport. Here the word "concrete" is used in its broadest sense to include "soils stabilized with cement". The more important role here is the "follow-up" role when, to reduce maintenance, temporary bridges and roads are replaced by more permanent structures.

The third and expanding field of application to be considered is that of aid to the civil authorities in underdeveloped areas.

THE ENGINEER IN GLOBAL WAR

This is a dangerous field in which to speculate, but it is not inconceivable that, after an initial onslaught, hostilities would settle down to an old-fashioned stalemate and slogging match. Under such circumstances, it is certain that communications will be disrupted and there will be an immediate need to replace or repair damaged roads, airfields, bridges, and port installations. Modern, high-speed bridging equipment can be used to fill an immediate short-term requirement, but this would soon have to be released for re-use in order to maintain stocks for future operations.

Before leaving BAOR, there is the problem of the huge bill presented annually resulting from damage on field-training exercises. In the past the Sappers have been employed in repairing, and even rebuilding bridges, in addition to other tasks which have saved the taxpayer money and provides useful training. As well as hoping that this will be continued, the author suggests that these tasks can themselves be undertaken against a setting of nuclear war in which there will be a considerable number of bridges damaged rather than destroyed. In this context use could be made of rapid hardening epoxy resin cements and mortars.

THE ENGINEER IN LIMITED WAR

A wealth of experience exists in dealing with engineering problems in the context of a war confined to a small area and using conventional weapon systems. All that can be said is that there may be some developments in concreting techniques which deserve wider publicity. In the past many campaigns have been conducted in under-developed areas where there was no local source of cement readily available. However, it should be noted that today one of the first steps taken by a developing country in its economic progress is to build a cement plant, and more and more countries in which a limited war could occur are now moving from the under-developed to the semi-developed state.

THE ENGINEER IN AID TO THE LOCAL AUTHORITY

The expression "aid to the local authority" is used to differentiate between what is normally understood by aid to the civil power and assistance to a civil power of a purely engineering nature. Naturally, the two are linked indirectly in that engineering assistance such as building roads, airstrips, schools and hospitals often prevents the need for military aid to the civil power by cutting off some causes of discontent at the root.

In this context the use of concrete is purely traditional, but the military engineer is faced with the same problems that his civilian counterpart has had to deal with for some time—the task must be finished to a high standard, at the lowest cost and in the shortest possible time. Here the value of the Long Civil Engineering Course on which RE officers have to work in an atmosphere of cost effectiveness and contract programme becomes obvious.

The military engineer has, in the construction field, much to learn from his civilian counterpart. Architectural and financial requirements have meant that considerable resources have been spent on concrete research in every country in the world, and some of these are discussed in this article—the emphasis being on techniques developed to achieve a rapid gain in strength.

THE DEVELOPMENT OF CONCRETE TECHNOLOGY

The last twenty years has seen enormous strides in the field of research in concrete technology. At one time *ME*, Volume XIV, Part 1, covered concrete practice in a few pages. Latest textbooks on the subject, such as W. H. Taylor's *Concrete Technology and Practice*, now runs to 650 closely printed pages and act as an introduction to the subject. Quality, alone, is now covered by a separate book.

Concrete is used in industry now more than ever before, and the field of activity which could well be studied closer is industrialized building. This new branch of engineering developed after the 1939–45 war, when the requirement was for the most economic use of manpower, and materials to produce houses as quickly as possible. Bricks, timber, tradesmen and, above all, houses were in demand, and in 1947 one of the first houses to be built entirely of large precast concrete panels was constructed near Romsey. System building in large panels has grown rapidly since that humble beginning, and, basically, an entire wall is cast in one piece, the ends being so shaped as to provide a permanent shutter for *in-situ* concrete, which acts as a load-bearing column for the panels above. The first shell took some time to erect, but recently, starting from just a plain concrete slab, six houses were handed over to their tenants after fourteen working days in Leeds, and four houses were handed over in twelve working days at Brownhills, Staffs. Having the necessary materials and by applying modern techniques, schools, hospitals and dwellings can be constructed in precast concrete in a very short time. It is interesting at this point to note that, eight years ago, houses and hospitals were being built on the Cayman Islands by a firm of industrialized builders using large precast panels, and countries such as Jamaica, Iran, and Egypt are as advanced in this field as any of the major powers.

The rapid completion of such structures would be impossible without detailed planning and good organization, but concrete technology did play a large part. The two fields of development of interest to the military engineer are:

(*a*) The degree of accuracy to which precast elements can be manufactured, and

(*b*) The techniques adopted for a very rapid gain in strength.

DESIGN

Accuracy and degree of tolerance in design is now clearly set out in British Standard Code of Practice 116: "Precast Concrete". This, however, does not bring out the fact that the design of structures in precast concrete is a skill in its own right, demanding a particular discipline and experience. The designer must have field experience and also be able to satisfy the sometimes conflicting requirements of structural continuity and allowance for movement. He must know just what he can expect of the manufacturers and erectors, and must make allowance for the degree of skill of the tradesmen involved. He must constantly ask of himself: "Can this structure I have designed be built with the men and plant available?"

RAPID GAIN IN STRENGTH

Rapid gain in strength is best achieved now by using steam curing techniques. For example, using only an old coal-fired boiler in field trials, a panel measuring 16 ft × 8 ft, and weighing 3 tons, was lifted from its mould after only 5¾ hours from time of casting. The rapid gain in strength can be achieved in other ways, the most common, possibly, is the use of rapid-hardening Portland cement with 2 per cent calcium chloride added. This would achieve the same strength as quoted in the last example, but after sixteen hours. It should be noted, however, that the use of both steam curing and calcium chloride demand considerable study and careful control in use. It would be misleading to give the impression that there are no snags or pitfalls in these techniques but, with care, they can produce precast concrete units ready for use within forty-eight hours of casting. To emphasize this it is worth while looking at these possibilities in more detail.

Steam Curing It must be remembered, that the setting of cement paste is a chemical reaction, and the reaction rate varies with temperature, stopping completely at about −10°C. Steam curing has the advantage that it simply accelerates the setting and hardening process without introducing chemical additives which may have an adverse effect in other directions. According to work carried out independently by A. G. A. Saul in the UK, whose report quoted in Reference (*a*) gives an excellent summary of the technique, Alexander and Taplin in Australia and Hanson in the USA, as well as many others, the strength of a given concrete is related to the product of the curing temperature above −10°C multiplied by the time in hours the concrete is held at that temperature. This product is normally referred to as the maturity factor. (*b*) Hence, concrete cured at 90°C for 4½ hours will give about the same strength as a similar concrete cured at 10°C for 24 hours.

When one thinks of steam curing, one normally thinks of large factories, costing millions of pounds, set up on a mass-production basis. This picture is false in that, as indicated earlier, all one requires is a means of raising steam at low pressure, some piping to distribute it, and some steel tubing with a few holes drilled in it to release the steam. Some means of conserving the heat is necessary and, naturally, the more efficient it is the better. The photographs in Photos 1–3 show very clearly that no elaborate factory is needed to make prestressed concrete beams with spans of up to 55 ft. In this case there was only a steel pipe run under the mould with holes at regular intervals to allow the release of the steam, the whole beam being covered with a canvas sheet. Note, however, that in this case it would be difficult to achieve temperatures of 90°C. The site factory shown in Photos 4 and 5 also relies on steam curing. The company took over some existing Romney huts, and set up a plant to

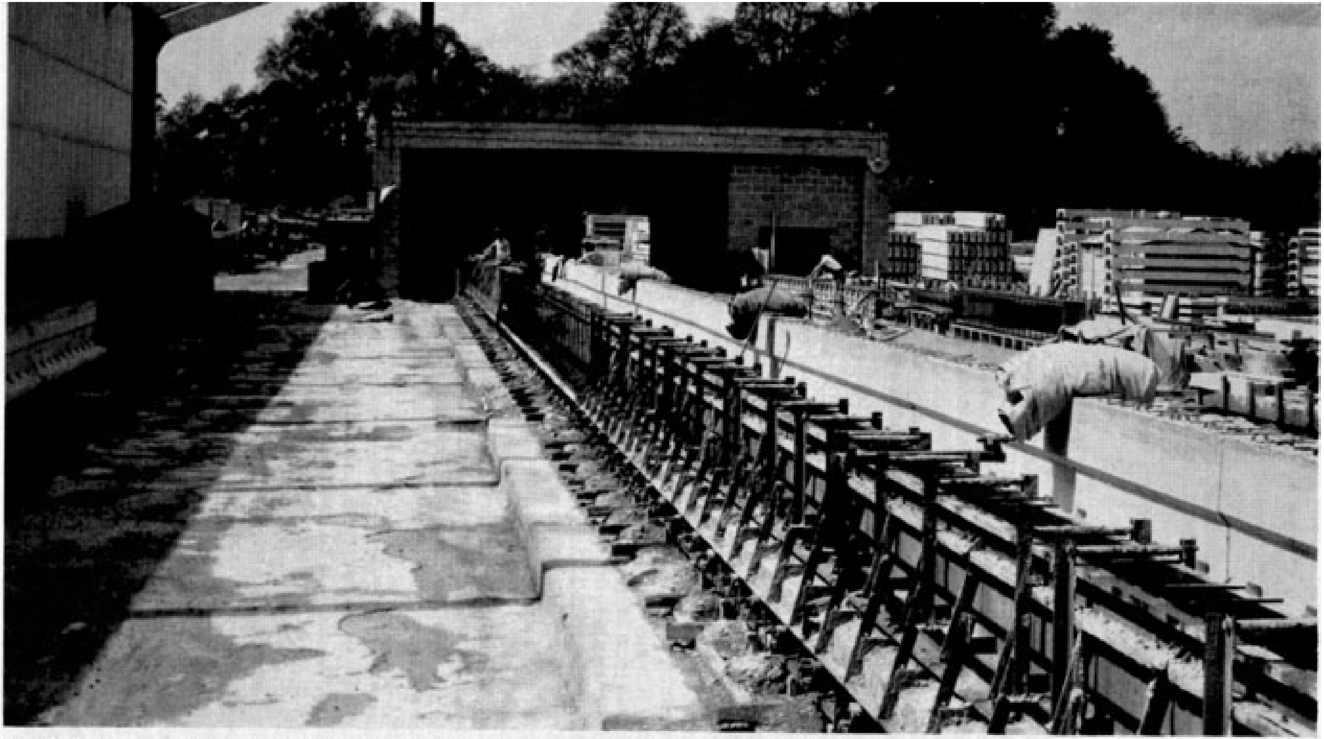

Photo 1. A general view of the prestressing beds which are 300 ft long and can make standard road beams up to a length of 55 ft. The nearer bed is set up ready for fitting the formwork, whilst the one behind is still covered with the canvas used during the steam-curing process.

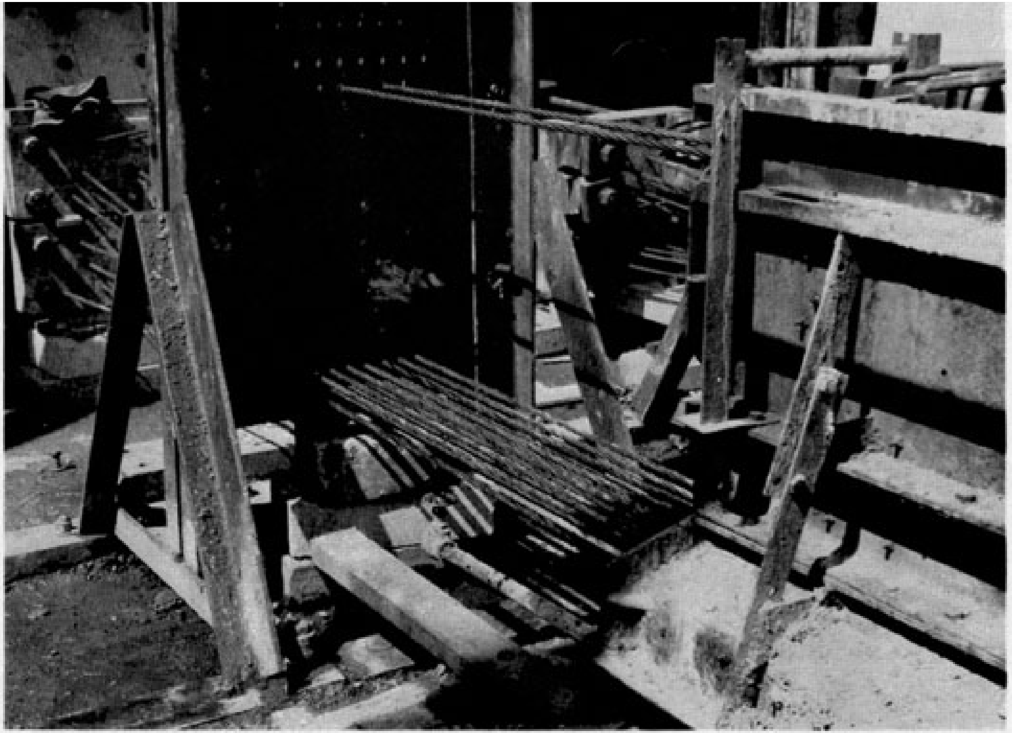

Photo 2. This shows the end of the prestressing bed and one can just see the steam pipe and valve. The steam pipe runs under the whole length of the bed.

The Applications for concrete in peace and war 2

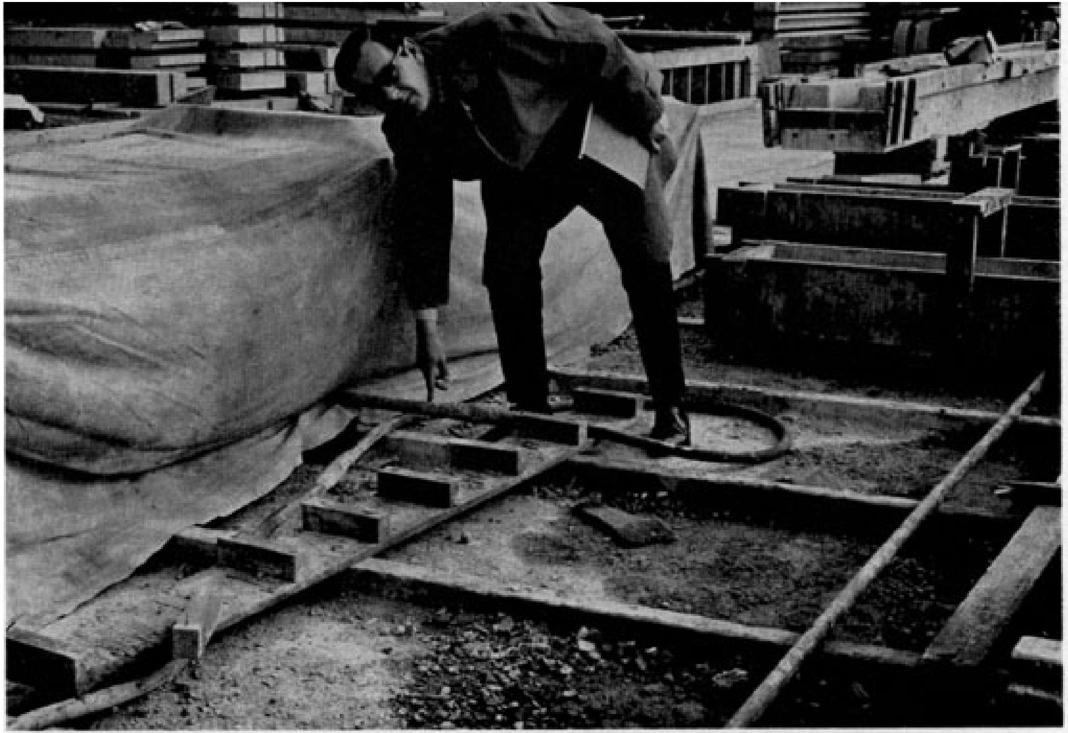

Photo 3. A group of moulds under a canvas sheet. Here one can see the steel pipe used for steam distribution, and the rubber hose connecting from the main to a second steel pipe under the mould. The holes in the steel pipe are $\frac{1}{8}$ in diameter and at 18 in spacing.

The Applications for concrete in peace and war 3

Photo 4. A general view of the site factory showing the converted Romney huts, the type of unit cast, the mixer arrangement, and behind it the steam-raising plant.

The Applications for concrete in peace and war 4

Photo 5. The mixer arrangement and steam plant. Note: The steam plant is so situated that it can be used for de-icing the aggregate in winter.

The Applications for concrete in peace and war 5

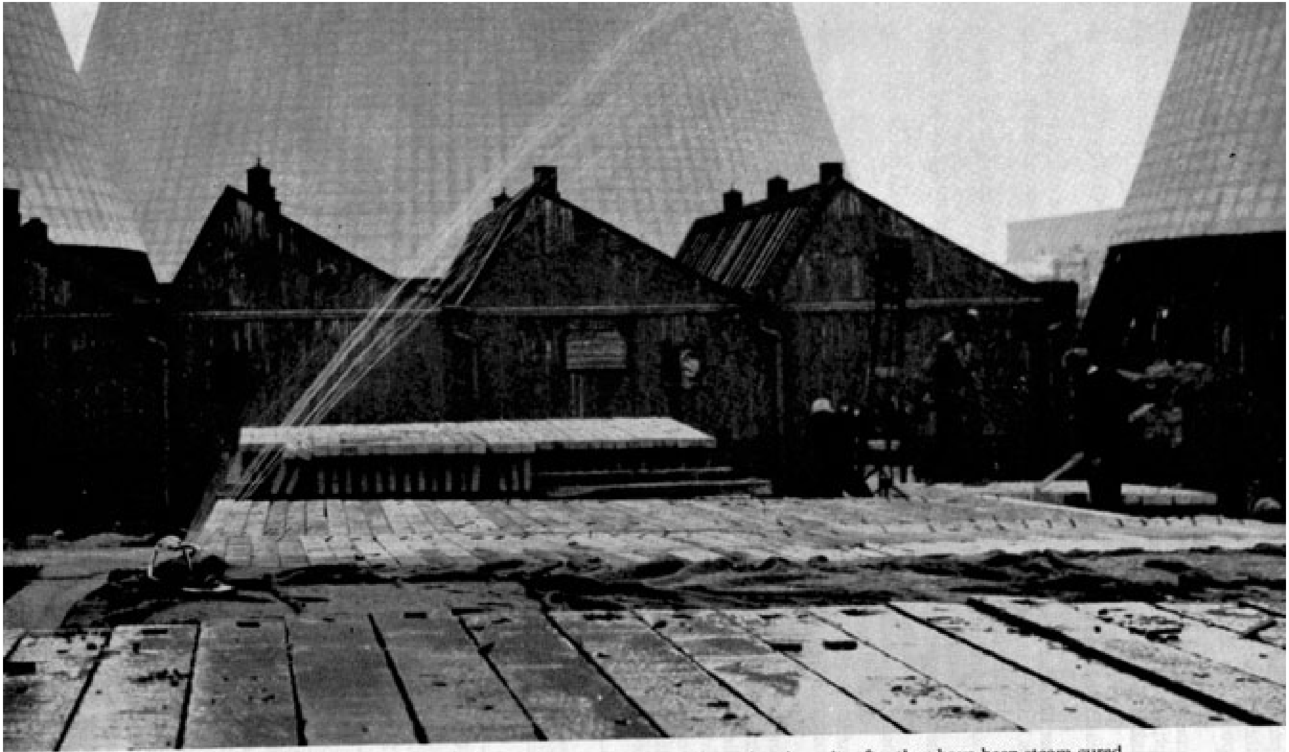

Photo 6. A simple water spray used to keep the hessian wet whilst curing the units after they have been steam cured.

produce precast concrete units for a cooling tower which are produced well within the accuracy required by CP 116. Without steam curing, it would have been impossible to complete the contract on time without increasing the number of moulds.

However, it is not the author's intention to go into the details of costing such contracts; all that is required is to show how simply and cheaply steam curing can produce high-strength concrete quickly provided, of course, certain precautions are taken. For simplicity, the major precautions are listed below.

(*a*) Freshly cast concrete should be kept at a temperature below 30°C for at least two hours before steam curing.

(*b*) The temperature should be increased steadily at a rate of no more than 10°C per hour for prestressed concrete and 30°C per hour for unreinforced concrete such as building blocks.

(*c*) Maintain a high humidity throughout the process to ensure there is sufficient moisture present for hydration.

(*d*) Allow to cool at a steady rate and ensure that the units are kept moist during the cooling period. (See Photo 6.)

(*e*) In the manufacture of prestressed concrete, care must be taken in calculating the loss of prestress.

Although creep and shrinkage are reduced by steam curing, allowance must be made for the differences in coefficients of thermal expansion between steel and concrete when prestressing is by pretensioning.

Rapid-hardening Cements In dealing with rapid-hardening cement, it is best to consider first only those which contain no accelerating additive. The rate at which cement hardens is governed, to a large extent, by the fineness to which the cement clinker is ground. Coarse grinding gives slow-setting low heat cement, fine grinding gives the more rapid-hardening cement because the increased surface area per unit weight increases the reaction rate. Although British Standards lay down fineness limits for these cements, modern manufacturing techniques mean that the standards set are well below those actually achieved. Cements now available are:

Type	Other description	Min fineness cm^2/gm	
		BS 12	Actual
OPC	—	2,250	over 3,000
RHPC	e.g. "Ferrocrete"	3,250	about 4,500
RHPC	e.g. "Swiftcrete"	—	about 7,000

All these finely ground cements can be used to advantage in conjunction with steam curing, but note that this does *not* apply to extra rapid-hardening cements which contain 2 per cent by weight of calcium chloride. This will be discussed later in relation to the use of calcium chloride, but the graph in Fig. A gives an indication of the range of strengths achieved using the different cements.

Not mentioned so far is high-alumina cement. The graph shows the very high early strength of high-alumina cement, but you have to pay for it, current prices being about three times that of OPC. Furthermore, high temperature is a distinct disadvantage and temperatures over 30°C can cause severe disruption of the set paste due to the instability of the hydration products. This is not to say that this cement should not be considered for use, particularly since it may be much cheaper outside the UK and steam curing may be impracticable, but it must be remembered that high-alumina cement and Portland cement are chemically very different, and each requires its own individual treatment.

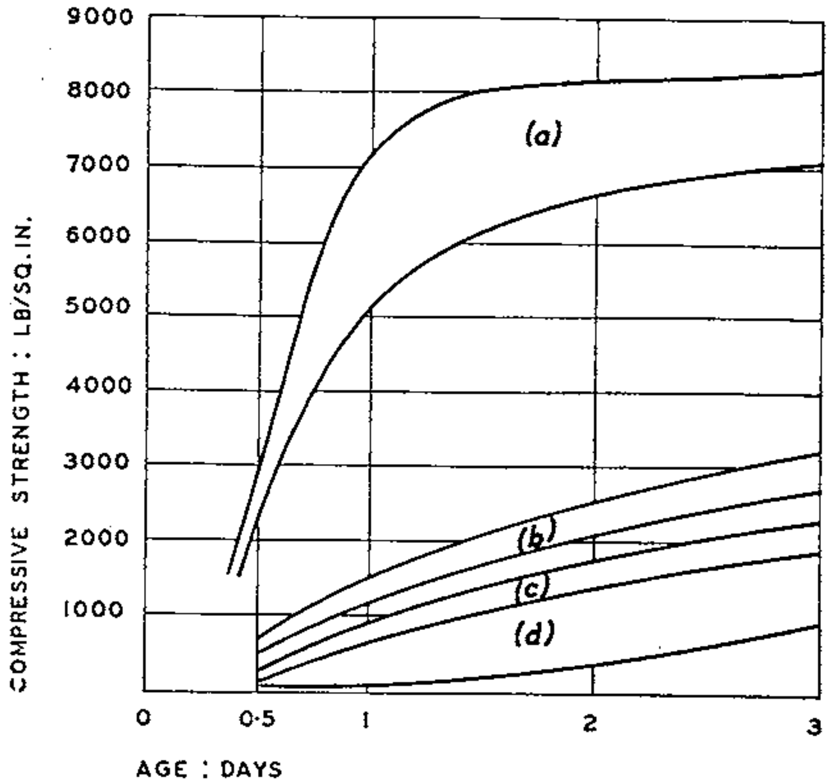

FIG. A *Compressive Strength Range at Early Ages*

Mix 1:2:4 concrete, water/cement ratio 0.6 by weight.
Temperature: 64°F (18°C).
Specimens: 6-inch diameter x 12-inch cylinders.
(a) High-alumina cement; (b) High-early-strength portland cement with calcium chloride; (c) High-early-strength portland cement; (d) Ordinary portland cement.

Accelerating Additives There are many concrete-hardening additives available under a large range of trade names, but in the final analysis they mostly come down to a certain percentage of calcium chloride to weight of cement. The graph in Fig. B shows how the strength of concrete is improved by the addition of calcium chloride, but it should be noted that over 2 per cent and less than ½ per cent can, under certain circumstances, actually retard the set. Two per cent will double the strength of the concrete at one day, and so cannot be said to be as effective as steam curing, but it is less costly to administer.

With calcium chloride, as with chlorides generally, e.g. common salt (sodium chloride), there is always a risk of corrosion of the reinforcement, and it is recommended that it should never be used in conjunction with high-tensile wire as used in prestressed concrete. This risk is particularly acute when the cement has a low tricalcium aluminate (C_3A) content. The $Ca\,Cl_2$ combines with the C_3A to form Friedels salt, and if the C_3A content is low, then there will be significant amounts of free calcium chloride present which could corrode the reinforcement.(*c*)

Furthermore, researchers advise that calcium chloride should never be used in

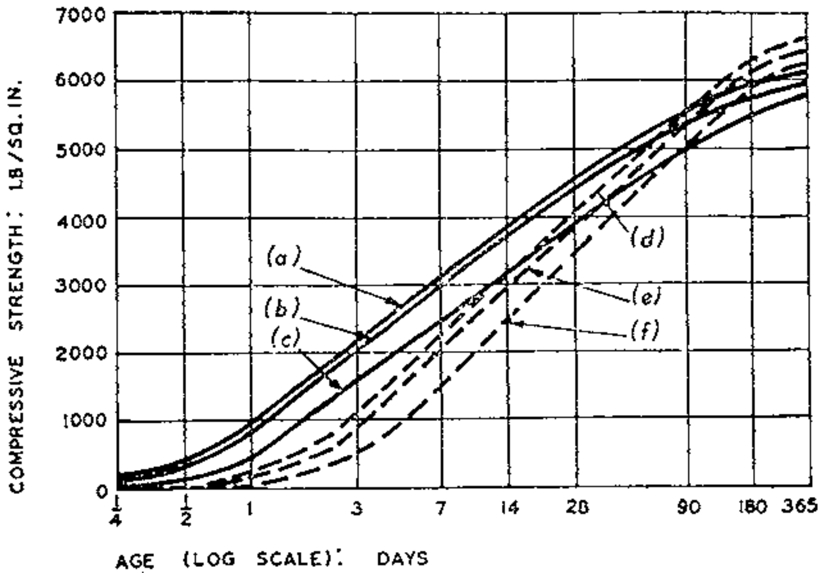

FIG. B *Effect of Calcium Chloride on Compressive Strength*

(a) Two per cent $CaCl_2$; (b) One per cent $CaCl_2$; (c) No $CaCl_2$; (d) Two per cent $CaCl_2$; (e) One per cent $CaCl_2$; (f) No $CaCl_2$.

Mix: 1 : 2½ : 4 concrete, water/cement ratio 0.53 by weight.

——— *Specimens made and cured at 70°F (21°C).*

- - - *Specimens made and cured at 40°F (4°C) for 37 days and cured at 70°F (21°C) thereafter.*

conjunction with steam curing, although there are some who care to accept the risks of corrosion and use both techniques together.(*c*) Calcium chloride will increase the amount of shrinkage from 10 per cent to as much as 70 per cent and will reduce the ability of the concrete to withstand sulphate attack.

Having considered all these points, one must add a word of warning. If using a proprietary brand of accelerator, always read the instructions carefully and decide upon the degree of risk which can be accepted. Prices for accelerators vary enormously, but there is no doubt that the cheapest is to buy flaked calcium chloride direct from ICI, and make up your own solution according to the directions you would receive from the supplier.(*d*)

DEVELOPMENT OF CONCRETE PRACTICE

In step with technology, methods of producing and placing concrete have developed at the same rate during the last twenty years. The progress which has been made has resulted from the contractors' demands for reducing cost and increasing output. Since the first motorway, the Preston Bypass, built in the late 1950s, plant techniques and organization have improved to such an extent that costs have risen only slightly and speed of construction has increased considerably. In the early days one would expect over two years for eight miles of motorway, now most contractors would expect to be out in under eighteen months. This point is made only to indicate how the needs of the military and civilian civil engineers are coming closer together. Mobile crushing and screening plants, improved truck mixers, and air-portable skips, are just some of the fields in which progress has been made.

Crushing plants are well known to the Corps, but these are becoming more efficient and more mobile. This reflects the change in the requirements of the industry, where now contractors on large contracts set up mobile plant in specially opened local quarries rather than haul stone for long distances. The economics of the use of truck mixers was studied by the author on one site. Although this was a building site of about 900 houses and shops, there was a fluctuating demand for concrete and it was more economic to use truck mixers bringing the concrete from a plant four miles away than to set up a batching and mixing plant on site. In spring and autumn, one truck carrying 6 cu yds does not cut up the ground as much as a ½ cu yd dumper making twelve visits, as well as the fact that handling 6 cu yds at a time is more economic for the concretors than spreading a ½ cu yd. These are just some of the factors which have led to the boom in ready mixed concrete, and the demand for truck mixers which combine reliability, with high cross-country performance and high speed on the road (as no doubt everyone has seen for themselves).

Photo 8 clearly shows that it is not only the Army which has to think in terms of air portability. Audax developed their air-portable lightweight skip to fulfil a definite requirement. The CEGB, in extending the national grid, had to construct pylons in very isolated areas. Helicopters were used not only to fly in the pylon superstructure, but also all the concrete used in the foundations. The skips carried 21 cu ft of concrete, and had the advantage that 90 per cent of its total laden weight was payload.

Precast concrete beams, in themselves, have been the subject of advances in practice as well as technology. The principle is to lay them side by side so as to form a complete bridge deck. The designer's aim is to reduce the "on site" work to a minimum by incorporating all details for fixing, services, etc, in the factory. The principle of making bridges in this way is not new at all, but the execution is greatly improved. Readers interested in this may care to look at the "Preflex" system introduced by Boulton and Paul.

The practice in the field of lightweight concrete has also improved, but the use of lightweight aggregates relies naturally upon a source of supply which will, in all probability, be denied to the military engineer working in underdeveloped countries. Provided a lower strength can be accepted, however, weight reductions can be achieved by air entrainment, and the Wimpey technique of no-fines concrete, both requiring only skill on the part of the engineering project team.

On the question of organization, the Royal Engineers are well equipped and trained to plan the most efficient use of manpower, materials, and plant. They are perfectly capable of planning an operation in such detail that it will be completed in the shortest possible time.

Let us consider what manpower is required to set up a site factory producing precast concrete. Assuming nothing too elaborate is being made, and steel formwork is not being used, then the key trade is joiner. It requires a joiner's skill to supervise and check mould assembly as well as make the moulds. Obviously steel fixers are needed and possibly a welder, but he is not essential. Plant fitters are required on maintenance, and plant operators as necessary, certainly crane operators will be needed. The labourer requirement can be local labour supervised by NCOs. A typical organization may be:

Carpenters and joiners	6	
Steel fixers	2	
Engine fitters	3	
Crane operators	2	
Plant operators	2	
Skilled labourers	8	(incl. storeman and laboratory assistant)
Semi-skilled labour	12	

Such an organization should be capable of producing 3,000 cu ft of concrete in five working days, given a reasonable degree of repetition.

Photo 7. Truck mixer M5P by Stothert and Pitt Limited. Delivers 5 cu yds of dense concrete, and can be petrol or diesel engined. The mixer can be put on a wide range of approved chassis.

Photo 8. In 1964 concrete foundations for electricity pylons were constructed by delivering ready-mixed concrete by road to selected points, and then air-lifting it in lightweight Audax 12 cu ft "Dual Flow" skips to the erection area.

The Applications for concrete in peace and war 8

CONCLUSION

What is the value of concrete, as a material, to the military engineer? This is the question this paper poses rather than answers.

An attempt has been made to show some of the advances in the concrete industry, and these advances show a continuing trend towards greater speed and efficiency. It would not be possible in one report to go into too much detail, but for those still interested the author recommends *Concrete Technology and Practice* by W. H. Taylor. This book is one of the few up-to-date textbooks which covers the whole field of concrete. To complete the report on a provocative note, it is suggested that the Corps should pay less attention to "meccano" and more to the use of real engineering materials.

ACKNOWLEDGEMENTS

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The King's Lynn Bridge Project

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INTRODUCTION

On 8 October 1969, the unsuspecting public of King's Lynn learned that the important Cut Bridge over the River Ouse would have to be closed by Christmas. Nine weeks later a massive 550 ft long Heavy Girder Bridge was open to traffic alongside it. This article describes the part played by 48th Field Squadron RE in the design and construction of the project, but there were many others involved in its planning and administration. There were those in the Ministries of Transport and Defence who conducted the negotiations, the Norfolk County Surveyor's Department who did the preparatory work, the Engineer Branch Southern Command and the Engineer Support Group, who did much of the preliminary planning, and others who supported the squadron before and during the operation. The final completion date of the operation was made possible by the speed at which these preliminary negotiations and planning had been conducted.

The Cut Bridge, a reinforced concrete bowstring arch bridge completed in 1928, is the gateway to West Norfolk. It carries traffic from as far away as Norwich, Lowestoft and Yarmouth to the Midlands and the North—a total of 20,000 vehicles a day, much of it heavy articulators. Its closure, made necessary by alarming cracks appearing throughout the structure, would be a major disaster for the area. The alternative was almost unthinkable—a twenty-eight mile diversion along narrow country lanes barely wide enough to take heavy lorries, and local firms estimated that this would cost them several million pounds a year. It was thus in an atmosphere of urgency that the Army was approached for help. Could they provide a temporary bridge to take such a traffic flow, and could it be left up for a year—the time needed to rebuild the existing bridge? Fortunately there were some existing piers at 120-ft intervals alongside the Cut Bridge which might prove useable. They were relics of a previous bridge, constructed in 1873, and long since taken out of use. Hurried consultations followed to see if the men and equipment could be made available, and to clear the project with the unions and contractors. On 7 November 48th Field Squadron RE of 38th Engineer Regiment was provisionally tasked with the job, and two days later a recce party consisting of the Squadron Commander and Squadron Sergeant-Major left for King's Lynn.

PLANNING THE PROJECT

Preliminary Reconnaissance

The recce party visited the site the following day and met senior officials of the Ministry of Transport and Norfolk County Council. Its aims were to decide whether the project was feasible and, if so, to gather sufficient information on which to design and plan it. The Ministry of Transport had specified that the temporary bridge should take two-way traffic to "Construction and Use" loading (75 per cent of Type HA loading). This would take all vehicles up to 32 tons laden weight, which is the maximum weight legally permissible for travel on the highway without special clearance. A preliminary design of the bridge was made from this data, and this was used to check the piers. By the end of the day the feasibility of the project had been confirmed, subject to a drilling test to find the depth at which the piers were founded. The recce party left for Ripon the same evening, after requesting the County Council to do some preparatory work on the piers and on the approaches.

Preparatory Work

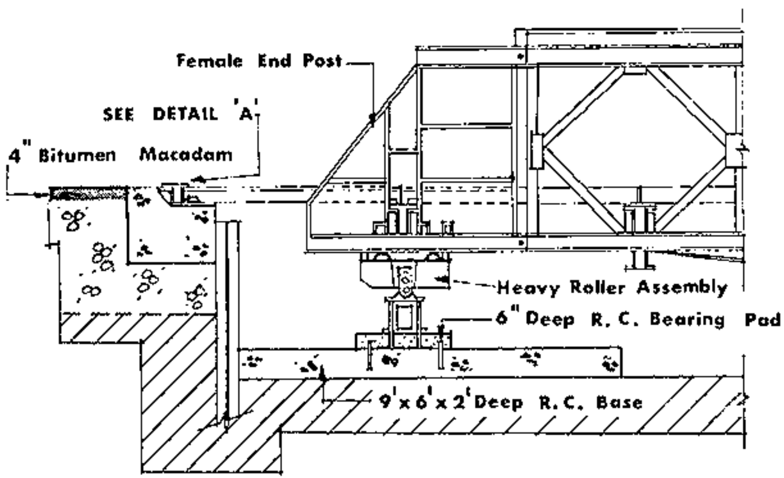
The site was a good one. There was a long, level and fairly firm construction site on the east bank, and a similar but shorter exit on the west bank. Both sites fell away steeply on the south side, and in the event needed building up with hardcore. The preparatory work involved the removal of signboards and lighting columns, and resiting an overhead HT cable. The brick abutments of the old bridge were still there, but were considered too weak for use in the new bridge. There were 70-ft approach spans between these abutments and the first set of piers at both ends of bridge, and three intermediate spans of 120 ft. The piers were pairs of cast-iron columns, 6 ft in diameter and infilled with mass concrete of rather dubious quality. The lateral distance between the columns was 26 ft 1 in, and this fitted in reasonably well with the distance of 23 ft 3 in between centres of trusses of a heavy girder bridge. Preparatory work on the piers involved strapping the columns and bracing laterally between them. The top 12 in of concrete in each column was broken out, to be replaced later by better-quality concrete. Ragbolts were sunk into the concrete below this to prevent the new concrete from sliding. Finally the County Council arranged for scaffolding platforms to be fixed 2 ft below the tops of the columns, in order to facilitate work during the construction of the bridge.

Design and Planning

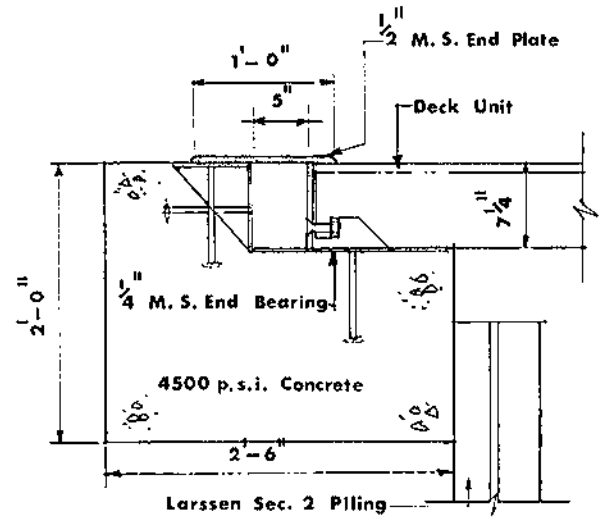
The bridge was designed as a broken-span bridge, with spans of 87 ft 6 in, 125 ft, 112 ft 6 in, 125 ft and 87 ft 6 in. The east-bank approach span was later increased to 100 ft because of erosion of the bank seat. The intermediate spans were to be level, and the approach spans were to slope down to the bank seats at a slope of 1 in 70. Preliminary investigations indicated DSR construction throughout equivalent to military Class 120W loading. This was checked against the bending and shear stresses imposed by Construction and Use loading, and proved adequate. Allowable stresses in the bridge had been reduced by 15 per cent on the advice of MEXE, to allow for fatigue failure. It was decided to anchor the bridge on the east bank, and to leave it on heavy roller assemblies over the piers and at the west bank. Reinforced-concrete bridge seats and a piled end dam were designed for the ends of the bridge, and special steel end bearings were designed in conjunction with the Central Engineer Workshops. The end bearing for the west bank incorporated a 5-in expansion joint. The completed design and drawings were checked by MEXE on 14 November, and approved at a meeting at the Ministry of Transport in London three days later. It was to be another three days before negotiations were finally concluded, and the project was officially approved.

Meanwhile the planning of the project went ahead. A preliminary works programme showed that a force of about 100 men would be required—two field troops of twenty-five to thirty men each, a support troop of twenty, and a small headquarters element. Accommodation had been provisionally arranged by Eastern District with Royal Air Force Marham, and the Squadron Quartermaster visited the station on 14 November to tie up the details. Seldom can any Army unit have been made to feel more welcome, nor have been looked after better. Plant requirements were calculated, and plant borrowed by the Regiment from all over England—four cranes from Wyke Regis and Long Marston (later reinforced by a fifth from Waterbeach), a CAT D6C tractor from Waterbeach, five 10-tonners from 27 Regiment RCT at Bulford, piling equipment from Long Marston, and an assortment of items from other squadrons in Ripon. The major planning commitment, however was, as usual, the stores. Stores lists were prepared, checked and rechecked, and programmed to arrive in the right order. A contract to collect them was quickly prepared and let to a King's Lynn firm of hauliers, Messrs Pointers Ltd. About a quarter of the stores were to be provided by 47th Command Engineer Park at East Harling, and the remainder from the Central Engineer Park at Long Marston. The squadron had been lent the services of the Stores Officer of 15th Support Squadron for the duration of the project, and visits by him to Pointers and to Long Marston

ANNEX 'A'



SECTIONAL ELEVATION



DETAIL 'A'

WEST BANKSEAT

on 14-15 November tied up most of the details. Close liaison in all phases of the operation was to contribute much to its success.

THE CONSTRUCTION PHASE

Advance Party

The advance party, consisting of a section and the recce element from one of the field troops, moved to King's Lynn on 22 November. Their mission—to do the initial setting out, and to place the four 2-ton cross-beams on top of the piers. These cross-beams, a special HGB pier part, had been modified at Long Marston by welding on bearing plates at 26 ft 1 in centres so that the load of the bridge came centrally on to the columns. A floating crane had previously been hired from Messrs Dredging and Construction Ltd for the purpose, and the four cross-beams were lifted into position during two high tides the following day. They were later aligned and levelled to the nearest $\frac{1}{4}$ in by jacking over the columns and inserting packing.

The Plan

The main party moved to King's Lynn on Monday, 24 November, exactly two weeks after the initial reconnaissance. The general plan was that two sections of No 1 Troop would be employed permanently on handling the stores in the marshalling area, and the third section of this troop would do all the piling. No 2 Troop would be employed on constructing the bank seats and building the bridge. The detailed works programme, which might prove useful for future projects, is shown at Annex B.

Stores Handling

The first five 40-ft articulators arrived in the marshalling area early the following morning. These vehicles proved ideal for the purpose. The trailers could carry several 10-tonners' worth of stores, and they could be unhitched in the marshalling area and off-loaded at will. The marshalling area was a large open space on Messrs Pointer's land some 600 yards from the bridge site, and a traffic circuit was quickly established around it. This was later to require many tons of hardcore and brick rubble to keep it open. On arrival in the marshalling area the stores were off-loaded and checked, and they were then laid out in the order in which they would be required for construction. The construction site at the bridge was too narrow to permit stores dumping there, and the stores were therefore ferried to the site on the five RCT 10-tonners. Since the bridge was to be constructed directly off these vehicles, it was essential that the stores were laid out in the marshalling area in exactly the order in which they were required for construction. Twenty fully laden articulators were required to bring in all the stores, and they had to operate to a tight schedule. Very close co-operation between the bridge site, the marshalling area, Messes Pointers Ltd and the Central Engineer Park at Long Marston was necessary to achieve this. In the event construction was only once held up for lack of stores, and this was due to an articulator being involved in an accident—happily without serious injury to the driver.

Preparing for Construction

In the meantime No 2 Troop began work on the banks and piers prior to the bridge construction proper. Atrocious weather prevailed from the start, and was to continue throughout the project—wind, snow, hail, rain and freezing temperatures. It is doubtful if this had much effect on progress, but it certainly aroused the sympathy of the local townspeople and the Press. The main job on the banks was excavating and concreting the RC slab bridge seats. This was quite straightforward, but it did provide some useful lessons in shuttering joinery and in concreting generally. The top 12 in of the columns were concreted at the same time, special

ANNEX 'B'

KINGS LYNN BRIDGE
WORKS PROGRAMME

WORK SCHEDULED:
WORK COMPLETED:

SER.		NOVEMBER.							DECEMBER.												
		24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	
1	SETTING OUT.	SDP																			ADVANCE PARTY ARRIVES 23/11.
2	PLACE CROSSBEAMS ON PIERS.	4																			
3	ALIGN PIER ROLLER ASSEMBLIES.		4																		
4	CONCRETE PIER CAPS 1 & 2.			4	CURE																
5	CONCRETE PIER CAPS 3 & 4.				4		CURE														
6	SITE CLEARANCE & EXCAVATION EAST BANK.			5																	MAIN PARTY ARRIVES 24/11.
7	SITE CLEARANCE & EXCAVATION WEST BANK.			6																	
8	CONCRETE BRIDGE SEATS.				5&6	CURE															
9	SET UP & ALIGN ROLLERS.					4 5 6															
10	CONSTRUCT LAUNCH NOSE.						4 5 6														
11	CONSTRUCT & LAUNCH BRIDGE.								4 5 & 6												
12	BREAK SPAN & JACK DOWN.												4 5								
13	WIRE NETTING.												6								
14	COMPLETE DECKING DOWN.													4 5							
15	BRIDGE SIGNS, CLEAR SITE ETC.															4 5 & 6					2 TP. RETURNING 8/12.
16	PREPARE MARSHALLING AREA		1 2																		
17	CHECK & LAY OUT STORES.					1 & 2															
18	FORWARD STORES TO SITE.								1 & 2												
19	RETURN STORES TO ESD.													1 & 2							1 & 2 SECS. RETURN 8/12.
20	CONSTRUCT PILING FRAME.			3																	
21	PILE END DAM WEST BANK.					3															2 LIFTS.
22	CONCRETE END DAM WEST BANK.								3	CURE											
23	FIX EXPANSION BEARING WEST BANK.										3										
24	MOVE PILING & EQPT.											3									
25	PILE END DAM EAST BANK.														3						
26	CONCRETE END DAM EAST BANK.																	3	CURE		2 LIFTS.
27	EXCAVATE AND CONCRETE ANCHORAGE																		3		
28	CLEAR SITE & RETURN.																			3	REAR PARTY RETURNS 12/12.

holding-down bolts attached to the cross-beams being cast in *in situ*. The heavy roller assemblies were then built up on the cross-beams, and the construction rollers were aligned and levelled on the east bank.

Piling was started on the far bank as soon as the bridge seats had been concreted. A Delmag D5 piling hammer had been obtained from Long Marston for the purpose, but its considerable length and weight made handling difficult. A smaller McKiernan Terry BSP5 air-driven hammer was therefore borrowed locally, and it proved most satisfactory. Some seventy Larssen Section 2 piles were driven, and provided some very useful experience for the section involved.

Bridge Construction

Construction of the bridge proper began at midday on Friday, 28 November, and took exactly five working days. The record time for completion of a bay was about nineteen minutes, but span junction bays took much longer and the average time per bay was nearer forty minutes. A bridging crane was used for booming forward for the first 150 ft of bridge, but the site had by then become very slippery from mud and ice and the crane tended to jack-knife. It was therefore replaced by a CAT D6C tractor with the blade removed, for the remainder of the launch. This had the additional advantage that the yoke could be raised or lowered to keep the push-bar horizontal. Provision had been made to winch the bridge across from the far bank once the half-way point had been reached, but in practice this proved unnecessary. The CAT D6C had no difficulty in moving the bridge even at its full weight of 360 tons. The launch was controlled with the aid of A41 radio sets at the roller positions, on the bridge and on the tractor, and a fine degree of control was achieved.

The spans were broken by removing the headless panel pins as the strain came off them in the final 30–40 ft of launch. Some juggling of the bridge was necessary to find the correct point for each span junction, but the operation proved less difficult than expected and was completed in two hours. It is important to ensure that the pins are wired to the bridge before knocking them out. When all the span junctions had been broken the launch was completed and the launching nose removed. The approach spans were then jacked down in the normal way.

Completing the Job

Much work remained to be done once the bridge was over. On the bridge itself this included completing the decking down, fixing chain-link fencing on the inside of the inner trusses, and filling the gaps between the kerbs and the trusses with timber—the two latter being safety measures. The deck units are eventually to be treated with epoxy resin and grit to increase skid resistance, and plastic seatings are to be inserted beneath them to reduce noise. On the west bank the expansion bearings had to be accurately levelled in position and concreted in. On the east bank the end dam had still to be piled, and the end bearings levelled and concreted in. The anchorage at this end of the bridge, capable of resisting a braking and acceleration load of 50 tons, had also to be constructed. Two 25 ft long sloping trenches were excavated back from the inner end panels of the bridge to a depth of 6 ft, and a lateral trench was excavated joining them at the lower ends. Two reinforcing chords in echelon were then taken back in the trenches from the end panels, and these were yoked to a 30-ft Larssen Section 2 pile in the lateral trench. Finally the latter was concreted to a depth of 4 ft. Two handsome bridge signs, constructed in the Central Engineer Workshops, were concreted in position to complete the squadron's work on the bridge.

The County Council were in the meantime putting in the approach roads with phenomenal rapidity. These had to be constructed to full highway standards, and were landscaped accordingly. The work was completed and the road open to traffic within three days of the squadron leaving the site. Other work included fixing speed-limit signs—MEXE had recommended a speed limit of 10 mph—and installing 25-ft lighting standards at the span junctions. A 5 ft 6 in wide pedestrian way will later be cantilevered off one side of the bridge.

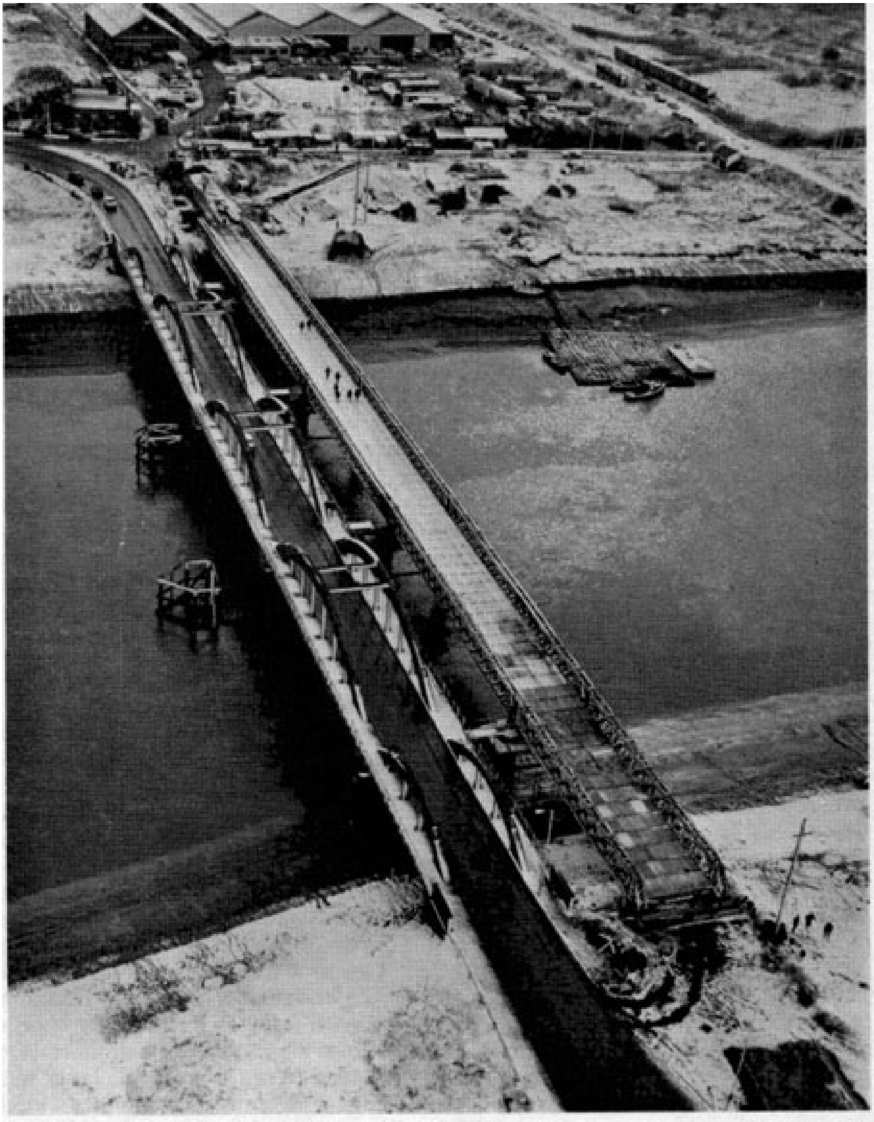


Photo 1. An aerial view of the bridge just prior to completion, with the Cut Bridge alongside it.

Photo courtesy of Eastern Counties Newspapers.

The King's Lynn Bridge project 1

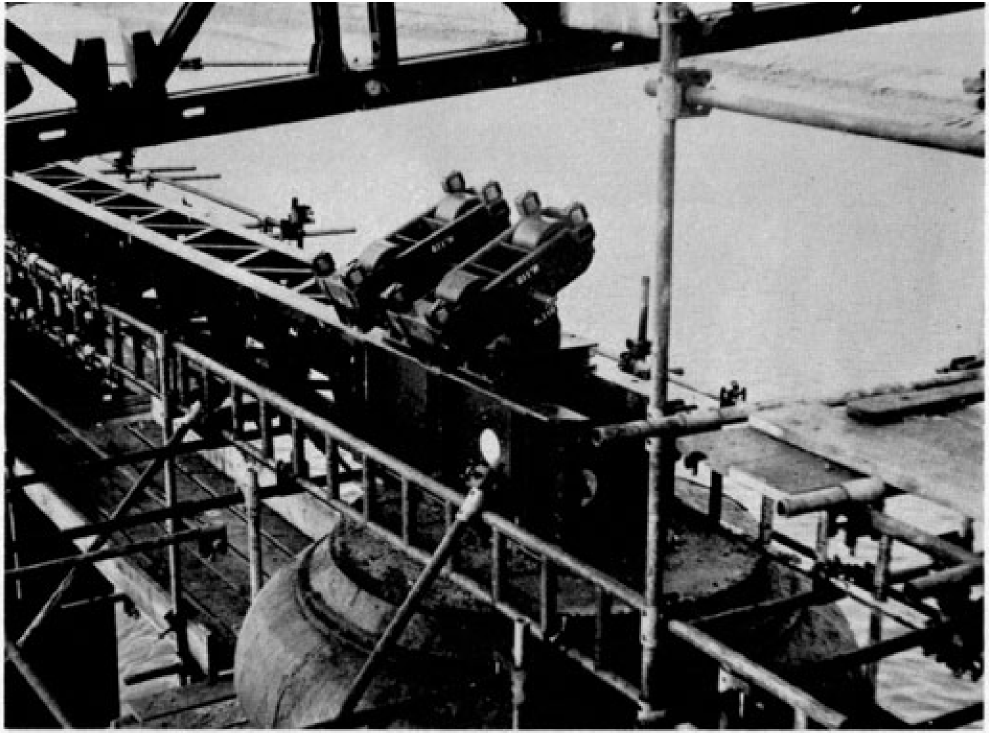


Photo 2. The launching nose just about to come down on to a set of pier rollers. The launch was controlled by NCOs with manpack radios at the roller positions.

The King's Lynn Bridge project 2

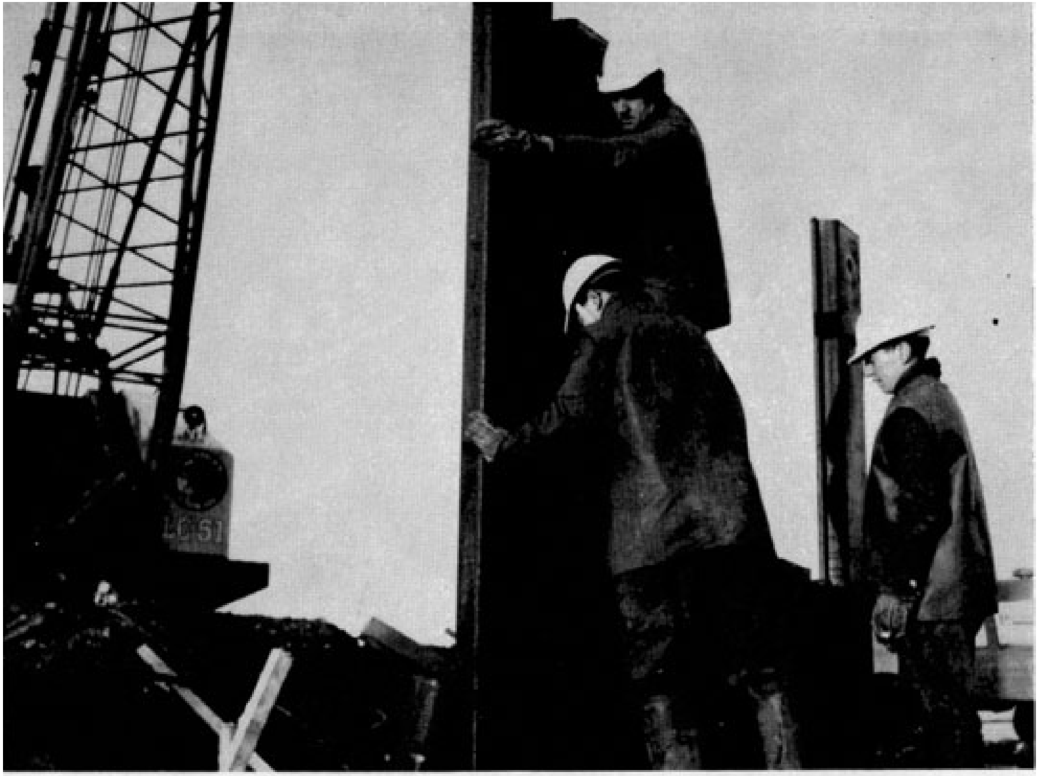


Photo 3. Piling the end dam. A timber piling frame was used for the first eight piles at each end.

The King's Lynn Bridge project 3

Photo 4. The bridge during launching. The scaffolding off the Cut Bridge enable concrete and roller assembles to be carried on to the piers.

The King's Lynn Bridge project 4

CONCLUSION

The project provided training for war of an order which can seldom be found in peacetime. It was a big bridge—easily the biggest Heavy Girder Bridge ever constructed—and it had to be built in a hurry and to a tight schedule. It was a most worthwhile project, and it attracted much goodwill for the Corps—evinced both in the generous presents which were showered on the squadron, and in the immense publicity it received in the Press, television and radio. Many people and organizations contributed to its success, not least those at MEXE who had developed such excellent bridging equipment in the first place. One can only hope that this success will result in the Corps being given more jobs of a similar nature in the future.

Structural Design by Computer

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INTRODUCTION

The article starts by briefly describing the system of structural design and how a computer can be used in the system. This is then illustrated by a number of examples of how computers are being used. The examples include: Details of a relatively simple design program; use of a desk-top computer and standard drawings for reinforced concrete design; another approach to reinforced concrete design; computer graphics; bridge design; a design study and one of the main future developments in structural programs. This first part of the article is largely based on a course "Computers in Design" at the University of Technology, Loughborough, Department of Civil Engineering. The article is completed with general comments on the problems facing a structural designer who wants to use a computer and a conclusion.

This article describes the use of computers for structural design, but at the same time it reinforces some of the points made in an earlier article, (*a*) which discussed the use of computers generally, and acts as a postscript to it.

Some consultants and contractors have computers, some use remote terminals, others have desk-top computers and others use computer bureaux. Most of the use is for data processing and there is some use for analysis of structures and other highly repetitive standardized computations. The use of computers for structural design is much less, but is steadily increasing. Many organizations do not use computers. Why not? Should they take the plunge?

Besides questioning the economics, engineers will sometimes raise two main objections to the use of computers in design: Design requires engineering judgement that cannot be exercised by a computer and that structural design is not generally mass production of standard items. This article should dispel both these objections by showing how computers fit into the design system.

THE DESIGN SYSTEM AND THE COMPUTER

In order to produce a structure design must provide drawings, bills of quantities and costs. The design system can conveniently be divided into five stages. These stages are listed below with brief comment on the use of computers.

1. Definition of the structure including the requirement, loading, materials and basic geometry. This is entirely engineering judgement and can only be carried out by an engineer and not by a computer.

2. Analysis of the structure for the various conditions of loading: an ideal computer task.

3. Design of members of the structure. This can be another ideal task for the computer, but there are problems. The design rules, or code of practice, must include statements of the basis of design that can be used in the computer program. If a statement does not give a smooth curve, the first use of a computer may be to produce design tables for use by the computer or manually. Design rules usually allow the choice of alternatives, set limits and give warnings. All these will complicate the computer program, but the computer is the best way of quickly comparing alternatives.

4. Completion of the detailed design. This includes standardization, detailing the junction of members and dealing with "non-standard" items. Some of this work will be suitable for a computer, but much will require engineering judgement.

5. Production of drawings, bills of quantities and costs. This is another ideal task for the computer. There is a considerable range in the method and cost of producing drawings by computer. Some drawings, such as general arrangements, will probably still be produced manually.

COMPUTERS IN USE

Structural analysis Most computers have compilers for mathematically or scientifically orientated high-level languages and can run a variety of structural analysis programs. These programs are extremely useful, but most of them suffer from the disadvantage of requiring a unique form of input data and producing output that cannot be used directly as further input data and may require further translation or editing before it can be used in a drawing office for detailing. The user must, of course, agree with the structural basis of the program and any assumptions. It may not be possible to follow the program and it may be necessary to prove it against already accepted analysis.

Loughborough University of Technology Computer Design Service No. 1 This program designs reinforced concrete symmetrical column bases subject to a biaxial force and moment system. The user must provide the following input on a standard form: References; number of bases; loading with up to four alternatives; type of reinforcement to be used; strength of concrete; allowable ground bearing pressure; depth of overburden and whether the base will be backfilled; column dimensions; minimum base thickness and any base limits. The present program is limited to bases that bear over their whole area. A mass concrete base is produced if the 45 degree load dispersion lines from the column faces fall outside the minimum required base. The proportions of the base are chosen to give minimum total cost using unit rates for excavation, shuttering, reinforcement and concrete. Calculations are carried out in accordance with the British Standard Code of Practice for Reinforced Concrete, CP114. The program produces a thorough and economic design. The user receives the following documents: Calculation sheets giving the design assumptions and equations in algebraic form; the appropriate translucent drawing, chosen from seven standard drawings, which requires a few minutes' clerical work for its completion and the computer line-printer output. The computer output consists of: Detailed calculations; bar bending schedule; instructions for completing the drawing and a list of material quantities. The cost of this postal design service is 35*s* per design, which can be compared with a drawing office cost of approximately £5. The more thorough computer design should save approximately 10 per cent on the cost of a manually designed base.

GNK Reinforcements Limited. GNK have produced an impressive suite of programs for the design of reinforced-concrete structures using the Olivetti Programma 101 desk-top computer. (*b*) The scope of this relatively simple and cheap machine with these programs is remarkable. The use of the desk-top computer was originally an interim measure, but it has been so successful that the intended step up to a larger machine is not being made at present. The Programma 101 has ten memories and completes forty-eight program steps from one magnetic card. A program can run on through a number of magnetic cards providing no more than ten bits of data need to be transferred each time. The machine has a tally roll print out. The programs include the following: A set of nine connected programs for beam and frame analysis; nine programs to design slabs spanning in two directions; five programs to design slabs spanning in one direction and beams; two programs to design column bases and two to design retaining walls. The longest program uses six magnetic cards and several programs use four cards. There is obviously a limit to the amount of data and calculation that can be handled economically by this system. It would be uneconomic to use the moment distribution program for a two-dimensional frame of more than 4 × 4 bays. An important feature of the system is the adequate documentation. For the user there is a description of what the program does, followed by a detailed explanation of principles, assumptions and equations used, the input required, the output obtained and operating instructions. The printed tally-roll output is stuck on a preprinted answer sheet that identifies the input and results and the included checks. The answer sheet with the program explanation is suitable for presentation to checking authorities. It is estimated that these programs save from five minutes to two hours per calculation. The cost of the Programma 101 is just under £2,000 and GKN are offering the suite of programs for approximately £500.

GKN are also using a system of standard drawings with a tape-driven typewriter to complete the details. The tape is produced at the design stage when the most suitable standard drawings is also selected. For example, there are ten alternative drawings for retaining walls with reinforcement already marked. The drawings are obviously not to scale and at least one original general arrangement to scale will be required and probably a number of specials.

Computer Consortium The Computer Consortium was formed by three consultants and two reinforcement suppliers who also have design offices. An integrated set of programs has been produced for designing reinforced-concrete buildings. The system is primarily designed to simplify and speed up tasks carried out by detailing draughtsmen. There are frame-analysis programs, design and detailing programs and bar-scheduling programs. These programs are used on a computer with a 40K direct-access store: approximately 75 per cent of the storage is used to generate drawings.

The design and detailing programs cover: Columns; beams, slabs; portal frames and walls. The input is: Permissible stresses; cover; concrete dimensions for each member; grid reference; preferred reinforcement type and the loading or SF and BM envelopes. The output is: Error checks; data verification; SF and BM envelopes; bar schedule; steel-fixing drawing; design calculations for all critical sections by ultimate load method and steel-weight summaries for bills of quantities. Concrete dimensions are normally input and warning is given of overstressing or over-reinforcement, but the program can also select concrete dimension. The programs provide efficient design complying with current codes of practice and standards. Where the code does not give firm guidance, or where the system requires simplifying detail, members of the Consortium have agreed a definite approach. Bent-up bars are not generally used, reinforcement is carefully selected by the program and overweight steel may be used if it is cheaper to fix. Beam column junctions are simplified by using starter bars. Drawings are produced cheaply by using a line printer. Cross-sections on drawings are not to scale the nearest standard section being chosen. The drawings are of a lower quality than those accepted in the past, but they provide the necessary information.

The most immediate benefits were obtained from the bar-scheduling programs, which cover the following sequence: Complete calculation of reinforcement details to produce bar schedules for each drawing and job and summaries for bills of quantities; a sorted bar schedule for the reinforcement supplier; a reinforcement cutting schedule which minimizes the steel wastage from stock lengths and finally a bar-labelling program.

Computer Graphics One of the problems in using a computer is the man-machine interface. High-level languages are an improvement, but still require precise use of the language. The Marconi Company have developed the use of a cathode-ray tube display as the interface device using interactive graphics in computer-aided design. Data can be fed in directly by drawing on the CRT tube using a light pen or a tracker ball. Data is also inserted through a normal alphanumeric keyboard. Some control is possible by pointing at appropriate instructions on the CRT display which are called "light buttons". The processor must obviously have on line real time capability. Results can be recorded by a copy of the CRT display or by conventional computer output. The Marconi system uses the "Myriad Ring Structure Program", which is a sophisticated form of data storage developed specifically for visual displays. The data structure contains more information than is shown on the screen in order to cope with expansion and maneouvre. There are two main facilities for the user; frequently used items can be called up from a catalogue and any item can be scaled in a range unity to eight million in steps of powers of two.

Most of the use to date has been in fields other than structural design. However, in order to show the potential Marconi have produced a relatively simple program to design single storey steel portal frame buildings with cladding. The input includes: Dimensions; loading and special components like doors and type of cladding. The computer analyses the structure, selects members and draws. There are 1,000 items in the catalogue. Details are produced by scaling up. A design is completed in thirty minutes at an approximate cost of £15, but it will take a pen plotter a further forty hours/£40 to produce working drawings.

SPAN SPAN is a series of Fortran programs developed by Freeman, Fox and Partners for bridge and highways design. It consists of a system and set of subsystems. The system is a permanent program dealing with input, output, data storage and the handling of subsystems. The subsystems solve particular engineering problems. At the moment there are four subsystems: BRIDGE, COMBIAX for bending in two planes; DECK and FREEWAY. The hardware for SPAN is being extended from a 32K-core store and two discs to a 65K-core store and discs with multi-processing and remote terminal facilities.

BRIDGE analyses simply supported or continuous bridges constructed of reinforced concrete, steel excluding trusses, composite steel and concrete or prestressed concrete. It is not strictly a design program, but by the use of nominated design variables an engineer can quickly arrive at an economic design. The engineer first sketches an elevation and cross-section of his outline design and chooses his variable dimensions. The elevation is arbitrarily divided into segments for design. Data defining the bridge shape is entered in arrays. Support conditions, erection conditions, loading extra to the dead load calculated by the system, standard live loading, temperature range, settlement and design variables are also entered. The engineer can store or select any required output from the program and need not be inundated by a mass of output. Output is by line printer or incremental plotter. The following can be output: The bridge elevation which is a useful check; input data; influence lines; envelopes due to any loading or combination of loadings and section properties.

BRIDGE works as a plane-frame program dealing with the longitudinal plane of the bridge. A finite element subsystem DECK is under development for analysis of slab decks: it covers transverse distribution of loading, skew bridges and probably torsion of box members. BRIDGE assumes an elastic structure: analysis is based on strain energy of bending and direct loading using the stiffness method. To calculate stresses in reinforced-concrete sections subject to cracking the moments and axial thrusts output from BRIDGE are input to COMBIAX.

The ultimate aim of SPAN is the automatic design of motorway bridges with the dimensions coming from the motorway-alignment program. SPAN could possibly incorporate general structures, but this has not been required so far. SPAN is a forerunner of GENESYS, which is described further on, and it will be possible to use the SPAN subsystems in GENESYS without major changes.

Bridge analysis and design programs are also being sponsored by the Ministry of

Transport and will be made available to engineers in the UK for the design of bridges at home and overseas. The first program, "Finite Element Package for Analysis of Reinforced Concrete Slab Bridge Decks", became available in October 1969.

Design Study A set of Fortran programs to study the influence of design specification on the shape and dimensions of reinforced-concrete structures supported on columns is being developed at the Queen's University of Belfast.(*c*) The program designs simple rectangular reinforced-concrete structures such as bridges and building frames. Work has been started on the specification of materials and geometric configuration to attain minimum costs. A design-control program links the following interdependent programs: Structural configuration; materials specification; costing; analysis and stress control. One level of the structure is re-designed and the complete structure is analysed during each cycle. The dimensions of slab elements, beams and columns are adjusted by as many iterative design cycles as are required, usually until the changes become insignificant. These design programs illustrate what can be done beyond the reinforced concrete detailing programs already described. Design programs generally do not use sophisticated optimization, as it is expensive in machine time and cost information is probably not sufficiently accurate.

GENESYS General Engineering Systems (GENESYS) is sponsored by MPBW and is being developed and propagated by the GENESYS Centre opened at Loughborough University in 1969. GENESYS is a master program and a set of application programs. The initial set of application programs will be for the design of reinforced-concrete and steel building frames, bridges and roads. The first programs should be available in 1971 and should be an advance on any existing programs.

GENESYS is machine independent, only requiring a Fortran compiler. The minimum hardware requirement is a 32K-core store plus three magnetic-tape backing stores. The GENESYS control system gives a virtual store, as it organizes overspill and return of data and programs from the core store to the backing store.

The aims of GENESYS are as follows. Firstly to produce a link system so that an engineer can link a variety of small programs, supply the input data and order the specific output he requires, cutting out "visual clutter". Secondly the standardization of input data, generally in arrays. Thirdly to simplify the writing of application programs as the master program organizes input and output and core storage. Fourthly to enable the engineer to modify data or important design parameters simply.

COMMENTS

General A few examples of design by computer have been given. These generally show that the computer is not replacing the engineer's judgement, but programs can be used for repetitive calculation. In the reinforced-concrete detailing programs the engineer provides the geometric layout and probably material specification. He can further reduce the computer running time by dimensioning the concrete members which may be essential for some programs. Additionally in most structures there will be non-standard parts or details that require the engineer's attention. The use of computers by consultant engineers has increased considerably over the last few years and there are many other programs, some of them similar to the ones described, developed for particular uses and problems. Most of the examples quoted are for reinforced-concrete design, but for steelwork design it is easier to choose a section, from a list of available sections, than it is to proportion a reinforced-concrete member, and it should not be difficult to produce intersections with compatible members and standardized joints.

Software Software is one of the newest industries and the major growth area in the fast-developing computer world. It is expensive to buy a computer without software. Software is expensive to produce, but none the less it does not seem easy to sell structural design programs. Someone else's program may not be exactly what is required and it may well be extremely difficult to alter. Some consultants have covered the cost of a program on large or complex projects. Most software will have to be proven against conventional manually designed, and probably existing, structures. Remote terminals are currently selling well in this country without software: a purchaser in the United States would select a terminal on the software available. GENESYS is a major advance for structural design programs providing a control and standards. It will be necessary to spend a considerable amount of money on centralized software development. It is hoped that some software will become accepted as much as standards and codes of practice are today.

Hardware The main trend is to larger central processors. Therefore for structural design the computers used will generally be in a bureau or on a time-sharing basis using remote terminals. Also there will be no problem in accommodating large structural programs like GENESYS. The Myriad visual-display system requires even greater storage capacity and a second computer may be necessary to carry out calculations. The core storage of installations in use ranges from 32K to 150K. Apart from considerations of cost and the need for repetitive production there is design work outside the structural field that is so complicated that it can only be done by computer, and graphical display is the best form of communication. Desk-top computers will continue to be useful and development is expected to produce brief-case machines in the late 1970s and pocket-size ones in the mid-1980s.

In the Ministry of Defence the Holder Report has recommended that design and other tasks should be carried out using a few very large central processors and a network of data links.(*d*)

One should note that IBM have approximately a 75 per cent share of the world computer market and for Britain, which is the only country besides the United States to have a viable computer industry, ICL has a three per cent share.

Liveware The computer can be used for repetitive analysis and design and then there is more opportunity for the engineer to use his judgement and concentrate on real design. The designer does not delegate responsibility, but is relieved of tedious detailing. The need for the detail calculating engineer, who is trained and tested as a calculator, will be considerably reduced. By trying several alternatives on a computer an engineer increases his design experience. There is a shortage of computer liveware, but this may be relieved by the concentration of computing power into fewer large centres. Designers should only be required to direct the production of software. The increasing number of young engineers who have experienced the potential of computers in their training will tend to go where such facilities are available.

Communication It is true that the use of computers will not really become widespread until communication between the user and the computer is improved. This is not such a problem in design, as mathematically orientated engineers do not find it difficult to use a high-level language such as Fortran. The use of interactive graphics is attractive and may be essential for some problems, but not for the general run of structural design. Good documentation of programs is essential. The GENESYS Centre will provide user handbooks and run courses to show the best use of the system.

There is a wide range of drawing production available. Incremental plotters work on line or more economically on computer output. An electronic plotter completes an A4 drawing in approximately three seconds and costs £100,000. A mechanical plotter is cheaper and completes an A4 drawing in approximately five minutes. One consultant has found the operating cost of a mechanical plotter equivalent to three draughtsmen and the output at 50 per cent utilization equivalent to eighteen draughtsmen. This standard of drawing is necessary for panoramic views and non-rectangular structures. Satisfactory detail drawings are produced using the normal line printer and even cheaper drawings are provided by filling in data on standard pre-printed drawings. Standard drawings can be completed by a tape-driven typewriter costing £2,000. Standard drawings will improve communication. An eventual aim is to have a national set of standard drawings which should cover at least 50 per cent of the drawings required for a normal reinforced-concrete structure. Apart from design it may also be possible to transmit the data to complete the drawings by computer.

The physical presence of a computer is preferable to sending work off to a bureau, and for this reason remote terminals should flourish. A desk-top computer at the engineer's elbow is extremely useful and provides good training as well as providing computer-aided design. A tally-roll output is preferable to a copy of the normal desk-top computer visual display.

Advantages The advantages are worth repeating. There is no chance of human error in computer calculation once a program has been proven. The computer never tires and calculations and detailing can be repeated every time they are required. This leads to greater precision and efficiency in design and economy in construction. There is an improvement in communication from the designer. The engineer can increase his output providing he does not spend too much time increasing efficiency or his experience, as it is effortless to do so. There must be savings. An extreme example is the reinforced-concrete design program that enabled one senior engineer to complete thirty man weeks' work in one day.

Disadvantages The main disadvantage is the capital investment required in hardware and software. There is also the slight possibility of a design program being used without engineering judgement and intervention which could result in an impossible or unsafe structure.

CONCLUSION

The problems in using computers for design are similar to the three main problems established by MPBW investigating the application of computers in the construction industry. First the lack of knowledge of computer technology. Secondly the dispersal and duplication of programming effort and thirdly the small amount of long-term development work in progress. However, structural design training is becoming more computer orientated and one hopes that GENESYS will help to overcome the other two problems.

What should the structural designer without a computer do? A desk-top computer does not require a great capital outlay and it may be used as a calculator at first and then programs can be slowly evolved. No time should be lost in using existing software, probably through a bureau. Later, based on the experience gained, when remote terminals offer suitable software one should be installed. It would seem sensible to keep in close touch with the progress of GENESYS and if one does have to produce special programs they should be geared to GENESYS and become available for general use. Of course, if it is possible to make a major capital investment against a particular project, or for progress, this course can be accelerated. If the software does not already exist, special staff may be employed, but the acquisition of an 8K or 16K core store computer would be against the general hardware development trend. The alternative is to be left behind in a particularly fast-moving world and to become a victim of paralysis by analysis.

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Luscombe Field — Nui Dat

MAJOR W. W. LENNON, ROYAL AUSTRALIAN ENGINEERS

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INTRODUCTION

SINCE December 1966 there have been more than 3,000 Royal Australian Air Force sorties of Caribou aircraft alone, in and out of Luscombe Field, the airhead of the First Australian Task Force (1 ATF) in Phuoc Tuy province, South Vietnam. In addition to these, there have been innumerable light aircraft sorties by 161 (Independent) Reconnaissance Flight and by United States Air Force (U.S.AF) forward air controller (FAC) aircraft. C130 and C123 aircraft of United States Air Force have supplemented the regular Caribou courier service in moving men and material to and from 1 ATF. Most task-force soldiers have landed and taken off Luscombe Field at least once in their tour of duty, on joining or leaving their units or going on Rest and Recreation leave. Many have no doubt wondered why the airfield was built with an embankment on the northern side; and why the runway has so many appreciable hills and valleys along its length; and why it was located across Route 2; and why it was called Luscombe Field.

The purpose of this paper is to chronicle the events relating to the construction, naming, opening, and subsequent developing of Luscombe Field. Some of the factors which were considered in locating and orienting the airfield are presented to give some explanation of the peculiarities and deficiencies which are apparent today.

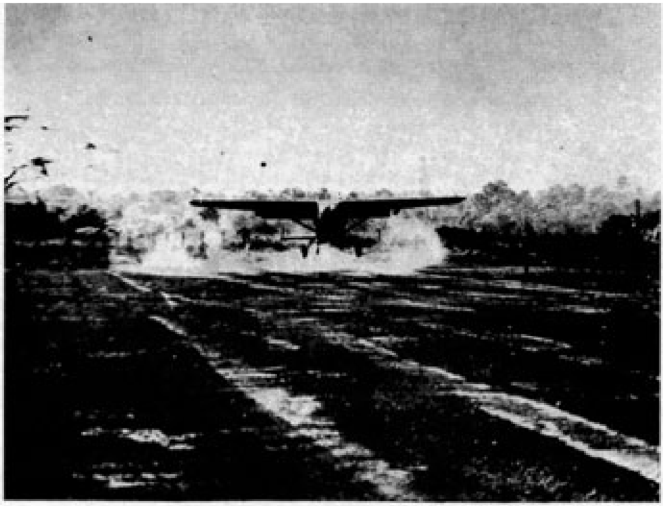
BACKGROUND

1 ATF moved into the Nui Dat area in early June 1966, and units were deployed so that a compromise was struck between immediate and future requirements. On the one hand was a need for a fairly compact defensive layout around the Nui Dat feature; on the other was the requirement for early development of domestic roads, and provision of adequate empty spaces for eventual construction of essential buildings and installations. Not the least important of these installations was an airfield. With the wet monsoon imminent, top priority for engineer base development effort was directed to construction of scale "A" accommodation and access service roads to units, in the hope that units would not become mud-bound in their essential domestic activities. To further assit with this aim, re-supply for the first few days in the area was by means of 2½-ton trucks along Route 2 to a hastily built transhipment area adjacent to Route 2, where cargo was transferred to ¾-ton and ¼-ton vehicles. These latter vehicles were used to move stores to unit areas, avoiding movement on proposed road alignments, to minimize development of quagmires.

During this early period, it was necessary for 161 (Independent) Reconnaissance Flight, a Task Force unit, to remain at Vung Tau with the First Australian Logistic Support Group (1 ALSG), since the fixed-wing light aircraft had to use the Vung Tau air field.

After graduating from the Royal Military College in 1956 Major Lennon attended the University of Queensland for a degree of Bachelor of Mechanical Engineering. Service with 17 Construction Squadron followed until 1962 when he was attached to the Snowy Mountains Hydro-Electric Authority. Posted to 7 Field Squadron in 1963 he became, in 1964, an Interchange Officer with the 25th US Infantry Division (Hawaii). In 1965 he was OC of 20 Field Park Squadron which was redesignated 20 Engineer Support Squadron.

As OC of 1 Field Squadron he served with 1 ATF in Vietnam in 1966 after which he returned to 17 Construction Squadron as OC. In May 1967 he was appointed SORE 2 in the office of E in C, AHQ Canberra, a position he occupied until August this year when he left to attend the Staff College, Camberley.



A Cessna of 161 (Independent) Reconnaissance Flight making the first landing on Luscombe Field on 31 October 1966.

EXTRACT FROM MACV AIRFIELD CRITERIA FOR TACTICAL C130 AIRFIELD

Runways:

Length	2,500 ft
Width	80 ft
Gradients	
Longitudinal	0–3%
Changes	0–1·5% in 100 ft
Transverse	0–2%
CBR	10+
Shoulders	10 ft
Clear Areas	
Width	35 ft
Grades	0–5%
Overruns	
Length	300 ft
Width	60 ft
Lateral Safety Zones	
Slope	7 : 1
Width	75 ft
Runway Clear Zones	
Length	500 ft
Width	150 ft, flares to 500 ft at 500 ft
Grade, maximum	5%
Runway Approach Zones	
Length	6 miles
Width	500 ft, flares to 2,500 ft at 2 miles
Slope	35 : 1

Luscombe field-Nui Dat

Taxiways:

Length	Variable
Width	
Straightway	30 ft
Turn radii	70 ft
Gradients	
Longitudinal	0–5%
Transverse	0–3%
Clearance from runway	245 ft
Clear Area	
Width	65 ft
Grade, maximum	5%

Aircraft Parking Areas:

Dimension	Variable*
Clear Area	
Width	65 ft
Grade, maximum	5%

The staff, assisted by engineers, prepared an initial master plan, making provision for a Caribou standard airfield and a large landing area for helicopters, in addition to other facilities. Sites for the airfield and main helipad were selected by 1 Field Squardon (RAE) based on the TF Commander's tactical and logistical requirements, the ruling airfield criteria provided by Military Aid Command Vietnam (MACV), and local advice from RAAF.

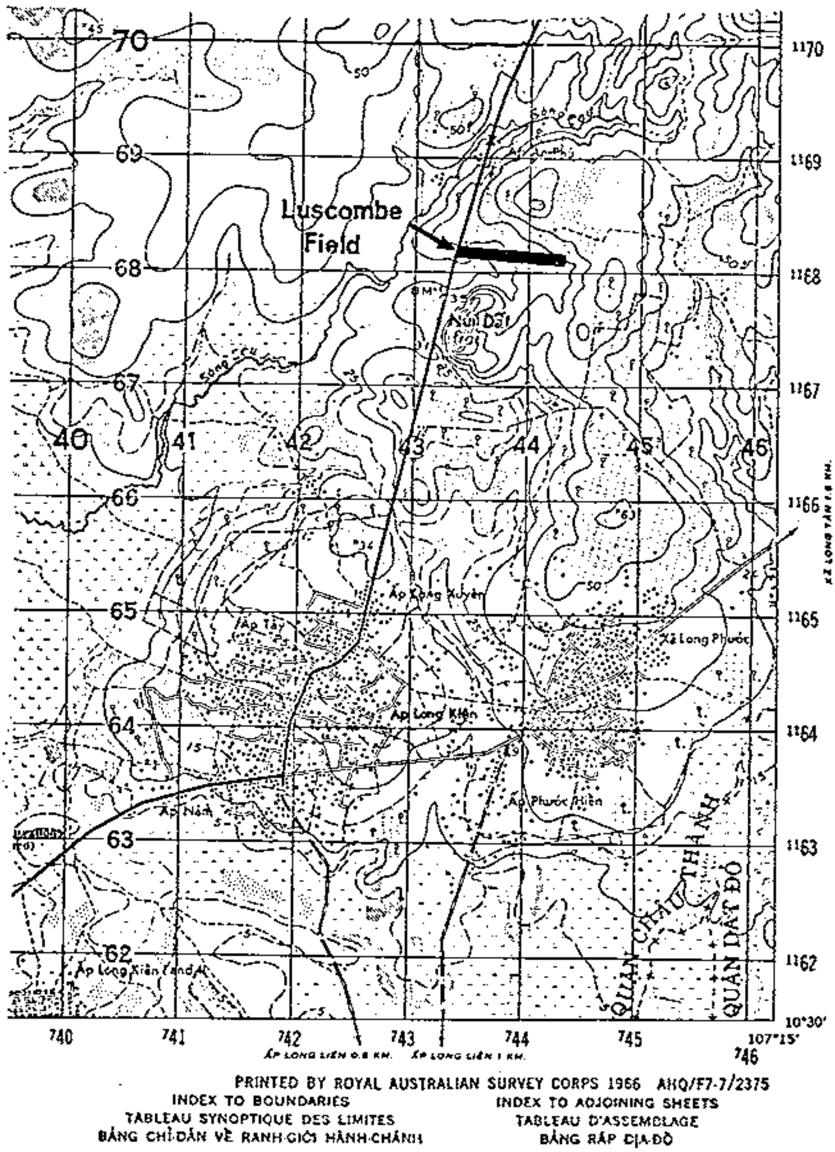
SITING THE AIRFIELD

Route 2 was selected as the Main Supply Route (MSR) in the initial maintenance plan. The road had certain obvious disadvantages. South of Baria it crossed two large rivers by means of French military Eiffel bridges (similar in construction to Bailey) which were estimated to be Class 12. In each location the Eiffel bridges were supplemented by old bridges of local construction of Class 9 capacity. The road was narrow, the surface of poor quality, and the route passed through Baria and the village of Hoa Long. There were many areas well suited to enemy ambush and sniping, or to road obstruction. The usual precautions were taken to obviate the inherent difficulties of the MSR, and alternative maintenance plans were made, to be executed if the MSR should fail. These plans included limited re-supply by US Iroquois utility helicopters which were supporting the Task Force, backed up if necessary by Chinook medium helicopters over longer periods. Initial road convoys attempted to carry forward enough essential stores to provide a small reserve on the ground. If all other means failed, a re-supply airlift operation could have been conducted with C130s into Binh Ba airfield, 7 kilometres to the north in insecure territory. Light fixed wing aircraft sorties were to be flown out of Vung Tau, and Baria, where there was a 900-ft-long dust-sealed runway adjacent to the Van Kiep military compound. This strip was marginal at best, and virtually useless in cross winds. Helicopters used natural and hastily cleared pads in the various unit areas.

In the initial laying out of the Task Force, three large tracts were left vacant within the area to provide for the airfield and a major heliport. Since all three of these areas were naturally fairly low and virtually below the wet monsoon high-water

* The minimum parking area for ten (10) C130 aircraft on this type airfield is 1,500 ft by 150 ft (25,000 sq yds).

Runway Surface: Packed earth runways are adequate for C130 use on this type of field. However, to ensure trafficability during all environmental conditions (especially the rainy season) runway surfacing is desirable. The type of surface ranges from concrete to dust repellent.



mark, they were not attractive for the initial deployment. Since engineer effort was directed to other tasks and since the wet season was commencing, reclamation could not be attempted at that time. Between the Nui Dat feature and the TF HQ rubber plantation was a natural cleared area which was used initially as the main helipad, and was known as Kangaroo Pad. By means of some fairly substantial drainage and excavation, this area could be converted to a large heliport running east–west, or, with considerably more effort, a Caribou airfield with a number of fairly stringent restrictions. The proxmity to TF HQ and the extensive earthworks requirement for an airfield made this area better suited to ultimate development as a heliport. The two main areas which were considered for the airfield were:

To the west of Nui Dat using Route 2 as a centre line (running north–south), and located between 5 RAR in the north and TF HQ in the south.

To the north of Nui Dat just south of the rubber plantation which was occupied by 5 RAR and to the east of Route 2, oriented east–west.

The former location offered several advantages in the short term—the alignment was already fairly clean of vegetation; the road provided a ready-made (though narrow) runway, which could be widened and graded smooth; the entire runway would be dominated by the Nui Dat feature, and the ends secured by Task Force units; the airfield would be centrally placed for easy access from all units.

Many disadvantages were apparent, however, particularly in the longer term. The alignment was at right angles to the prevailing wind directions, these being east to west from Noevmber to February and west to east from April to September. The flight path of fixed-wing aircraft would cross that of helicopters using Kangaroo Pad. The western flank of the entire length of the runway would be exposed to enemy observation and possibly direct fire from Nui Thi Vai hills to the west. In addition this flank was vulnerable to enemy ground attack, since there were no friendly units located to the west of Route 2 in this area. Immediate approaches from both ends were over rising ground and gradients along the centre line were too great for ultimate use by aircraft larger than Caribou. If excavation had to be done, the advantage of the ready-made runway was negated. Drainage for subsequent expansion of parking areas and service areas would be a major task, as there were two perennial streams crossing the road in this area. If Route 2 were used for the airfield it would be necessary to construct a bypass road so that civilians to the north could get produce to the markets in Baria and Vung Tau.

Consideration of these, and other relatively minor factors pointed to the ultimate location as the most suitable. This site, too, presented some problems. Although most of the proposed area was only lightly covered with young rubber trees and scrub, the northern and eastern boundaries were covered with tall rubber, up to 45 ft in height—which provided cover for elements of 5 RAR and 6 RAR respectively. There was quite a pronounced cross-slope from the 5 RAR area on the north side to a perennial watercourse running parallel with the proposed runway to the south. The space between 5 RAR and the stream was obviously restrictive for proper lateral cleared zones. The pronounced cross-slope indicated a requirement for substantial drainage structures to carry run-off from 5 RAR to the stream. The approach glide path from the west was across unoccupied ground to the west of Route 2, and the western end of the runway could be observed from Nui Thi Vai. Eventual extension of the airfield to C130 standard would involve crossing Route 2 to extend the runway proper into unoccupied ground to the west. Notwithstanding these shortcomings, the advantages (or minimal disadvantages) made this site the most attractive for the Task Force air-head.

DESIGN AND CONSTRUCTION

During the first three or four months, while the bulk of the engineer construction effort was diverted elsewhere, there was little work done on the airfield site. Since the 5 RAR area needed major monsoon drains to carry away run-off, these were constructed at proper levels, and in the right positions to fit into the drainage plan of the future airfield. To permit earthworks to continue at a later date, two 48-in diameter corrugated iron culverts were installed under the runway alignment, each one being 150 ft long. Some clearing of the site was demanded during this period to permit construction of the northern limb of Canberra Avenue, which ran parallel to the airfield and provided major access to 5 RAR. From time to time some additional patchy work was accomplished when machines were precluded from working on priority jobs by bad weather.

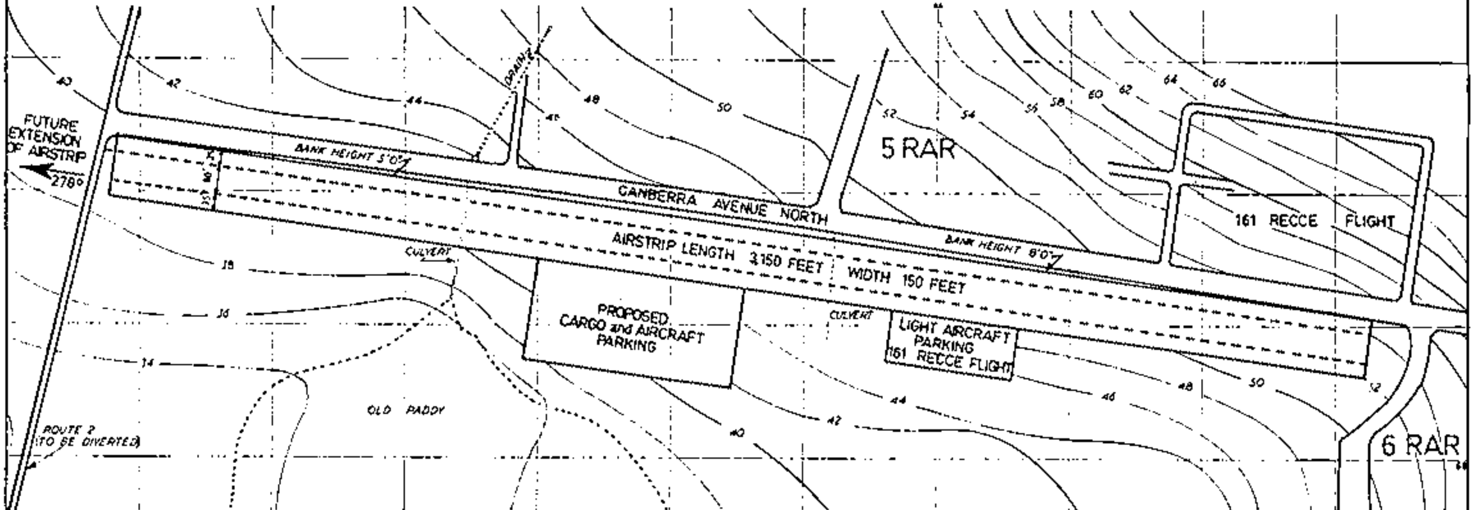
The MSR remained intact, though its condition deteriorated, until early October 1966, when an overweight US vehicle fell through one span of the old Class 9 bridge near Cau Rach Ba. Although the Class 12 Eiffel bridge was undamaged, the vulnerability and inadequacy of the bridges was demonstrated by the incident. By this time, there was a greater proportion of heavy loads required to be moved from Vung Tau to Nui Dat—and several risk crossings had been necessary over the Eiffel bridges with loads greater than Class 12. There were two significant results from the bridge failure. Firstly, a semi-permanent hard-standing was constructed south of Baria, so that Australian Army Landing Ships Medium (LSM) and US Navy Landing Craft Utility (LCU) could bypass the weak bridges with heavy loads. Secondly, it was emphasized that daily tonnages required by the Task Force had increased to the extent that helicopter resupply, as an alternative maintenance system, would probably be unable to provide the lift capacity demanded. Furthermore, 1 ATF operations were ranging further afield, and placing heavier demands on the limited available helicopter support for daily resupply from Nui Dat to forward operational bases. The Task Force Reconnaissance Flight was still located in Vung Tau. As essential base development work had progressed well since June, priority of engineer effort was directed to the construction of a Caribou airfield in mid-October 1966.

The detailed survey of the site revealed a dilemma for the airfield designers. Between Route 2 in the west and the 6 RAR rubber plantation in the east there was more than sufficient length for a Caribou strip. There was, however, a total rise of 50 ft, with several natural hollows and bumps over the length of approximately 3,000 ft (i.e. approximately 1½ per cent). The 6 RAR position at the eastern end of the site lay on a crestline rising to about 100 ft above the end of the clearing at a distance of 500 yds from the edge of the clearing. If an attempt were made to cut-and-fill to reduce the overall fall in the runway, a large amount of excavation would be required, and the 6 RAR crest would be accentuated. In addition, surrounding cleared zones would be at different levels from the runway (unless enormous excavation work was undertaken) and this would constitute increased hazard to pilots, and introduce difficulties with access to parking areas. On the other hand, if the 50 ft fall were retained, being well within the 3 per cent gradient limit prescribed by MACV, the effect on aircraft on the runway was assessed to be equivalent to a permanent easterly wind of 25 knots—except that during take-off to the east, the effect would contrive to lower airspeed rather than to increase it. After consultation with RAAF, it was decided to accept the overall fall and adapt operating procedures to allow for it. The added restriction of the 6 RAR crest reinforced this decision. It was decided that aircraft would generally land uphill (towards the east), and take off downhill, exploiting the assistance of gravity, and avoiding a glide path over the 6 RAR crest. On the rare occurrences of strong easterly winds, procedures might have to be modified. In order to minimize excavation it was considered satisfactory to accept relatively large percentages changes in longitudinal gradients, provided they were within the limits of the MACV criteria—hence the dips and bumps in the airfield—not designed to provide ski-jump take-off assistance, as was suggested by one early passenger.

A Caribou airfield would not require the full 3,000 ft which was available, so it was decided to attempt to construct the field to meet requirements of MACV criteria for limited use by C130 aircraft. The unique operating procedures made it possible to do this, since the overrun at the eastern end could be converted to extra runway. The runway could be extended at a later stage to the west of Route 2, to measure up, with some minor restrictions, to the standards for a fully operational C130 airfield. The cross slope of the runway and limited width of the site meant that an embankment had to be cut along the northern edge of the flight strip.

From the engineering point of view, it was desirable to accomplish earthworks as quickly as possible. Disregarding the formidable list of other tasks on the job-priority table, it was desirable to cut, fill, and compact the earthworks during the period between the wet monsoon and the dry season. It was hoped that it would be possible to work the soil at close to optimum moisture content, thus minimizing the need to

LUSCOMBE AIRFIELD NUI DAT 151 FEET AMSL



METEOROLOGICAL DATA:
AVERAGE ANNUAL RAINFALL 80 inches
TEMPERATURE 70–85° F

CONTOUR INTERVAL 2 METRES

DECEMBER 1966

A view of Luscombe Field looking east to west.

Luscombe field-Nui Dat 2

haul and spread water for compaction, and for dust laying. The plant operators of 21 Engineer Support Troop RAE, under command of 1 Field Squadron, responded to the challenge in characteristic Sapper fashion. Earthmoving equipment operated from daylight till dark, clearing, cutting, hauling and compacting. With the end of the wet season the soil quickly lost its moisture, and it became necessary to spread water to ensure adequate compaction. Improvised water tanks were constructed by reinforcing and lining large packing-cases which had contained prefabricated metal buildings. Water was distributed and the airfield was rolled in pre-dawn darkness to minimize evaporation losses and to exploit overnight condensation. This operation was made possible by the co-operation of the APC squadron and the infantry battalions who provided standing patrols to the west of Route 2, while engineers worked in darkness. After about 50,000 cubic yards of soil had been excavated and the flightstrip had been graded and compacted, a covering of locally won laterite was laid over the runway and shoulders. The runway proper was clad with high-quality leached laterite which was extracted from a quarry between 1 ATF and Hoa Long. Some 5,000 cubic yards of this material were imported to provide a 9-in-thick compacted pavement on the 80-ft wide runway.

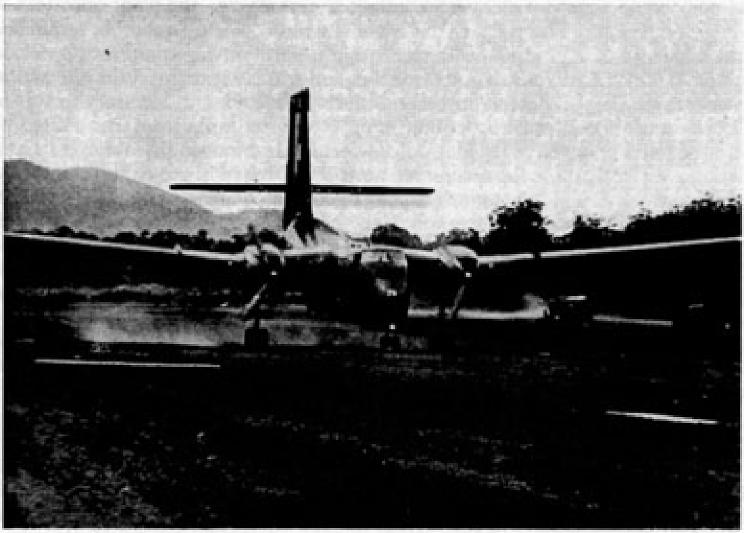
OPENING THE FIELD

On 31 October a Cessna of 161 (Independent) Reconnaissance Flight conducted several "proof landings" on the airfield, though it was far from complete at this stage. The purpose was twofold. The landings confirmed that the runway could be used in emergencies from that date. Plant operators working on the site had noticed FAC aircraft of the US Air Force doing low-level runs over the cleared area. While engineer graders and excavators pre-empted an American inaugural landing on the strip, a hasty engineer/aviation reconnaissance was arranged and a Cessna was diverted from Baria to conduct the proof landings. By late November, the airfield was ready for inspection by USAF representatives. They required the removal of some 400 trees from the eastern end of the airfield in order to certify the field suitable for use by Caribou and C123 and by C130 with Grade A pilots. This additional work was completed in time for the official opening of the field on 5 December 1966, the completion date which had been forecast in early October. At this stage the airfield was regarded as a dry-weather strip—since traffic during wet weather could damage the surface.

A simple opening ceremony took place on 5 December 1966 before a small guard of honour of engineers and army aviators, flanked by light aircraft and earthmoving equipment. Brigadier O. D. Jackson, Commander 1 ATF, unveiled a commemorative plaque, naming the airfield "Luscombe Field". A Caribou of 35 Squadron (RAAF) landed on the runway, using only a small part of the total length available. The airfield was named after Captain B. Luscombe (RAA), who was one of the first Army aviators. He was killed in action in Korea whilst flying an air observation post mission.

SUBSEQUENT DEVELOPMENT

Later in December the runway was sealed with "Peneprime", a bituminous dust palliative. In the absence of crushed rock, sand was used with the bitumen. Even spreading was difficult to achieve without special equipment, and a technique was developed whereby hovering helicopters spread the sand and blew away excess material from the sealed strip. Repeated applications created a waterproof skin which enabled Luscombe Field to be used throughout the following wet season without damage. 1 Field Squadron (RAE) built workshops, parking areas, and accommodation for 161 (Independent) Reconnaissance Flight in the rubber adjacent to the northern edge of the airfield, at the eastern end. Prefabricated metal airfield matting was laid over a plastic membrane to give a waterproof, dust-free, parking and working area in the shelter of the rubber plantation. Aircraft parking areas were constructed on the south side of the runway, and a new Task Force



A Caribou of 35 Squadron (RAAF) landing on Luscombe Field at the official opening on 5 December 1966.

Maintenance Area was built between Nui Dat and 6 RAR, to the south of the airfield. Development progressed continuously until December 1968 when engineers of the US 34 Engineer Group extended Luscombe Field to 4,100 ft and permanently sealed the whole runway. The pavement of the extension was made from locally won crushed rock and it had been intended to sheath the entire runway with similar material. Since the existing runway had shown no signs of failure or weakness at any time, and since the existing pavement was obviously adequate to the task, the runway reconstruction plan was abandoned as unnecessary.

CONCLUSION

Luscombe Field is probably taken for granted by most new arrivals to the Task Force area. An airfield is to be expected in a well-developed task-force base. Probably the only comments which are aroused are those which question the peculiarities of the airfield or those which wonder where it got its name. Luscombe Field is a monument to much more than Captain Luscombe. It represents many aspects of the part played by the Australian Force in Vietnam. It contributes to the connecting link between the Task Force and its supporting units and commanding HQ. It is the "front door" of 1 ATF through which thousands of men have passed, going to and coming from the war. Luscombe Field is a symbol of co-operation and mutual support between the forces of Australia and the United States; between the Royal Australian Air Force and the Australian Army Aviation Corps; between those who need roads, buildings, and airfields and those who construct them—the Sappers of the Royal Australian Engineers.

The Upchat Road Pavement Construction

MAJOR R. B. DOWNS, RE, FIPlantE, MICE, AMBIM

INTRODUCTION

For a variety of reasons it has not been possible to publish a detailed article on this work. It is felt that a short article describing the project, with some observations on the methods used and the problems, will be useful, even though the project is now over a year old.

The project was carried out by 52nd Field Squadron (Airfields) for the Ministry of Public Buildings and Works (MPBW). The Ministry were responsible for the design, supply of all materials (including those required for temporary works) and supervision of the work. The Squadron was permitted to undertake this work, as it came within the category of work suitable for training as well as being of assistance to MPBW.

DESCRIPTION OF PROJECT

The Upchat Road (see Sketch Plan) was intended as a direct link between the new Chattenden Barracks and Upnor Hard, and is approximately one mile in length. It has a 24-ft carriageway, and is designed for class 80 traffic. The road starts at Upnor Castle House and descends in cutting for approximately 1,400 ft to "Church Crossing". Here Kent County Council, with military assistance, have lowered the old Lower Upnor road about 5 ft so that the two roads meet on a cross-roads. From Church Crossing the road is in sidehill cut for approximately 2,200 ft to Four Elms Hill road, which it crosses with a 225-ft broken-span heavy girder bridge, built by 24th Field Squadron on abutments cast by 52nd Field Squadron (Airfields). From here the road runs uphill firstly on a high embankment then in sidehill cut for approximately 1,600 ft to the roundabout outside Chattenden Barracks. Work started in 1965, and over the next two years a number of regular and TA units carried out the earthworks. 52nd Field Squadron (Airfields) started on the pavement construction on 7 May 1967, and completed the asphalt surfacing by 5 January 1968. Site clearance, however, was not completed until late summer 1968.

The subgrade was of three main types. These were: a heavy clay, mainly in the cutting from Upnor Castle House; an SC sand, mainly over the embankment; and an SP sand in isolated pockets. The pavement was designed for a wet clay CBR of 3 per cent and consisted of 8 in cement-bound granular sub-base. On this were laid the kerbs to contain 7 in of dry lean concrete base with a surfacing of 2½ in hot rolled asphalt base course and 1½ in of hot rolled asphalt wearing course.

In addition to the pavement, the normal drainage was required, together with the general landscaping and grassing of the area adjacent to the road.

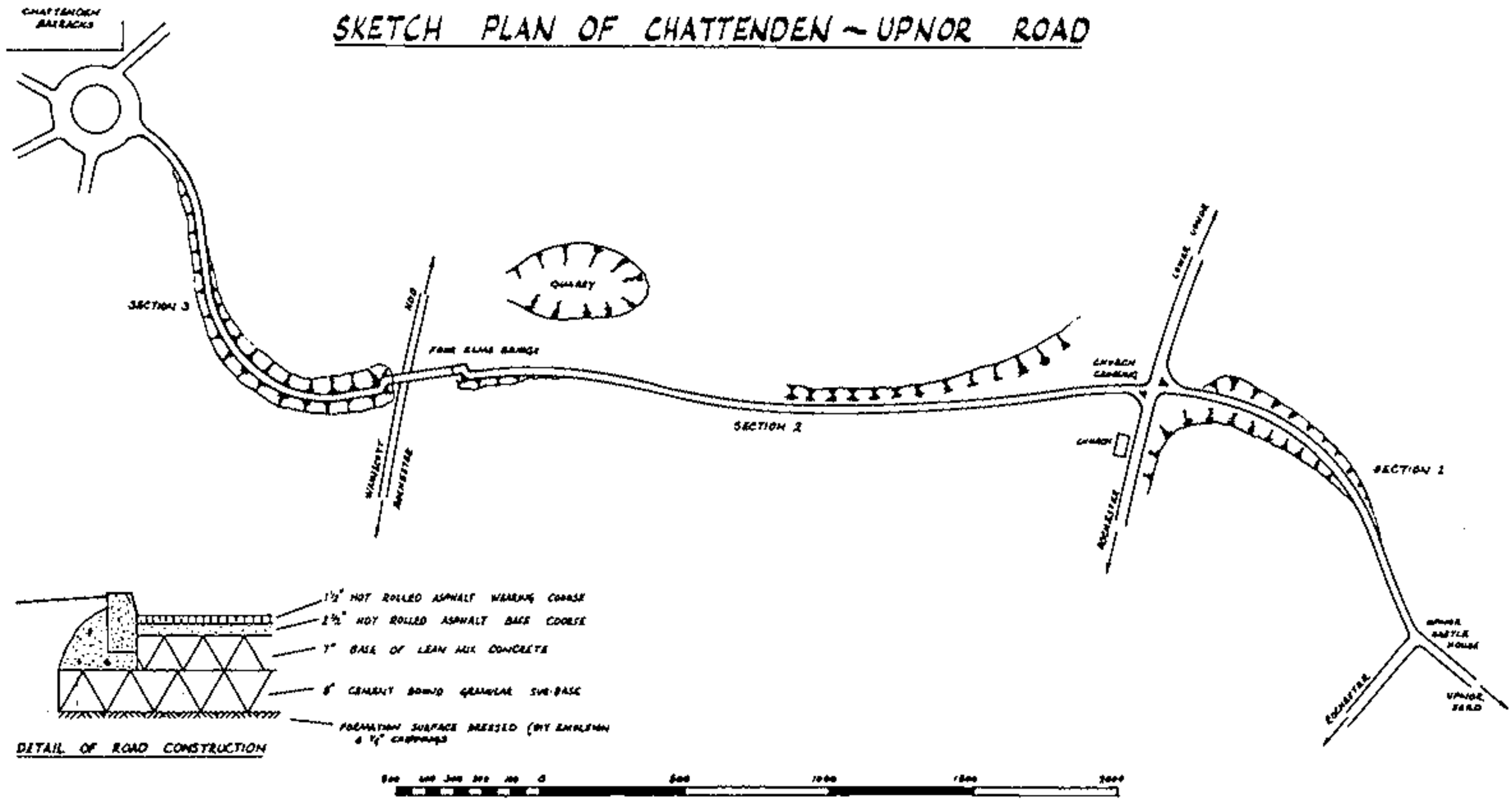
PLANNING AND CONTROL

The Squadron in 1967 was already committed to constructing a large concrete hardstanding at RAF Aldergrove, and had a detachment of forty soldiers, with fifty local Irish labourers under command in addition. For the Upchat Road the Squadron was reinforced with a composite troop drawn from all units in BAOR. During most of 1967 the Squadron was effectively about 300 strong.

All the planning followed normal lines with activity lists, and critical path analysis of the work. Since the work fell into eight well-defined operations, responsibility for these operations was allotted to individual troop commanders, as under:

Plant Troop Commander	Earthworks, asphalt, piling.
Construction Troop Commander	Kerbs, drainage, bridge foundations.
BAOR Troop Commander	Sub-base and base.
Clerk of Works (Construction)	Final site clearance.

SKETCH PLAN OF CHATTENDEN ~ UPNOR ROAD



At each Friday's works conference the OC laid down the detailed programme for the following week. At subsequent daily conferences Troop Commanders bid for plant, extra manpower, transport and stores for the following days work. It was then the responsibility of the Troop Commander to get on with his own section of work. Setting out and quality control were directly under the CW (C), who also assisted the Troop Commanders with technical advice when necessary.

MPBW had a CW (C), who visited the site periodically. The relationship between MPBW site staff and a military unit tends to be vague. This is partly because few MPBW staff have experience of working with military labour, and partly because they have the dual role of supervising the quality of our work and also of supplying us with the materials. In the present system the exact relationship can only be arrived at by compromise and must depend on personalities.

EXECUTION OF THE PROJECT

The problems in executing the eight main operations were not new but, as projects of this type are not yet common, some notes may be helpful.

The theoretical task in the earthworks was to strip 12 in from the subgrade to leave a clean formation. Apart from the usual problems of levels being altered after work started—5 ft was our maximum cut in places—there were two major problems. The first was the discovery that a drain had been leaking for many months in the middle of the formation of Section 2. This delayed the earthworks several weeks whilst extensive new drain runs were laid. The second problem was the level at which the earthworks had been left. When cutting 12 in to final formation level, there was not enough room to deposit this spoil on the shoulders, and the spoil was cut to waste. Subsequent efforts to build up the shoulders in December 1967 were abortive. It would have greatly eased the overall problem if the formation had been left 24 in high, even though it would have doubled the quantity cut to waste in bringing the formation to final level.

The cement-bound granular sub-base had to be laid in two 13-ft widths. This narrow working face made it more economical to spread by hand between forms. It was compacted by a 15-cwt Bomag vibrating roller which gave densities averaging 139 lb cu ft, and average cube strengths of 950 lb/sq in. Levels were generally kept within the 0 to -1 in region. One senior NCO, 1 + 8 on formwork and 1 + 12 on laying laid 90 cu yds per day.

The kerbs proved a major headache, as few bricklayers have ever done this work. It demands a good eye which is only inborn or learnt with a great deal of practice. It was found better to lay kerbs correctly to level first, laying to exact line the following day. This is contrary to normal civilian practice, which is to lay to line and level and haunch all in one operation. This, however, requires a great deal of skill. The kerbs were laid generally to $\pm$ 1 in on road width and $\pm \frac{1}{4}$ in on the absolute levels shown on the drawings, Two NCOs + 8 men with one mixer laid 140-ft run of kerb per day, one side of road only.

The dry lean base was laid the full width of the road, and it was thus possible to use a light wheeled tractor to help spread the dry lean. After this initial spreading a screedboard with wheels running on the kerbs gave final levels. The dry lean was then rolled by the Bomag, which averaged a density of 144 lb/cu ft, a cube strength of 2,175 lb/sq in, and levels of $\pm \frac{1}{2}$ in. One NCO + 11 men, 1 LWT, and 2 rollers laid 105 cu yds per day.

The asphalt laying was the most difficult operation of all. A good finish is achieved entirely by the operator knowing exactly what he is doing. No amount of control testing or talking by supervisors will achieve this finish, and it can only be got by experience. We managed to obtain 25 tons of asphalt for practice, but would have preferred 150 tons at least. We had to take up 25 tons of badly laid asphalt (out of 2,510 tons total), but it would have been desirable to take up another 70 tons which was marginally acceptable.

The laying was not helped by the fact that the asphalt specification was for a minimum base course thickness of 2¼ in, whilst the quantities (and our dry lean base laying) were for an average thickness of 2¼ in. The base course asphalt dragged badly on the thin areas. One Barber Greene 875 with 2 rollers, 1 NCO and 15 men laid 65 tons per day. The same party could have laid over 100 tons per day if supplies had allowed.

The bridge foundations for the Four Elms Hill Bridge were conventional reinforced-concrete abutments and pier bases. On the west side the abutments rested on a reinforced-concrete raft cast on top of a sheet-steel piled coffer-dam. This ensured that the weight of the bridge was confined within the coffer-dam until below the road level of Four Elms Hill Road and would not cause any slips of the embankment. The piling frame was built from old 4 × 4 in and 6 × 6 in timbers from the Bomb Disposal School, although heavier timbers would be desirable. All the piles were pitched before driving. It normally took 6 minutes to pitch one pile, but the closing pile took 7 hours. Driving was by a No 5 McKierman-Terry hammer with bodged-up hoses to a 315 cfm compressor. Unfortunately the Corps does not at present appear to possess a matched set of hammer, hose and compressor, nor do we have a complete set of hammer-legs to suit all normal sheet piles.

The major planning error was in the site clearance. It was hopefully expected that four weeks would be ample even in December! In fact, all work stopped in the winter of 1967/8, and a small party spent most of the summer of 1968 tidying up.

Photo 1. Earth works in the Church Crossing area where the KCC road crosses the Upchat road.

Photo 2. Final compaction of the cement bound granular sub-base with Bomag vibrating roller.

The Upchat Road Pavement Construction 2

Photo 3. Spreading the dry lean base with Michigan, and final levelling with the Travelling Screed Board on the kerbs.

The Upchat Road Pavement Construction 3

Photo 4. Kerb laying in Church Crossing area.

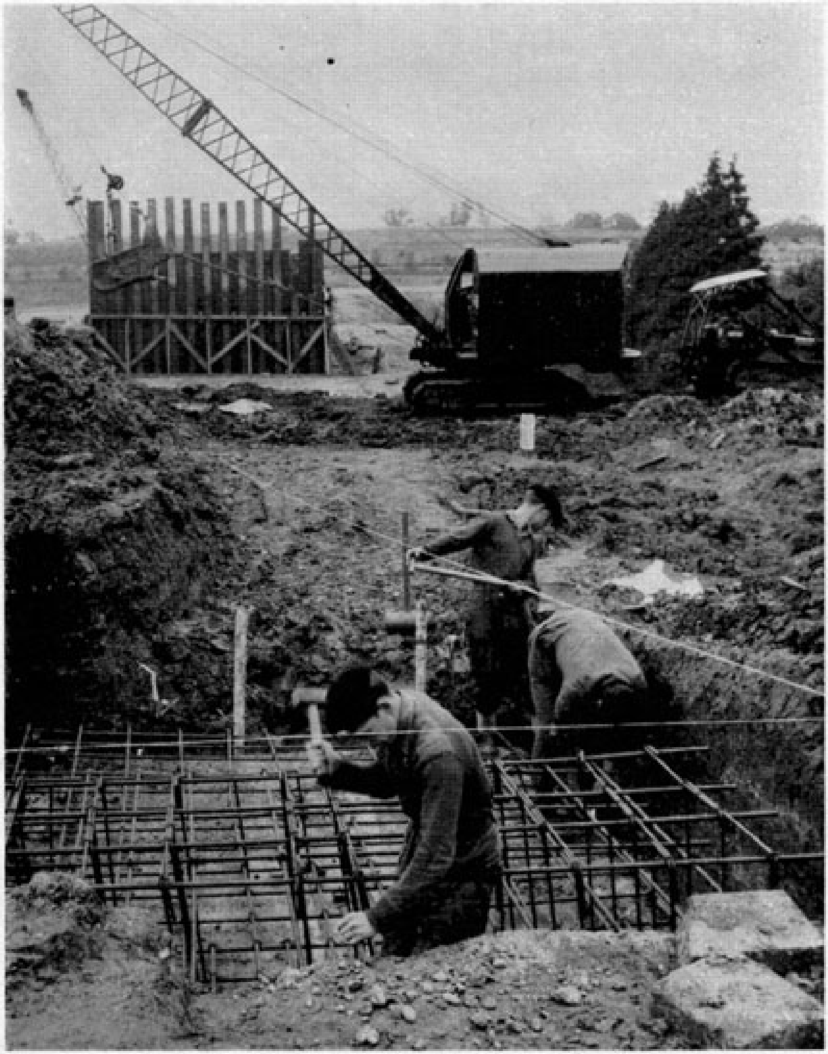


Photo 5. Fixing reinforcement for the Upnor abutment of the HGB, with the Chattenden Cofferdam in the background.

The Upchat Road Pavement Construction 5

Photo 6. Welder at work inside Cofferdam.

CONCLUSIONS

There is no doubt that the Corps has the technical knowledge, the skilled man-power and plant to carry out major civil engineering works. To date, however, we have had but few opportunities to deploy these on major costed projects in the UK and until more experience is obtained, procedural and technical difficulties are bound to occur in each new project undertaken. Each project must have a time scale to allow proper planning with the peacetime stores ordering system and for contingencies. Any attempt to shorten the time will inevitably lead to increased cost in money, labour or plant.

A Trophy of the Conquest

LIEUT-COLONEL R. S. HAWKINS, RE (Ret'd)
MA, AMIMechE

AT the turn of the nineteenth century two inscriptions were composed. One was the Dedication in a printed book, and, translated from the French, proclaimed:

To Bonaparte

To combine the lustre of your Name with the splendour of the Monuments of Egypt, is to associated the glorious annals of our time with the history of the heroic age; and to reanimate the dust of Seostris and Menes, like you Conquerors, like your Benefactors.

The other was engraved on a marble slab, and preserved for posterity by the mighty endeavours of British soldiers; it bore these words:

In the Year of the Christian Æra, 1798,
The Republic of France
Landed on the Shores of Egypt an Army of 40000 men,
Commanded by their most able and successful General
BUONAPARTE.
The Conduct of the Generals and the Valour of the troops
Effected the Entire Subjugation of that Country.
But under Divine Providence it was reserved for the British Nation
To annihilate their Ambitious Designs.
Their Fleet was Attacked, Defeated and Destroyed
In Aboukir Bay
By a British Fleet of equal Force
Commanded by Admiral Lord NELSON.
Their intended Conquest of Syria was counteracted at Acre
By a most Gallant Resistance
Under Commodore Sir SYDNEY SMITH,
And Egypt was rescued from their Dominion
By a British Army inferior in numbers but
Commanded by General Sir RALPH ABERCROMBY,
Who landed at Aboukir on the 8th of March, 1801
Defeated the French on several Occasions,
Particularly in a most Decisive Action near Alexandria,
On the 21st of that Month,
When they Were driven from the Field
And forced to shelter themselves
In the Garrisons of Cairo and Alexandria,
Which places subsequently surrendered by Capitulation.
To record to Future Ages these Events;
And to commemorate the Loss sustained
By the Death of Sir RALPH ABERCROMBY,
Who was Mortally wounded on that Memorable Day,
Is the Design of this Inscription;
Which was Deposited here in the Year of CHRIST, 1802,
By the British Army, on their evacuating this Country,
And restoring it to the Turkish Empire.

J. Alexander, Sculp.

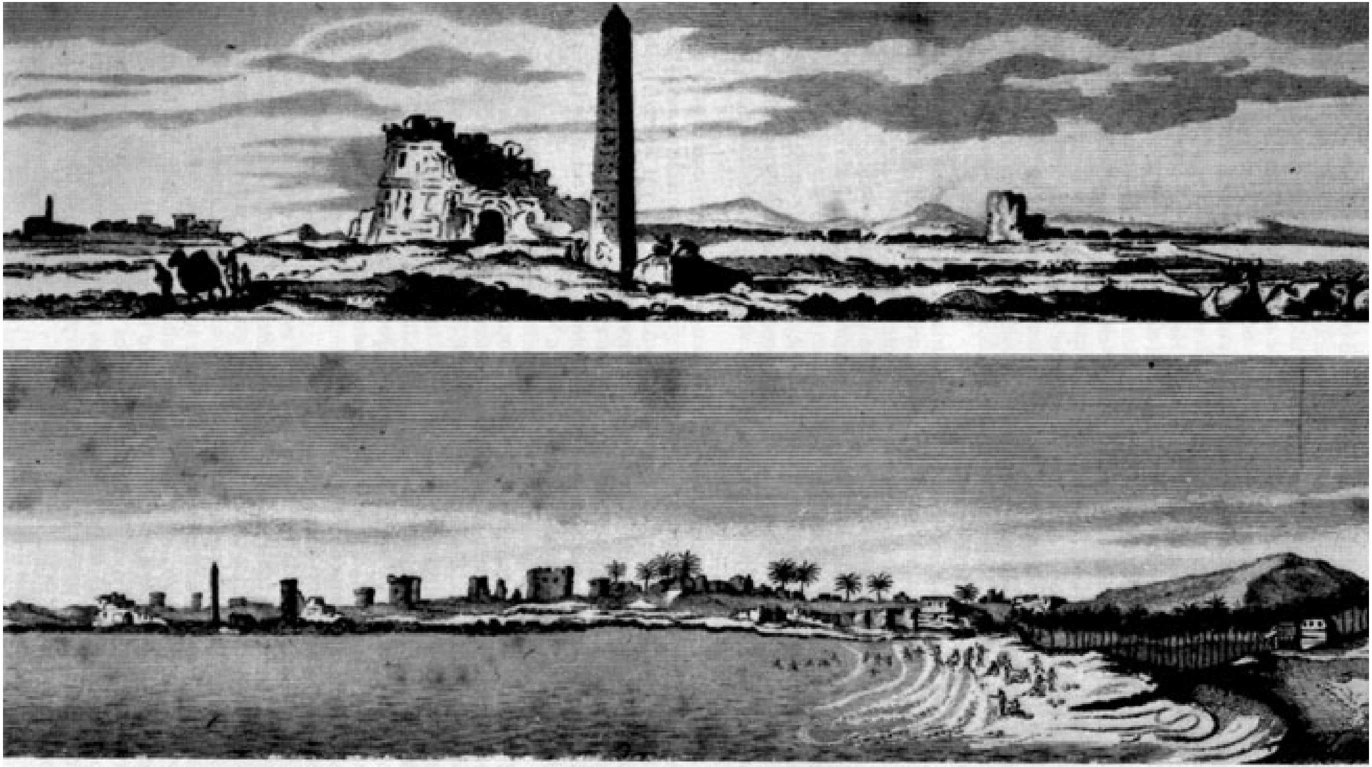


Photo 1. *Sketches by Vivant Denon* (*c.* 1800). Cleopatra's Needles looking north-east. Eastern Harbour, Alexandria, looking south.

A Trophy Of The Conquest 1

On 19 May 1798 Napoleon's battle fleet and transports set out from Toulon for a secret destination. Joined by other units, it eventually amounted to nearly 400 ships and 50,000 men, among them a small body of talented men, the Commission of Arts and Sciences, vital to Napoleon's plans for the exploitation of his intended victim. The activities of this monstrous force were not unknown to My Lords of the Admiralty, though its precise whereabouts was obscure. Rear-Admiral Nelson, with thirteen ships of the line, reconnoitred off Toulon at the beginning of June, and then sailed eastward without sighting the enemy. He followed his firm conviction that Napoleon was heading for Egypt, and received news of the capitulation of Malta on 15 June. Captain Hardy, RN, in the corvette *Mutine* sailed into Alexandria harbour on 27 June, but found no trace of the French; Nelson, therefore, sailed in the direction of Greece, unaware that he was ahead of his quarry.

The French frigate *La Junon*, sent ahead of the main fleet, entered Alexandria harbour on 29 June and returned with the report of the arrival and departure of the British. This frigate carried M. Dominique Vivant Denon, a skilled artist and diarist, and a member of the Commission of Arts and Sciences. He it was who later prefaced his book(*a*) with the first inscription.

The leading French units landed at Alexandria on 1 July, and M. Denon hastened ashore to record on paper the astonishing artistic and architectural features of ancient Egypt. Of the events on 2 July he wrote:

"We came afterwards to the obelisk named Cleopatra's needle; another obelisk down at its side indicates that both of them formerly decorated one of the entrances of the Palace of the Ptolemies, the ruins of which are still to be seen at a little distance. An inspection of these obelisks proved that they have been brought from Memphis or from Upper Egypt. They might be conveyed to France without difficulty, and would there become a trophy of the conquest, and a very characteristic one, as they are in themselves monuments."

Alas for his patriotic sentiments! Nelson, acting on vague reports, was in sight of Alexandria on the afternoon of 1 August and, ignoring the etiquette of naval battles, attacked the French fleet at anchor in Aboukir Bay then and there. The battle continued throughout the night, and by morning the French had lost six ships as prizes, three were crippled or stranded, and the enormous flagship *L'Orient* blew up. Three ships escaped, but Napoleon and his army were entirely cut off in Egypt, and the Royal Navy was in complete control of the Mediterranean.

Military events continued to follow the course outlined on the marble inscription. The East India Company had contributed a force under Sir David Baird, including a ninety-strong Company of the Madras Pioneers, with two English officers. There were also Captain H. Elphinstone, RE, one officer of the Bengal Engineers and one from the Bombay Engineers. This contingent reached El Quseir in the Red Sea in July 1801, and set out on a 500-mile march to the Nile Delta. The terrible shortage of water and difficulty in obtaining camels impeded their progress, so that they did not reach Alexandria till shortly after its surrender, and the capitulation of the French under General Menou on 2 September. This Indian contingent was retained as part of the garrison for the next eight months.

The command of British troops in Egypt eventually fell to Major-General the Earl of Cavan in October 1801; he had been a Brigade Commander in Abercromby's force. He soon decided to commemorate the great British victories in some lasting way, by the unaided exertions of the Army and Navy. Captain Thomas Walsh (93rd Regiment) observed at the time, "Close to the sea side, South by East of the Pharos, is Cleopatra's needle. Near it lies its fellow obelisk,[1] which had always been supposed to be broken, part of it being buried in the sand; but the French cleared away the ground all round it, and found it to be perfectly whole. Round the summit of that which is erect we perceived the remains of a rope, most probably put there for the purpose of pulling it to the ground, preparatory to the transporting of both of them to France" (*b*).

[1] It was felled by an earthquake *circa* 1300.

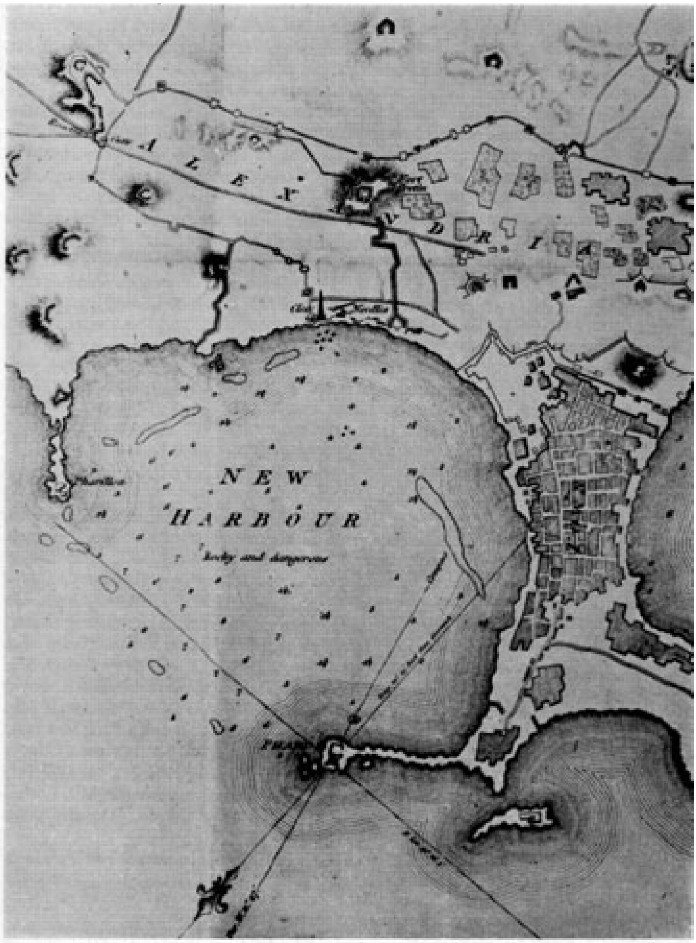


Photo 2. *Map of Alexandria, 1802*, showing site of Cleopatra's Needles.

Cavan's plan was to transport the fallen needle to England, and the execution of this plan depended on the technical skill and energy of his Commanding Engineer, Captain Alexander Bryce, RE, and those RE officers in Egypt who had survived the battles. Bryce commanded a Company of the Royal Military Artificers in Abercromby's force, and, for his great services, was promoted Major in the Army on Christmas Day 1801, at the age of 32. He had nine RE officers at his command, all of whom had served through the Egyptian campaign.

Cavan first had to obtain the sanction of the Sublime Porte, under whose suzerainty Egypt then lay. The effective Governor in Lower Egypt at the time was

Mohammed Ali, but he was not the official nominee of the Porte. When the Turkish Army was severely repulsed by the French on Aboukir Beach in July 1799, this young Albanian officer wisely took to the sea and swam for safety to the ships of Sir Sydney Smith, where he was picked out of the water by British sailors. After the final capitulation of the French in 1801, there was a struggle for power in Egypt between the official Turkish Pasha, the Albanian party and various Mameluke Beys. There was much bloodshed and intrigue until 1807, when Mohammed Ali, the most expert protagonist, was appointed Pasha of Egypt by the Porte. In 1819, by decree of the Sultan, he became hereditary Viceroy and so founded the dynasty which ruled Egypt for the next 135 years.

Cavan obtained permission from Mohammed Ali for the removal of the needle, and under the direction of Major Bryce, RE, the engineering requirements were put in hand. The needle lay above high-water mark on the sandy sea-shore which was swept by tides and currents. The first task was to build a stone jetty, beside which a ship could be berthed in such a manner that the needle could be loaded into it. The plan was to heave the needle on rollers or skids, across the shore, and introduce it horizontally through the stern of the ship, in which a hole of the necessary size was to be cut. A Venetian frigate, *El Corso*, captured in the Mediterranean in 1796, was purchased from the Prize Agents for the purpose. There was unlimited stone from Egyptian and Roman ruins near the shore, and, under General Orders, military working parties were allotted for building the jetty under RE direction. The stone pedestals of both obelisks were completely immersed in wind-blown sand, which had accumulated through the centuries. Cavan had the sand excavated until both pedestals were completely exposed to view.

On 8 January 1802, Cavan held a meeting at H.Q. Alexandria, at which Major-General Baird, Brigadier-General Hope and thirty-four other officers were present, including two naval officers, and Lieut-Colonel C. Holloway, RE, and Major Bryce, RE. The meeting was to consider the proposition "to transport to Great Britain the fallen needle stone of Cleopatra as a present to His Majesty,[1] to perpetuate the services of His Navy and Army in Egypt during the War". The meeting passed resolutions that a fund be opened to defray expenses and that a Committee of a President and six members be "named this day, to have the sole superintendence, direction and control over the whole undertaking". Letters were to be written to Admirals, General Officers, Captains of ships of HM Navy and COs of regiments who had served in Egypt, "to acquaint them with this undertaking and to request their subscriptions". Subscriptions donated at the meeting included £200 from Cavan, £150 from Baird, and £25 each from the two RE officers. Well over £1,000 was collected at the meeting alone. The working committee was nominated with Cavan as President, Captains Larcom and Stephenson, RN, Major Bryce, RE, and three other officers.

On 12 January 1802 Cavan wrote two letters to Lieut-General the Hon. H. E. Fox, C-in-C of the Mediterranean. The first one asked him and his officers for subscriptions, and started as follows:

"We have been for some days past busily employed about the fallen needle stone of Cleopatra, both in our minds and bodies, the former engaged in planning schemes for its transportation and the latter in constructing a wharf to launch it from, which is already advanced more than 25 yards into the sea.

The stone is near 70 feet long, 7 feet 8 inches square at its base, and 5 feet 1 inch square at the narrowest end; and weighs by calculation of 2700 Ounces to a cubic foot, containing 2600 cubic feet, 195 Ton. It has a solid pedestal of one stone, 6 feet 6 inches high by 9 feet square, standing on a flight of four white marble steps of 18 inches broad and as high."

The second letter was formal:

"To perpetuate on British ground the memory of the late events in this Country,

[1] King George III.

it has been proposed to remove one of Cleopatra's needles, and, in the name of the Navy and Army employed, to request His Majesty's acceptance of it. . . . Having thus explained our wishes and expectations, it remains for me as President, to solicit you to sanction and patronize the measure."

The C-in-C replied from Malta on 3 February approving of Cavan's motives, but he concluded his letter with these words:

"Yet from the Public situation I have the honour to be placed in, I do not conceive that I can with propriety sanction and patronize a measure, however honourable and commendable it may be, without previously knowing if it will be acceptable to His Majesty, without whose approbation I should hardly think myself authorized to assist in removing from the Country of an ally, a monument that has remained there for so many ages, and to which possibly there may be some ancient prejudice attached."

Admiral Lord Keith, the Naval C-in-C in the Mediterranean, wrote a letter in similar vein to Captain R. Donelly, RN, commodore in charge of the repatriation of French troops from Alexandria, and senior naval officer present. General Fox and Lord Keith both had their HQ at Valetta, and they clearly agreed on the policy to be followed.

On 20 February the Committee met again, and after much discussion decided to abandon the project, "in consequence of letters received from the Commanders in Chief of the Navy and Army, declining to sanction and patronize the measure of removing the needle-stone, and it appearing that they do not mean to countenance the undertaking". There was, in any case, some doubt if the work could be completed after the formal approval of the King and before the impending evacuation of British troops. Cavan therefore informed the C-in-C of the Committee's decision, pointing out in his letter that Mohammed Ali had given his permission, and that "subscriptions of the troops in Egypt, amounting to £4,000, was nearly, if not quite, sufficient to cover every expense". The *El Corso* was handed back to the prize agents, the troops were recompensed for "wear and tear on their Necessaries" while employed on the jetty construction, and the balance of the subscriptions was returned to the donors.

On 27 February Cavan wrote bitterly to General Fox: "As the matter is now decided, I express my opinion that Your Excellency and Admiral Lord Keith will hereafter feel concern for withholding your sanction, and indeed for giving almost direct orders to abandon the undertaking." Contrary to popular belief, both at the time and much later, General Fox never gave orders against the undertaking; on 31 March he wrote to Cavan, "I can form no opinion whether it may be approved by Government or not, but I must take the liberty of cautioning your Lordship that the Government cannot be put to any expense."

Many years later, Colonel Sir Alexander Bryce, CB, wrote this account of the needle in a Memorandum to the Foreign Office, dated 15 May 1820:

"It lies, I think, about 50 or 60 yards from the shore of the Eastern Harbour of Alexandria, and the lower side of it may be 5 or 6 feet above the level of the sea, which varies from a foot to 18 inches, according to the state of the winds and currents. The distance from the shore to where the water is 6 feet deep is about 50 yards, and it was intended that the Prize frigate, in which the needle was to have been embarked, should have been by means of casks, floated into the above depth of water, from which a way for rollers on a gentle descent was to have been formed.

"Not having any timber in the country, of dimensions sufficient to form a support for the rolling way in the water, or to form rafts, we were obliged to attempt the formation of a wharf, out of the materials of the ruined walls of the Ancient Town. The operation, having been begun in the boisterous season, the materials thrown in the water were frequently displaced, but I have no doubt the object would have been attained could we have procured, from Malta, the necessary stores of Purchase, which were withheld, and the undertaking discouraged.

"When the attempt was made, we had only the assistance of the *Hinde*, a 28 gun frigate, which was found quite inadequate, though Capt. Larcom made great exertions to furnish everything possible. A survey of the Harbours of Alexandria was made with great care by the Officers under my orders, and the Navy assisted in taking soundings."

Rear-Admiral R. Donnelly, in a private letter written in about 1825, (*d*) was rather more critical:

"As *El Corso* could not approach the shore in the Eastern harbour, near where the obelisk lay, a pier or wharf was projected into that harbour, upon which to convey the needle to the vessel. It appeared to me, that one quarter of its weight would have crumpled the wharf to pieces, and that the frigate, whose bottom was shaped like a wedge, was utterly unfit for carrying it down the Mediterranean Sea, much less across the Atlantic Ocean. The vessel must have been lightened to about 14 feet to allow her to approach the pier. In this state, the needle must have been conveyed into her stern or bow on rollers; but, as its weight would immerse her 2 feet into the water, the port hole to receive it must be more than 2 feet higher up than her then line of flotation. In fact, with ballast, or kentledge placed in her hold to counterbalance this great weight aloft, deposited near the line of flotation, she would, with a bottom like a wedge, be in danger of rolling away her masts and even of starting her planks and foundering."

The constructional activities for the transport of the needle formed a convenient starting-point for another operation devised by Cavan and his officers. A pale grey marble slab, 4 ft 9 in × 2 ft 4 in × 3 in, was engraved with the inscription already referred to. The words were composed jointly by the Adjutant-General, Colonel Samuel Auchmuty, 10th Regiment of Foot, and Lieut-Colonel John Montresor of the 80th Regiment. The inscription was carved by the hand of a craftsman, J. Alexander, possibly a mason of the Military Artificers. The plan was to entomb the slab within the pedestal, and then to re-erect the fallen needle in its original position, on the principle that a standing monument would survive the ages, against the probable destruction of a fallen and derelict one.

The RE and Artificer contingent came into their own, improvising enormous levers and planning the ramps required for the operation. The Artificers had their small quota of axes, mauls, saws and some carpenters' and masons' tools. No doubt some useful equipment was obtained from the defeated French and the jetsam of Napoleon's ships at Aboukir Bay, fourteen miles away. The country was in a shambles, and local resources were quite useless. The numerical strength of the Artificers was about sixty; there were also ninety Madras Pioneers, but the bulk of the manpower was entirely British soldiery.

The pedestal, shown in Fig. 1, consisted of an uppermost stone block of 25 tons, supported on a plinth of four steps. The first task was to heel over this block, so that the top surface of the plinth would be fully exposed. It is not known, of course, what engineering technique Bryce and his officers employed, but the description which follows is the most likely.

First of all, an array of iron wedges was driven in along one of the bottom edges, so that it was raised about an inch. Into this gap sand and small stones were forced. The wedges were then driven further, until larger stones could be forced in, and so on until the limit of lift from the wedges had been reached. They were then withdrawn and heavy wooden leavers inserted instead, each about 20 ft long. There was room for say six levers, each of which had to give a lift of 3 tons. With the levers manned for their full length by soldiers, each simultaneous application of their full weight raised the block a fraction of an inch, the gain in height being held by the stone packing, which was immediately driven further into the gap.

A quarter, then half an inch at a time, the great block was prised up at one edge, each tiny advance requiring the adjustment of added stone for the fulcrums of the levers. In time the stone packing started to assume gigantic proportions, smothering

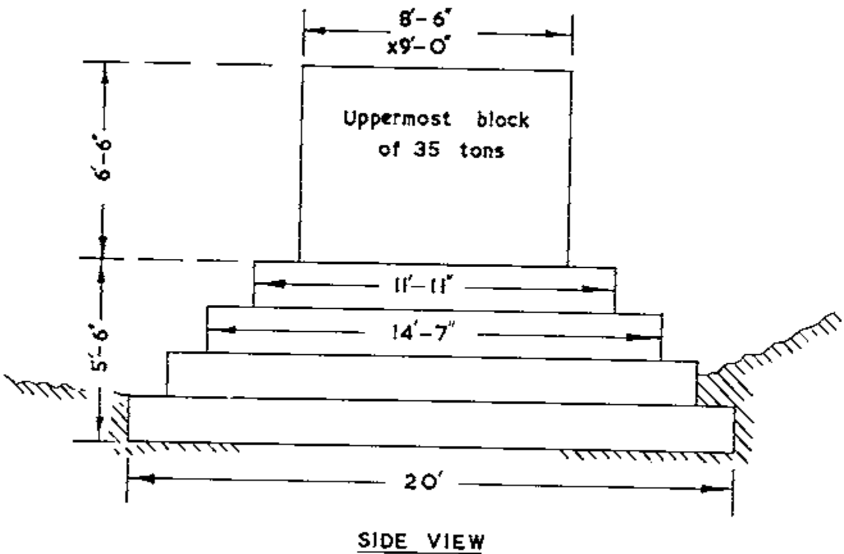


Fig 1.— Pedestal of Cleopatras Needle
(square in plan)

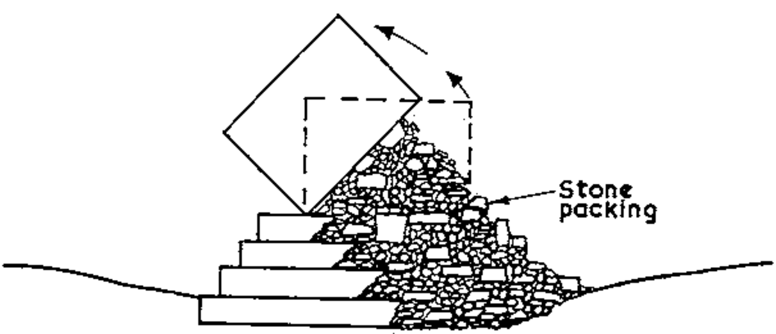


Fig 2. — Uppermost block near point of balance

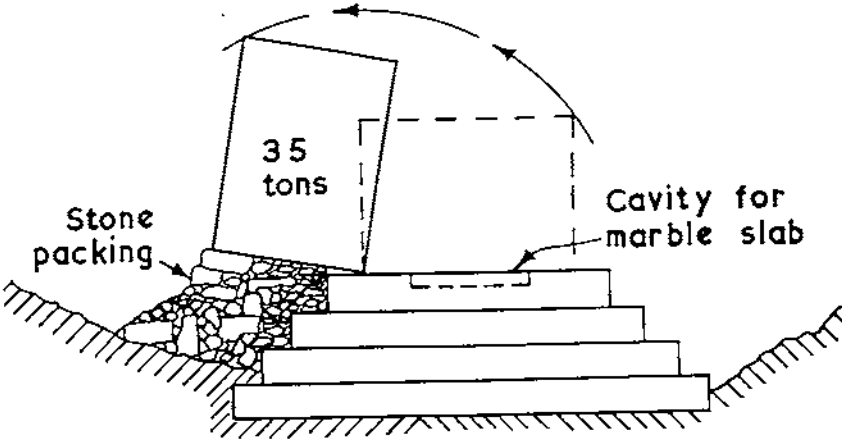


Fig 3. — Uppermost block heeled over

the plinth and towering about 6 ft above it. This was required to hold the weight of the tilted block and provide bearing for the levers. By the time the block had been levered through about 50 degrees (Fig. 2) and was near the point of balance, a rough stone platform had been built on the far side as well. In all about 80 tons of broken stone and masonry, from the surrounding ruins of centuries, had been man-handled to the pedestal for this operation. At last the block was levered over the point of balance, and rested on the platform in the position shown in Fig. 3. This engineering feat was directed by Bryce's RE officers, who unknowingly copied the technique of the ancient Egyptians, without any textbook guidance.[1]

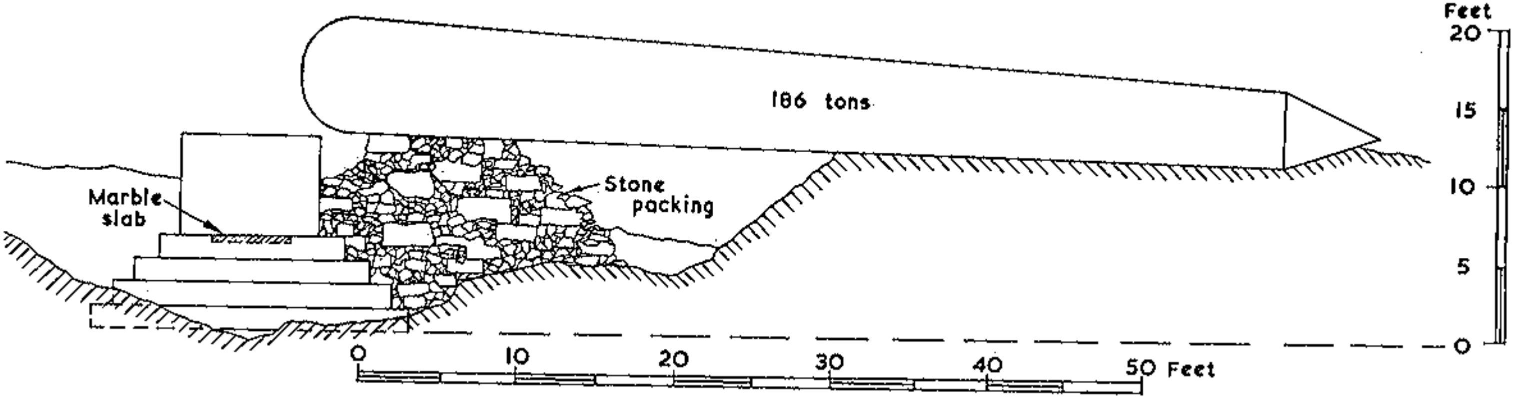
In the centre of the exposed surface of the plinth, masons of the Military Artificers cut a rectangular cavity, about 3½ in deep, of sufficient size to accept the marble slab. Into this cavity the marble and some coins were carefully deposited. Then the giant block was restored to its former position, by a reversal of the method already employed; but first a pile of about 40 tons of stone had to be rebuilt on the plinth, to take the weight as the block came over the point of balance. Major R. T. Wilson, of Hompesch's Mounted Riflemen, (*c*) recorded this part of Cavan's project: "The original pedestal he had raised on its outward angle, and, excavating the granite sufficiently to place in a piece of all the coins of George III's reign and of the present Sultan, he restored the surface by the Marble Slab, on which was sculptured the Inscription." John MacDonald, then a captain in the 89th Foot, also described this engineering feat, in his Memorandum of 8 March 1841, (*c*) when he was Adjutant-General.

The Indian Contingent set out in May 1802 on the long march to Suez, and thence home by sea. So it came about that the *Bombay Courier* of 9 June 1802 carried not only the full text of the inscription but also this account:

"The pedestal of the fallen needle of Cleopatra, having been heeled to starboard, and a proper excavation made in the centre of the base stone, this inscription on a slab of marble was inserted, and the pedestal restored to its former situation".

The next operation was to lever up the stone needle, of 186 tons dead weight, using the lever and stone technique. The RE officers, having successfully heeled over the 35-ton block, had sufficient experience to direct the raising of the needle of five times the weight. This mass was, of course, paltry when compared with far larger

[1] Engineering textbooks never have presented this technique! For a good description see *Aku-Aku* (Thor Heyerdahl, 1958) about raising stone figures on Easter Island.



NEEDLE DIMENSIONS

Butt end ———— 7′–7″ x 7′–0″

Narrow end below point —— 5′–1″ x 4′–9″

Overall length ———— 68′–6″

Fig 4. — Needle butt raised onto pedestal stones and monuments,[1] which the Ancient Egyptians erected—albeit with unlimited slave labour.

According to Major Wilson,(*c*) the needle was "raised horizontally on a block of granite, so that a man can walk upright under it". The needle was first raised and then edged, butt end foremost, on to a prepared platform of stones, until the end was resting on the uppermost block of the pedestal (Fig. 4). The Ancient Egyptian masons had rounded the butt at the edges, to facilitate the turning of the needle on its base when it was raised upright.

Time was running out. Towards the end of 1802 British troops were being evacuated from Egypt, and so the great project had to be closed down before its final consummation. The transports sailed from Alexandria, and the Engineer contingent watched sadly as the scene of their great endeavours receded in the distance, marked by the ever-dwindling height of the remaining erect needle. The men were Major Alexander Bryce, Captains William Ford, John Handfield, Lieutenants Charles Graham, John Squire, George Kennett, Robert Dundas, and James Arnold. Captain H. F. Brownrigg, RE, was also there; he had been attached to the QMG's Department. Lieutenant Charles Hayes, RE, was too ill to travel, and he died at Rosetta in July 1803. Sergeant John MacArthur, a Master-Smith, sailed too, with his men of the Royal Military Artificers. All British troops had reached England by March 1803.

From 1803 to 1810 HBM Consul at Alexandria was Samuel Briggs. During this period he was naturally in contact with Mohammed Ali, who chided him for Britain's failure to take away the needle, which was a gift from him to His Majesty. In 1819 Briggs returned in a private capacity to Egypt, and again Mohammed Ali confirmed that the needle was a gift from him. Of the obelisk, Briggs wrote: "It is now close to the sea shore at Alexandria, suspended horizontally on its pedestal, in the manner in which it was placed by our Officers in the year 1802, near to the site where the other obelisk is erected."

In 1820 Briggs returned to England, and on 11 April wrote to Sir Benjamin Bloomfield, private secretary to George IV, formerly Prince Regent:

"I was encouraged to submit to His Highness my opinion that one of the obelisks might possibly be acceptable to His Majesty, as unique of its kind in England, and which might therefore be considered a valuable addition to the embellishments designed for the British Metropolis.

"His Highness promised to take the subject into consideration, and since my return to England, I have received a letter from his Minister, authorising me, if I deemed it acceptable, to make in his Master's name, a tender of one obelisk to His Majesty, as a mark of personal respect and gratitude. I respectfully submit to you, Sir, in the first instance, this offer of the Viceroy of Egypt as being in its nature more personal than official,—therefore more complimentary to His Majesty. Should you deem it proper to take His Majesty's pleasure thereon, I shall be happy to convey to His Highness the Viceroy, the acceptance of his offer, if approved."

On 23 July Samuel Briggs was informed by the Foreign Secretary, Lord Castlereagh: "His Majesty has been graciously pleased to accept this testimony of good will on the part of His Highness, and to direct an Officer to proceed, without delay, to Alexandria, in order to enquire into and report upon the practicability, and the most proper means of transporting this valuable relic of antiquity to this Country". Appropriate instructions were then sent by the Colonial Secretary, Lord Bathurst, to the Governor of Malta, Lieut-General Sir Thomas Maitland. At the time HM Sloop *Spey*, of twenty guns, commanded by Captain J. D. Boswall, RN, was in Valetta Harbour. In accordance with the Governor's instructions, Boswall took aboard Lieutenant Charles Wright, RE, who was stationed on the Island, and the

[1] The largest needle transported outside Egypt was 105½ ft long (325 tons) erected in Rome in AD 40. It was re-erected in front of the Vatican in 1586. The largest needle quarried, but not erected owing to a defect, was 137 ft long (750 tons) at Aswan.

Spey set sail on 12 February 1821. She called in at Smyrna for four days, and later arrived in the Western Harbour, Alexandria on 8 March.

For the next twelve days Boswall and Wright, as instructed, were busily engaged in examining the needle and planning its transportation by sea to England. Their written report was completed on 21 March, and the *Spey* reached Malta again on 3 April. The report was there delivered to Sir Thomas Maitland, who, on a visit to London in June, sent it on to Lord Bathurst. A copy found its way to the Admiralty.

The report, of ten sides of handwritten foolscap, was, of course, the joint effort of the two officers, but it is evident that Charles Wright contributed the opening paragraphs:

"The obelisk lies 30 feet from the shore of the Eastern Harbour, 9 feet above the level of the sea, and separated from it by an Enciente of Fortification, which it would be necessary in part to destroy, previous to the formation of a Ramp, to conduct the obelisk to the beach. . . . (Here follow detailed dimensions of the obelisk and pedestal.)

"The specific gravity of the granite or Thebian stone, of which the obelisk is formed, has been found by several accurate experiments to be 2·67, and the weight of a cubic foot of it equal to 166·875 lbs. Avoirdupois. The weight of the obelisk by measurement and calculation of its original dimensions is 187 tons, and that of the Pedestal 36, from which at least 3 tons may be deducted on account of its multiated state. If to this be added the weight of the steps, 28 tons, the General Total of weight to be removed will amount to 184 tons."

For movement of the needle over the beach it was proposed to place it upon a cradle or frame, "to run on similar frames or ways, in which were metal concave grooves to receive spherical rollers of metal". The ship to carry it to England was required to be of about 1,000 tons displacement, for which 3 fathoms of water were required. This depth of water could only be reached by a jetty or mole 690 feet long. Such a jetty, if made of wood, would be difficult to make strong enough "to resist the prevalent gales of wind and long rolling swell to which it would be exposed"; the timber would have to be imported, and the estimated cost of a wooden jetty was £7,000. A similar one in stone would require 18,430 tons of material and six months to construct, at an estimated cost of £4,607.

The proposed method was to build a stone jetty only 90 ft long, and from its end to float the needle in a pontoon drawing about 9 ft of water. The pontoon could then be towed to the waiting ship, which would require a 12 ft square hole to be cut in its stern. The needle was to be transhipped horizontally. The report contained much technical detail on the internal arrangements of the ship, suitable for her heavy freight.. The overall cost, if carried out by civilian contract, was estimated at £15,000.

The report concluded: "It is the wish of H.H. the Viceroy that the whole expense of the formation of the pier should be defrayed by himself, offering at the same time every assistance in his power, either of labour or materials." He wished to defray every expense of the needle's removal, "until it was placed close to the very stern of the Vessel, appointed to convey it to England".

On 21 September the Admiralty were notified of the King's instructions "to proceed with the removal of the Obelisk". A year before the Admiralty had gloomily informed the Foreign Office: "None of our Men-of-War in the Mediterranean are fit to take on board the Egyptian Column." In November 1821, a sheer hulk, lying at Chatham, was examined as a possible means of transport. In fact, nothing happened, and the whole project gradually slipped into complete inanimation, which lasted for the next fifty-six years.

In 1847 the Prince Consort wrote to Lord John Russell, urging the removal of the needle. In 1851, the year of the Great Exhibition, there was a flurry of enthusiasm and proposals, all of which came to nothing. In 1860 the Khedive asked the British Government to remove the obelisk, "which my ancestor, Mohammed Ali, has given to England more than once"! At last in 1877, due to the determined enthusiasm of

Lieut-General Sir James Alexander, CB, a grandnephew of Sir Alexander Bryce, the needle was brought to England, and erected in London in September 1878. The expense of the order of £10,000 was defrayed by Sir Erasmus Wilson, FRS, and the story of its epic journey has been recorded on many occasions.

So the needle came to England, but not in the manner planned by Cavan and his officers, who had wished this event to be the personal tribute of the Navy and Army, in honour of Nelson and Abercromby. There remained, however, another memento, wrought, not by the hands of Ancient Egyptians, but with the loving care of a British craftsman, and preserved by the muscles of British soldiers and the ingenuity of RE officers; this had been entombed in the pedestal under 35 tons of stone in 1802.

In the 1820s the area of the Old Town, Alexandria, was being developed for houses and commercial ventures. The harbour wall needed strengthening, and there was a requirement for stone and site clearance. In November 1830 contractor's engineers demolished the pedestal of the fallen needle with gunpowder, and the marble slab was blasted into the light of day after its long sleep. This act of vandalism and "*lèse-majesté*" was promptly noted by H.B.M. Consul at Alexandria, John Barker, who wrote a strong protest to the Viceroy's chief Minister. The slab was intact after this violent treatment, but suffered surface score marks and a gash in the centre. Barker also reported the incident to the Foreign Office, and in a later despatch of 17 August 1831 added: "I have only further to state that the marble slab and medals, which had been placed under the pedestal, are in my possession, and that I await your Lordship's directions for the disposal of these objects." There were three gold, two silver and three copper English coins, and thirteen Turkish coins. On 20 August 1832 Lord Fitzroy-Somerset, the Military Secretary, wrote to the Foreign Office:

"I am directed by the General, Commanding-in-Chief, to request you will solicit Lord Palmerston to instruct Mr. Barker to send the marble slab and medals to this Country, Lord Hill being desirous of having them deposited in Chelsea Hospital."

Barker was therefore instructed to despatch them on the "first British ship-of-war, leaving Alexandria for Malta or England"; the package was to be addressed to "Lord Hill, The Horse Guards, London". Some time in 1833 the Royal Navy carried the precious burden home, and it was delivered to Lord Hill. He was so struck with the noble words, and the memorial nature of the tablet, that he humbly offered it, on behalf of the Army, to His Majesty, William IV. The offer was graciously accepted.

At the time the Royal Botanic Gardens, Kew, were the personal property of the sovereign, and it had long been the King's intention to build a memorial to British arms in the Gardens. In 1837 the Pantheon or King William's Temple was completed; on the inner walls of this Grecian temple were placed eighteen cast-iron tablets, bearing the dates and names of battles fought by British soldiers from 1760 to 1815. In the central and supreme place of honour, facing the entrance door, the marble tablet was affixed. The lettering was picked out in gold, and the whole surrounded by a stone frame, incorporating at the bottom a secondary tablet, with these words, carved in stone:

On the removal of
Cleopatra's Obelisk
the above TABLET was sent to
LORD HILL,
the Commander in Chief,
and presented by him to
King WILLIAM the FOURTH.

The Gardens were not open to the public till 1841, when Queen Victoria presented them to the State. The Temple, however, remained locked, as it contained personal property of the sovereign—a number of busts of the Royal Family and the marble slab. This state of affairs continued till 1887, when the Director of the Gardens,

W. T. Thistleton-Dyer, Esq, CMG, approached the Lord Chamberlain at St James's Palace. As a result, and with the Queen's agreement, the busts were removed to Windsor Castle, and the marble slab offered to the Metropolitan Board of Works. The Chief Architect inspected the tablet, and was so impressed that the Clerk of the Board wrote on 29 March 1888: "The inscription is very suitably placed. The Board might have some difficulty in finding a more appropriate place for its reception. They respectfully refrain from availing themselves of the offer."

In 1891 the inscription was accepted by the London County Council, and it was removed from the Temple[1] on 21 April. The Offices Committee of the LCC then recommended that it be placed "at the top of the first flight of the principal staircase of the Council's Offices". For some reason this plan was never put into effect. Owing to the military theme of the wording, it was then offered to the Royal United Service Institution, whose Council declined the offer. The tablet lay for the time being in the vaults of County Hall, London, until it was transferred to the War Department.

In the 1890s several of the long familiar red-brick barracks were built at Aldershot. The CRE South Aldershot at the time was Lieut-Colonel S. Waller, RE, and on completion of Mandora Barracks[2] he had the inscription and its attached stone tablet affixed to the wall in the entrance hall of the Officers' Mess just as it had been displayed in King William's Temple. Beneath it he left a space of about 2 ft for a final epitaph and, on 31 May 1895, wrote to Dyer at Kew Gardens:

"The tablet recording Abercromby's Victories in Egypt, which some 2 or 3 years ago passed from Kew Gardens into the possession of the L.C.C., is now fixed in one of the Barracks in this Camp. The secondary Tablet states that it was given to Lord Hill, and by him presented to King William the Fourth. We are anxious to fill in the missing link between its passing into the King's possession and being fixed in Kew Gardens, and I should be much obliged if you could give me any information on the matter".

With the information so obtained, he had a matching stone plaque suitably carved and inscribed, which was affixed in the remaining space. It bore the words:

It was fixed in 1837
By the King's Orders
In the Pantheon in Kew Gardens.
After the arrival in England of Cleopatra's Needle
It was given to the London County Council
And by them transferred to the War Department,
And fixed in MANDORA BARRACKS, Aldershot
In 1894.

In this manner Stanier Waller unknowingly recorded the epilogue to the works, so mightily executed by Alexander Bryce and officers of the Corps, generations before.

The story is now told. Through the endeavours of British soldiers and sailors, the tablet was preserved. It has found its last resting-place, most fittingly on English soil, amid a vast concourse of men of the same breed that fought under Nelson, Sydney Smith and Abercromby a long time ago. The slight imperfections of the lettering, the score marks on the surface, the gash in the centre, repaired with marble and lettered over, are poignant reminders of its creation and history. Cavan and his soldiers of 1802 can rest well content.

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(a) *Travels in Upper and Lower Egypt* (Vivant Denon, 1803).
(b) *Journal of the late Campaign in Egypt* (Captain Thomas Walsh, 1803).
(c) *History of the British Expedition to Egypt* (Lieut-Colonel R. T. Wilson, 1803).
(d) *Travels in the Holy Land and Egypt* (W. Rae Wilson, 1831).
(e) *Athenaeum* (22 September 1877).

[1] The outline of the tablet and the fixing marks on the wall are visible to this day.
[2] Now replaced by modern buildings, occupied by the RAMC, the new Officers' Mess houses the Marble Slab.

In the Year of the Christian Æra
1798
THE REPUBLIC OF FRANCE
landed on the shores of EGYPT an army of 40,000 men
Commanded by their most able and successful
GENERAL BUONAPARTE
The conduct of the General and the valour of the troops
effected the entire subjection of that Country
But under divine providence it was reserved for the British Nation
To annihilate their ambitious designs
Their FLEET was ATTACKED, DEFEATED and DESTROYED
In ABOUKIR BAY
By a British FLEET of Equal FORCE
COMMANDED by ADMIRAL LORD NELSON
Their intended conquest of SYRIA
was counteracted at ACRE
By a most Gallant Resistance
under COMMODORE SIR SIDNEY SMITH
And Egypt was rescued from their Dominion
By a British ARMY inferior in numbers, But
COMMANDED by GENERAL SIR RALPH ABERCROMBY
Who landed at ABOUKIR on the 8th March 1801
DEFEATED the FRENCH on Several Occasions
Particularly in a most Decisive action near ALEXANDRIA
On the 21st of that month
When they were driven from the FIELD
and forced to SHELTER Themselves
In the GARRISONS of CAIRO and ALEXANDRIA
which PLACES subsequently SURRENDERED
By CAPITULATION
To RECORD to Future AGES These EVENTS
And to commemorate the Loss Sustained
By the DEATH of
SIR RALPH ABERCROMBY
Who was MORTALLY WOUNDED
On That MEMORABLE DAY
IS The DESIGN of This INSCRIPTION
Which was Deposited here. In the Year of CHRIST 1802
By the British Army on their Evacuating this Country
And Restoring it to The Turkish Empire

J. Alexander, Sculp

ON THE REMOVAL OF
CLEOPATRA'S OBELISK
THE ABOVE TABLET WAS
SENT TO LORD HILL
THE COMMANDER IN CHIEF
AND PRESENTED BY HIM TO
KING WILLIAM THE FOURTH

IT WAS FIXED IN 1838
BY THE KING'S ORDER
IN THE PANTHEON IN KEW GARDENS
AFTER THE ARRIVAL IN ENGLAND OF CLEOPATRA'S NEEDLE
IT WAS GIVEN TO THE LONDON COUNTY COUNCIL
AND BY THEM TRANSFERRED TO THE WAR DEPARTMENT
AND FIXED IN THE 'MANDORA' BARRACKS ALDERSHOT
IN 1894

The Royal Engineers Benevolent Fund

On 19 November 1968 an Extraordinary General Meeting of the Royal Engineers Benevolent Fund resolved to amalgamate with the RE Association; to transfer all its property and assets to a new Royal Engineers' Association and to enter into voluntary winding up. On 19 January 1970 a General Meeting of the Fund approved the Accounts produced by the liquidator. The proceedings of this General Meeting are now with the Registrar of Companies and, after a period of three months from the date of registration, the RE Benevolent Fund, which had operated under various names for a century, will cease to exist.

There are no records to show what influences inspired the establishment of a Charitable Fund for the Corps in the early sixties of the last century, but it is not irrelevant to remember that at that time the writings of Charles Dickens were arousing the public conscience regarding the desperate plight of the poor. Indeed, in its early days the Fund aided windows of men who had served in the Crimea and the Siege of Delhi.

The origin of the Fund goes back to 1865, and in 1866 a proposal was discussed at the Annual Corps Meeting that an orphanage be established at Chatham for the daughters of NCOs and men of the Corps. This proposal was well received and a Committee was appointed to examine its expediency. Due, however, to various objections, it was found better to give effect to this proposal in a different form and so a "Royal Engineers Charitable Fund" was established at the Corps Meeting in 1868. The name was changed to "Royal Engineers Benevolent Fund" in 1943.

One of the Principal Objects of the Fund was "to focus the money given by officers to various military charities in order to produce a much greater benefit to the Corps than small sums can possibly effect". Another Object was to enable "Officers, not quartered at Stations where there are companies, to assist NCOs and men of the Corps and their widows and orphans, which they now have no opportunity of doing". Isolated sums, given by Officers to the Soldiers' Daughters' Home and to the Cambridge Asylum for Soldiers' Widows had small effect in influencing election to these Institutions, but collective sums, given in the name of the Corps, would have a greater power in securing the election of nominees of the Corps.

The Purposes of the Fund were numerous and included: assistance to widows of NCOs and the men and to assist in the education of their children; assistance to serving men and pensioners; provision was also included to assist wives or children in peculiar circumstances—cripples, incurables, idiots, etc; assistance also took the form of helping married NCOs and men to find lodgings at reasonable rents and to assist families in their expenses when proceeding to and from foreign stations. Help was also given in finding employment for pensioners.

On 22 January 1869 the first recorded Meeting of the Committee was held to settle various matters and on 9 February 1869 the first benevolence was effected by the award of an allowance of five shillings a week to three widows.

In 1869 253 officers and four other ranks subscribed a total of £503 10*s* 0*d* and £66 was received from units. By the turn of the century over £1,700 was being received annually from officers, but other ranks had been obliged to discontinue their contributions under current terms of Queen's Regulations. In 1901 there were 935 subscribers and £2,279 had been invested. When the Fund ceased to operate officers of the Corps were subscribing over £6,700 annually and the Fund was receiving £8,000 as the result or the "half-day's pay scheme". In 1969 subscriptions from serving soldiers had risen to over £20,000. Donations were also frequent and generous.

In the first year of its work £131 was awarded to deserving applicants and a further sum of £114 was paid to Institutions, which had accepted nominees of the Corps. Eight widows from the Corps were in the Cambridge Asylum for Soldiers' Widows, now the Royal Cambridge Home for Soldiers' Widows, and six daughters of soldiers had been placed in the Home at Hampstead. Two more children were found places in special homes.

During the course of operations by the Fund donations were received from time to time from Special RE War Funds. In 1870 the Abbyssinian Memorial Committee purchased a "perpetual presentation" in the Soldiers' Daughters' Home as a memorial to the Fallen of 10th Company. In 1901 RE Pretoria contributed £200. At the end of World War I moneys were received from special RE War Funds and others, and at the end of World War II over £50,000 was received from the funds of disbanded units.

After World War II there was a considerable feeling among senior officers of the Corps that a similar fund should be established for officers and their dependants. After much discussion the Annual Meeting of the Corps in 1950 approved in principle the establishment of such a fund, and at a Special Meeting of the Corps, held later in the year, it was resolved to establish a separate fund with its own income for officers and their dependants. A new Trust "A" was set up for this purpose and the existing assets of the fund were transferred to a new Trust "B", which was for other ranks. Trust "A" was established as the result of an appeal and by some officers earmarking their subscriptions to this new fund. Later a grant was received from the Army Benevolent Fund.

At the end of 1956 the total capital of the two Trusts stood at £124,000. Of this sum £119,000 had been invested, but the market price at the end of the year had fallen to £96,500. Income from investments amounted to a little over £4,000. To improve the position a number of holdings in Trust "B" were realized and some freehold property in the City was purchased for £24,000 which produced a rent of £1,650. At the close of the Fund this property was producing an income of £2,500 and was valued at £36,000.

Due to restrictions imposed by the Trustee Act in the field of investments which were giving returns of only 3½ per cent, authority of the Corps Meeting in 1959 was obtained for the Fund to become a Company, limited by guarantee. A Memorandum and Articles of Association were prepared with the agreement of the Charity Commissioners and the Fund was registered under the Company Act. A Committee of Management replaced the Trustees and a firm of merchant bankers was engaged to advise on investments. Income rose from £4,500 in 1957 to £9,300 at the end of 1967. When a Statutory Declaration was made to enable the winding up of the Fund in September 1968 the total assets of the Fund stood at £201,745. The cost of winding up the Company at less than 1 per cent of the assets more than justified the decision taken to form the Company in 1959.

At the time when the Fund was established the only form of State Welfare was the workhouse controlled by the local authority. Admission to charitable institutions was dependent upon a sufficiency of votes from sponsor-members. During the century a number of the original purposes of the Fund have been taken over by State and other bodies. The War Pensioners' Welfare Service attends to the needs of the disabled ex-service Man; National Insurance assists the sick and unemployed. Married quarters are provided for the married soldier. There are Old People's Homes and ex-soldiers may find employment both from Labour Exchanges and through the Regular Forces Employment Association.

Despite these and other forms of assistance real causes for help still remain and yearly over 1,500 applications for help are received from Sappers, past and present, and their families. Without the very generous help of retired officers and from serving ranks of the Corps the RE Benevolent Fund would not have been able to carry out its original purposes and to maintain its standards of help in the face of rising costs.

When the original RE Association was formed in 1912 there were two Corps organizations with complementary interests; in fact, the RE Association took over the finding of employment from the REBF. From time to time amalgamation had been considered, but when subscriptions from serving soldiers became a regular annual feature in the income of the Fund the necessity for amalgamating these two interests of the Corps became really apparent.

Confident that amalgamation would be in the best interests of the Corps, and that such a course would enable benevolence to continue on lines established for over a century, members of the RE Benevolent Fund at an Extraordinary General Meeting, held on 19 November 1968, unanimously resolved that the REBF Ltd should be wound up and that its properties and assets should be transferred to a new RE Association, the Trust Deed for which was also approved. The Objects, embodied in the Trust Deed, included all the original purposes and objects of the RE Benevolent Fund. So ended a century of benevolence of which the Corps may well be proud.

Correspondence

Brigadier Sir Mark Henniker, Bt, CBE, DSO, MC, DL,
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13 December 1969

TAKING TO THE BOTTLE

Sir,—Lieut-Colonel Everard ends his interesting description in the December *Journal* of the Dubai Petroleum Company's underwater "bottle" for storage of oil with the remark that "there could be a military application to this system of storage".

Whether this system will be useful in the future I cannot from retirement say; but it would certainly have been useful in the past. When landing on any beach a need would quickly arise for petrol, gas, oil and so on for vehicles; and as soon as an airfield was established enormous quantities of aviation fuel were needed. Hitherto the provision of storage, beginning with cans and barrels and ending with pipelines and tank farms, was a major supply and engineer problem.

The Dubai Company's submerged tank seems to solve those problems more simply. You bring your submerged tank by sea, filled with petrol, sea water and compressed air in suitable proportions to give it the desired (neutral?) buoyancy, and allow it to settle in the proper depth offshore. From it you pump to the captured landing ground near the beaches, and use tankers to replenish the "bottle".

Actually for the shorter duration of most military operations something simpler than the Dubai Company's "bottle", which is designed to last twenty years, might presumably suffice.—Yours faithfully, M. C. A. Henniker.

Memoirs

MAJOR-GENERAL J. C. T. WILLIS, CB, CBE, RI, RSMA, JP

JOHN CHRISTOPHER TEMPLE WILLIS, son of Paymaster-Captain G. H. A. Willis, RN, was born on 14 May 1900. He died in hospital, near his home in Farnham, on 12 October 1969, after a short illness, to the great sorrow of his many friends.

He went to school at Uppingham, and he later took a good deal of pleasure in recalling the fact that his subsequent entry into the Shop was due largely to his performance in Classics. In many ways this was typical of him; at heart he was a man of the Arts, rather than the Sciences, and for all his distinction as a soldier it was in the gentle art of water-colour painting that in later years he was able fully to satisfy his creative ability. None the less to a mind as quick as his no book was closed and he duly found himself in 1919 with a commission in the Royal Engineers.

Perhaps, with his artistic flair, it was inevitable that he should become a surveyor. Whatever his reasons, he found himself in 1923 in Malaya with one of the Colonial Survey Sections, which in those days were such an attractive form of employment for young officers. He was co-author of an article, published in an *RE Journal* of 1927, which described the work of the section in some detail; this bears all the hallmarks of his pen and might well serve as a model of how to inject wit and humour into a potentially prosaic subject. Later still, in 1931 and 1932, he wrote four short stories entitled *Survey Sidelights*, delightful little cameos of life in Johore as he saw it then, once again showing the family talent for writing which will probably be known to a wider circle through the work of his brother Anthony Armstrong.

He returned from Malaya in 1926 and served in MI4 in the War Office until 1930 and then in the Ordnance Survey until 1934. It was here that he once found himself observing pendulums for some gravity work. His superior, wishing to discover how he and a brother officer were progressing in this matter, wrote to enquire if they had yet finished swinging the pendula. Willis, no respecter of pedants, replied that they had swung the pendula and were now sitting on their ba doing sa.

From 1934 to 1937 he taught Survey at the SME, and there are no doubt many retired officers, and still one or two serving ones, who will remember the imagination and stimulating vigour with which he instructed his students. At the end of this tour he was given command of a small Sapper party, charged with the task of carrying out a principal triangulation for the hitherto untriangulated island of Jamaica. Such a neat, self-contained task was the sort of thing that all Survey officers dream of, and he was unlucky that the imminence of war led to his recall to England before the work was finally complete.

On the outbreak of war he became Assistant Director of Intelligence (Maps) in the Air Ministry, and when in 1941 a Director of Military Survey was appointed with a dual responsibility to both the War Office and Air Ministry, Willis became his Deputy, with special responsibility to the Air Ministry, and so he remained until the end of the war. By then he was clearly destined for higher things, and he duly progressed through Deputy Director of Survey Far East Land Forces to Deputy Director of Trig and Levelling in the Ordnance Survey, becoming Director of Military Survey in the War Office in 1950. It was in this post that he decided that the students at the Staff College needed educating in Survey, and he went down to Camberley to talk to them. It must have been a *tour de force*, because parts of it have been quoted so often and repeated in so many after-dinner stories by officers of all arms who heard him—being probably all they know or ever will know about Survey. To a somewhat bored and blasé audience, allegedly on the morning after a Guest Night, he opened by describing the scope of his job and illustrating it by saying . . . "and if I laid out all the maps in my main depot at Ascot end to end, beginning at Hyde Park Corner" (inward groans from his audience, who were

Major-General JCT Wills CB CBE RI RSMA JP surfeited with this sort of thing) . . . "I should be a damn fool". His listeners woke up, laughed, decided that this might not be so bad after all, were treated to more humour, and remembered what they were told.

In 1953 he was promoted Major-General and was appointed Director-General of the Ordnance Survey, which post he held until he retired in 1957. He was awarded his CB in 1956, having previously been given the CBE in 1953. For practically all his service he had been in Survey and it was with distinction that he occupied its most senior post.

He had always had a great talent for water-colour painting, and the increased leisure of retirement enabled him to develop and improve his skill considerably. He was elected a member of the Royal Society of Painters in Water-colour, where he exhibited regularly, as indeed he did at the Royal Society of Marine Artists, of which he was a Council Member, and at the Royal Academy.

He was an intensely warm-hearted, generous person, who was unsparing in his service to others. In 1957 he became a JP in Poole, where he then lived; he was a most active member of his local church, being a practical Christian in the full sense of the word, and he gave continuous support to the Blandford Disabled Club. Above all, he was a family man, and utterly devoted to his wife, Ursula, who for many years has suffered from multiple sclerosis. She, with their son Michael and daughter Pamela, survives him.

E.G.G. writes:

John Christopher Temple Willis was known as "Chris" to his many friends and probably to his enemies if, indeed, he ever had any, and that is most unlikely. I knew of none.

Chris was an artist. That he was a soldier and proud of being such was in keeping with that quality. He painted in water-colours, was a member of the Royal Institute, and all artists will agree that the successful use of that medium requires the dedication, stern purpose and self-discipline of the soldier. In particular it calls for careful thought and quick decision, acceptance of its limitations, accurate and deft strokes of the brush. There is no scraping out with water-colours. "How do you get those perfect white flecks on the running water?" I once asked him. "Leave the white of the cartridge paper unpainted," he replied.

The less said the soonest mended. Slow to anger but ever ready to forgive, he would tolerate lapses into inefficiency, never ungentlemanly behaviour from or by those who should know better. "What shall I do with him?" he asked me on one such occasion, and when I reminded him of the old saying that one cannot make a silk purse out of a sow's ear, he nodded and thereupon made up his mind. Shortly, the Army List was one fewer than it might have been.

It is probably true to say that Chris was not a deep thinker. Who can tell? Essentially his outlook was conservative, but imbued with the principle that those who have must give. Thus when he retired from the Army at the end of his term as Director-General Ordnance Survey he accepted without question a request that he be appointed a Justice of the Peace. How many brought before him when acting as such on the Bench benefited from his sympathetic understanding? He was a staunch member of the Anglican Church, served on the Parochial and Diocesan Councils. He had moved to Poole in Dorset and there I visited him. On the way to his house from the railway station we stopped at the church at which he worshipped and there I was invited to write my name on two slates, at half a guinea a time, about to go on the roof then under repair. Though my name might be obliterated in course of time, it would not, he assured me, be forgotten.

The house he bought backed on to Poole Harbour, in which he kept a small sailing-boat. To reach it one had to descend a flight of steps with handrails on both sides of them, carefully contrived so that his wife, Ursula, an invalid, could reach the boat, to be taken for a sail, and after it ascend without undue effort. The loft in the roof of the house he converted into a workshop and here he made from seasoned wood the frames to hold his paintings. They were made as though by a skilled craftsman. All he did was done as an artist. He was distressed when his son sought permission to resign his commission and asked me to interview him. This I did and from our friendly conversation came to the conclusion that the son's intention was wise, and I made my report. Chris was disappointed; then I reminded him that his brother, Anthony, had done just that when he was much of the same age, had served his country well, bringing happiness and pleasure to many by his books and plays. That seemed to console him.

Lest I have drawn a misleading picture of a man I revered, let me add that he was also a lover of fun. One example will suffice. When as a young officer he was given the task of doing a survey of the island of Jamaica, he carried with him a black-enamelled billiards-cue container, open at both ends, for personal use at night sleeping under canvas, when the rain was flooding down. In the bush he met an elderly man, an entomologist catching butterflies and moths for some museum. The latter was delighted at this unexpected encounter and wanted to know all about the survey instruments the porters were carrying. Chris explained. "What is that?" asked the butterfly catcher. "That is a thing to hold a billiards-cue. The man carrying the table is behind the other porters. You see, it is a bit awkward and it is heavy on the head." The entomologist gave a scream and ran into the scrub. He had met a madman!

Perhaps we all are madmen: but the world is the poorer for the passing of one such as Chris, and who shall doubt that the cold, grey slates on the roof of the church he helped to restore did not themselves weep at his going.

MAJOR-GENERAL B. K. YOUNG, CBE, MC

The Times and the *Daily Telegraph* recently reported that on 28 October 1969 Major-General B. K. Young died suddenly but very peacefully, after a long illness borne with great dignity and courage, the devoted husband of Eileen and loved by all his family and many friends—a man of gentleness and old-world courtesy. Faithful unto death. It was a short, but fitting, tribute to a most splendid Sapper officer, admired and respected by all who had the great good fortune to have served with or under him.

Bernard Keith Young—known throughout the Corps as "BK"—was born at Bangor, North Wales, on 11 March 1892. He was educated at Wellington College, where he became Head of House and a College Prefect. He passed sixth into the RMA Woolwich and was commissioned into the Royal Engineers on 19 July 1912.

During his young officer training at Chatham he played Rugby for the Corps, whipped-in to the RE Beagles and rowed seven in the RE Eight which competed in the Thames Cup at the July 1914 Henley Regatta. He was on his Mounted Duties Course at Aldershot when war was declared on 4 August.

Posted immediately to 9th Field Company RE, then a unit of 4th Division, he went to France with the Company on 22 August and took part in the retreat to the River Marne, during which operation he was involved in several major bridge demolitions and was mentioned in despatches. In April 1915 he broke his foot as a result of an accident and was sent back to hospital in London. From hospital he was posted to the RE Training Centre at Newark and in March 1916 he became Adjutant of the 60th (London) Divisional Engineers (TA), then undergoing its final preparations at Warminster before going to France in June. The Division took part in the battles of Vimy Ridge and Arras and BK was awarded the MC and mentioned in despatches. The Division was then transferred to the Salonika front, where it stayed for eight frustrating months before being sent in June 1917 to join General Allenby's Egyptian Expeditionary Force. It was closely involved in the battle for Beersheba, the capture of Jerusalem on 11 December 1917 and later in the assault crossing of the River Jordan.

In April 1918 BK gave up his appointment of Adjutant and joined the Egyptian forces in Khartoum. Frequent attacks of malaria, however, caused him to be invalided home towards the end of the year. After sick leave he was posted to Aldershot, where he served in the 1st Field Squadron and RE Mounted Depot.

He was given command of 15th (Fortress) Company RE in Gibraltar in November 1921. The next year the Company was sent at short notice to reinforce the British Forces in Turkey, then faced with the Chanak incident that nearly brought Britain single-handed into war with Mustapha Kemal's resurgent Turkey raised miraculously from the ruins of the recently routed Ottoman Empire. When this ugly and dangerous threat was overcome largely due to the coolness and diplomacy of General Sir Charles Harington, the British Commander, and the steadiness of his troops, 15th (Fortress) Company returned to Gibraltar in September 1923. From then on for the remaining three years of his tour of duty on the Rock BK was able to enjoy to the full the cricket, hockey, racquets, sailing, rowing, hunting and polo that the garrison had to offer in those spacious days.

Posted to the home establishment in September 1926 he took over command of C Company, the Training Battalion RE, and, on attaining his majority, he became Field Works Major at the School of Military Engineering. Whilst at Chatham he once again whipped-in to the RE Beagles. In November 1928 he was posted to Aldershot to command the RE Mounted Depot. In January 1931 he went to a Works Staff appointment in the War Office and in January 1933 he became Chief Instructor at the Royal Military Academy, Woolwich, and was made a brevet lieut-colonel. On promotion to substantive lieut-colonel he became CRE 2nd Division at Aldershot—a much sought after Sapper appointment—and he was the engineer adviser to two commanders who were later to become field-marshals: Earl Wavell and Lord Wilson. It was typical of him that, as a CRE, although he regularly played full back for the RE Aldershot hockey team, he was adamant that the team remained captained by a junior subaltern of the 1st Field Squadron RE.

In April 1939 he was promoted colonel with seniority back-dated to July 1937 and became the AAG RE. Although the Royal Corps of Signals was formed as a separate entity in 1920 its personnel administration remained with AG7 until the formation of AGII some time after the outbreak of the Second World War. When BK went to AG7 mobilization was imminent, yet its establishment consisted of only himself, an RE and a Royal Signals major and a small clerical staff. AG7 did, however, with these meagre resources manage not only the wartime mobilization of the Sappers and the Signals, but also the forming up of the Pioneer Corps. It was a hectic time and BK's inspired leadership was the driving force behind this remarkable achievement.

In January 1940 he was given command of 130th Infantry Brigade of the 43rd (Wessex) Division (TA) with the rank of brigadier. The two Territorial battalions of the Brigade were the 4th and 5th Dorsets, and after the War the Dorset Regiment made BK an Honorary Member of their Regimental Association, an honour of which he was always most proud and he took a great personal interest in all the activities of the Association.

Quite unexpectedly, and without prior warning, he was after the Dunkirk evacuation posted as a major-general to become Chief Engineer Home Forces commanded firstly by the late Field-Marshal Lord Alanbrooke and secondly by the late General Paget. The threat of invasion being over, he was posted in April 1942 to Egypt to become Deputy to Major-General H. B. W. Hughes, Engineer-in-Chief Middle East Land Forces. His duties involved responsibilities, not only in Egypt and the Western Desert, but also in Palestine, Syria, the Lebanon, Arabia, Iraq, Persia, Cyprus and the Sudan. After the landing of the Anglo-American forces in Algeria and the consequent early probability of contact being made between the First and Eighth Armies, General (later Field-Marshal) Earl Alexander went with a small staff to assume overall command of the Battle of Tunisia. He took BK with him as his Brigadier RE. He was, however, not to stay long in that appointment, as he was sent to Algiers, as a major-general again, to become Chief Engineer Allied Forces until the post was taken over by an American officer in August 1943, when he was posted home.

His final two appointments were Chief Engineer Northern Command, until March 1944, and Chief Engineer Home Forces until that Headquarters disbanded on 13 August 1945, after which he retired.

After retirement he was employed by the Royal Society for the Prevention of Accidents and when Lieut-Colonel J. A. A. Pickard, also a Sapper officer, left in 1950 after twenty-seven years' connexion with the inauguration and development of the Society, BK took over from him as Director-General, a position he held for nine years. During this time he was Honorary Colonel of 120th Construction Regiment RE (TA) from 1948 until the unit disbanded in 1950, and from 1952 to 1959 he was Honorary Colonel of 121st Army Engineer Regiment (TA). He was an active member of the Blyth Sappers and, on moving from London to Guildford after giving up his post as Director-General of the Royal Society for the Prevention of Accidents, he was closely involved with the Aldershot Branch of the Old Contemptibles Association and became their President.

On 4 March 1916 BK married Eileen Mary, daughter of Mr and Mrs W. Dawson, at St John's Church, Chester. They had two daughters. Our deepest sympathies are extended to his family.

BRIGADIER A. M. ANSTRUTHER, CB, OBE

ALEXANDER MEISTER ANSTRUTHER, Chief Engineer British Troops in Egypt at the time of the abrogation of the Anglo-Egyptian Treaty, died on 24 October 1969, in his sixty-eighth year.

Elder son of Arthur Wellesley Anstruther, CB, he was educated at Malvern and the RMA, Woolwich. He was commissioned into the Royal Engineers on 31 January 1923.

After his YO training he was posted to the RE Depot and in 1927 he took up a Works appointment in Edinburgh. He was at that time an oustanding swordsman and fenced for Scotland. He was twice placed third in the final of the Inter-Services Épée Pool at Olympia and he was a member of the British Épée Team in matches against Portugal and Holland. He also played cricket for the Corps.

From 1930 to 1932 he served with 40th Fortress Company in Hong Kong and Kowloon, and from 1933 to 1936 he served at Aldershot, first with 26th Field Company and then as Garrison Engineer Camps and Roads. In 1936 he was made Second Military Member of the RE and Signals Board, presided over from 1937 by Brigadier A. P. Sayers, when particular stress was being placed on the introduction of radar.

In 1939 he married Barbara Ivy (Sally) Macquisten.

Shortly after the outbreak of the Second World War he was promoted major to become a GSOII in the Intelligence Branch of the War Office. A year later he was given command of 77th Chemical Warfare Company.

On 1 January 1941, as a lieut-colonel, he was posted to the Inter-Service Research Bureau of the London Headquarters of Special Operations Executive formed in 1940 to encourage underground resistance by the planting of specially picked clandestine agents in enemy-held territory. He went as a temporary colonel to North Africa to represent SOE with the Eastern Task Force of TORCH (the British and American North African Landings of 1942). He worked with the American OSS representatives and, in conjunction with the French military authorities, he formed and trained an international force, known as the "Special Detachment", to operate on guerrilla lines. When the operations of this Detachment came to a successful conclusion he returned to London.

After a short time at the SME at Ripon, to catch up on Sapper developments, he became SOI E (Operations) at the War Office and during his time there he was twice sent to Washington, DC, in connexion with the procurement of engineer equipments and stores.

In January 1945 he was appointed Commander 17th AGRE, which was mobilizing in Northern Command for operations in the Far East. He embarked for India with the Headquarters of his AGRE later in the month.

In March 1946 he assumed command of 472nd Indian AGRE in Malaya and in June of that year he was given the task of the development of a 250-mile stretch of road from Kuantan to Kota Bharu along the east coast of Malaya to the Siamese frontier. His AGRE consisted of 25th Indian Divisional Engineers, 470th and 629th Indian Army Troops Engineers, 459th Forward Airfield Engineers and an Indian Tipper Company, together with four battalions of Japanese prisoners of war. It was a vast undertaking. Cuttings were blown through low hills, in some places stone causeways half a mile long had to be built, sixteen bridges and seventy-two culverts were constructed and several ferries, some of them power operated, were established. To supply the necessary stone a dozen quarries were opened. Work started in the middle of the monsoon and this slowed down progress. However, by November, when the repatriation of Indian troops began, it was possible to hand over the road practically completed to the newly established PWD. For his services he was awarded the OBE.

Brigadier A M Anstruther CB OBE

In December 1946 he was appointed Chief Engineer Singapore District with the temporary rank of brigadier, a position he held for almost two years.

In June 1948 he was appointed Deputy Director of Engineer Stores at the War Office and reverted to the rank of colonel and the following year he became Colonel (E).

In 1950 he went to the Canal Zone as Chief Engineer, British Troops in Egypt, with his headquarters at Moascar. In October 1951 the Egyptians unilaterally abrogated the Anglo-Egyptian Treaty and the large Egyptian labour force employed by us in the Canal Zone was either withdrawn or intimidated from working for us in the Zone, which had grown into a sizeable city full of soldiers and airmen with their families and a large military base with extensive ammunition and stores depots, workshops, hospitals and airfields with all the public utilities required to maintain them. At the same time the Zone and its inhabitants had to be safeguarded against armed Egyptian hostile bands. A heavy and vital responsibility was thus thrust upon the Chief Engineer BTE. The permanent RE establishment, backed up by three engineer regiments and airborne sappers from Cyprus, took over the multifarious tasks of maintenance and administration that had been abandoned. Sappers manned electric power stations and water-pumping and filtration plants—generally lonely posts on the Sweet Water Canal which, except for a few wells, was the Zone's only source of fresh water. They also ran the cold-storage installations and vital points in the sewerage and refuse-disposal systems. They took over the operation of the railways serving the Zone and stevedoring at the ports. They also constructed barbed-wire fences to protect camps, family villages and installations and laid minefields. They were reinforced by a number of RE Army Emergency Reserve technicians from home and specially engaged civilian engineers and tradesmen, and were fortunately able to call upon the services of East African and Mauritian Pioneers who had not at that time been repatriated to their native countries. However, so shorthanded were the Sappers that they often had to work twelve-hour shifts a day for seven days a week. For his services during those troubled days Brigadier Anstruther was created CB.

His last service appointment was Chief Engineer Western Command, which he held until his retirement on 6 June 1956.

After retirement he became Chairman of Nubold Development Ltd and he was a Director of Boathire International (1967) Ltd.

BRIGADIER N. A. BLANDFORD-NEWSON, OBE

NOEL ALEXIS BLANDFORD-NEWSON, "BN", died in retirement at his house overlooking Cork Harbour on 11 November 1969 after a long illness. He was a sapper of astonishing quality, endowed with ferocious energy, unusual technical knowledge, uncanny foresight, and an ability to get difficult things done rapidly, leaving behind him a trail of damaged egos, ruffled plumage, and memories of bitter argument which somehow almost always ended in his favour. There was much of the man of destiny about him, in that he cared nothing for the opinion of seniors, equals or especially juniors, who were always wrong. One remembers George Alms's famous dictum: "My Staff say they know where they are with me: they're always wrong." All that mattered to him were the rights of the problem as they appeared to his brilliantly quick and vivid brain with its power of instant decision.

How did this tiger of engineer dialectics, this eminent yachtsman and aviator, grow up? Born in England on 3 April 1900, he spent much of his early school life in New Jersey, USA. His father was in shipping in New York. Shortly before World War I the family came back to England and Noel went to school at Bedford. He then passed high into the RMA, Woolwich in January 1918 with nearly a year of war still to go. He chose Royal Engineers and passed out well up in Tuson's Batch after a fairly uneventful cadet year, becoming a corporal in his final term. 23 January 1919 was the commissioning date of this Batch. The newly commissioned second lieutenants all got first postings to field companies in the recently established Army of Occupation in Germany. Noel joined 76th Field Company for a year.

In 1920 Tuson's Batch assembled at Chatham as No 1 Junior Officers' Course. It was an energetic two years, during which Noel led the way for the yachtsmen. He quickly became the best and boldest skipper of *Fulmar*, the 14-ton REYC cutter yacht. He shared a small 3-ton sloop with others of the Batch, and skippered this tiny yacht on an adventurous cruise to Holland. The following year he took *Fulmar* to Heligoland in a stormy cruise which tore the mainsail and all the headsails into streamers and snapped the boom in two off Nordeney. She just managed to run back to Heligoland on her trysail, very low in the water with 4 ft of sea swilling around inside and a huge following sea which made bailing very strenuous and sick-making.

Powerful motor cycles gripped Noel's interest as a young officer, and with them he gave further hint of his rapidly developing dominant outlook on the world. His system of hand signals, quite unconsciously developed, and given so imperiously as to be successful, was one of directing opposing drivers to clear the way for him and his huge snorting Bellerophon.

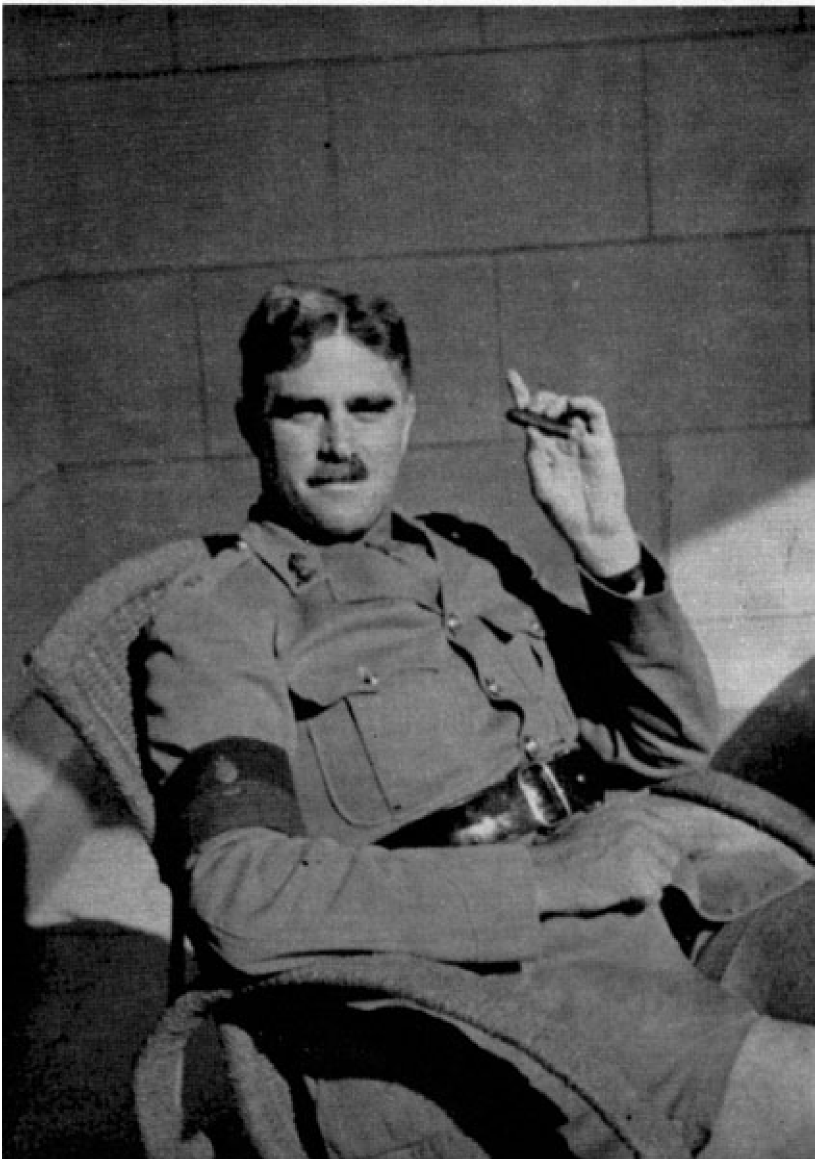
For a time Noel was a recruit party officer in the Training Battalion at Brompton. He was very strict. Then he was posted to the Experimental Bridging Company at Christchurch—the forerunner of MEXE. In 1925 he skippered *Fulmar* in the first Fastnet Race, gaining second prize and becoming a founder-member of the Ocean Racing Club, later RORC.

In the following year he skippered *Ilex*, a recent REYC purchase, into first place in tough conditions. She won the Fastnet Cup and set the REYC a hardy precedent which has guided it ever since.

He did a long E & M Course with Willie Blagden, later Deputy Director Fighting Vehicles. Both took fierce delight in intense technical arguments. For hours battle would be joined, with much personal abuse sharpening the fencing each delighted in. This rapid-fire lion-and-unicorn battle carried on into their adventurous yachting, but without damaging their friendship at all.

In 1927 Noel married Joan Penruddocke, who teamed up with him in a most colourful career of hard work, hard sailing and adventurous flying, chiefly in Egypt and in Scotland, where, while SOII, he helped to found the Edinburgh Flying Club.

For the next twenty-five years Noel did his sailing, on and off duty, in his *Nyata*, a powerful cruiser of 50 tons. In her he sailed, in 1931, from Scotland to Moascar in



Brigadier N A Blandford-Newson OBE

the Canal Zone for his posting to 42nd Field Company, and he sailed back in her to his SOII post in Scotland, where he used her to inspect the Scapa defences.

In 1936 he bought his own Miles Falcon light aircraft and, when posted once more to Egypt next year to the Treaty Building Committee, he flew there in her with Joan as navigator.

When World War II came Noel joined the Chief Engineer's Staff in Egypt and became a brilliant Engineer Staff Officer, working at furious pace to help turn Egypt and Palestine into a huge operational springboard. New problems of wild perplexity mushroomed. Under the inspired and inspiring direction of Eustace Tickell, Noel (and Joan, too, as his secretary) conjured up engineer answers from desert and delta and unskilled Arab—not without much of the savage biting argument and blazing invective which was Noel at work, shifting the Earth, or making a remarkable attempt to do so. His impact was immense on all ranks. His OBE came at about this time, while he was a lieut-colonel.

With the Mediterranean closed, Engineer workshops in Egypt started up a huge war-output of millions of anti-tank mines of local engineer design, petrol cans, jerrycans, Bangalore torpedoes, steel barrels, cement, oxygen and so on—all sinews of a desert war. Noel was deep in all this enormous effort, partly as AD Stores and later as CRE Production. He piloted himself throughout most of the Middle East war zone in a special light aeroplane, stirring his scattered bailiwick into strenuous activity. Ahead of him urgent warnings, "Look out. BN's coming", went as herald, carrying alarm and apprehension akin to visits of Gogol's Government Inspector.

At the end of a day of outstanding mental and physical activity, with the tiger that was Noel at full stretch, this astonishing man suddenly became the most thoughtful of hosts, or pleasantest of guests, the moment the office door closed. Others found this detachment difficult to match or understand, for passions boiled so furiously during his working hours.

When active war in the Middle East was over, Noel was posted to Calcutta and then to GHQ Delhi in the Engineer Branch. His last appointments were to Long Marston and then to Control Commission Germany as Brigadier, Director of Disarmament, in 1947.

Nyata was brought from the Hamble to Minden and Hamburg as a floating base for this large task. He retired in 1950 as a brigadier, and took to the sea and to Ireland with *Nyata*, then *Golden Gleam*, *Heatherbell* and *Perpetua*, all yachts of great seagoing quality.

He leaves a widow, two sons and a daughter. A brilliant sapper in the grand manner, with real bite.

W.G.F.

COLONEL G. WILLIAMS, OBE

Gerald (Gerry) Williams, one of the famous band of Middle East Movements and Transportation Sappers, died on 30 September 1969, aged 56 years, after a long and painful affliction borne with great fortitude.

As a signalman in the Royal Corps of Signals he was granted an emergency commission in the Sappers in 1941. He was after the war given a regular RE commission and spent his entire service in Transportation.

He served for the greater part of the war in the Middle East and was, in 1945, awarded the MBE in recognition of gallant and distinguished services in the Mediterranean Theatre.

After the war he spent a short time at Longmoor and from 1948 to 1951 he was firstly a DAD Transportation in GHQ MELF and then in command of a MELF Port Squadron. Returning home again in May 1951 he became DAD Transportation at HQ 264th (Scottish) Beach Brigade (TA) and, on promotion to Lieut-Colonel in 1953, he was made Port Superintendent and OC Troops of the military port of Cairnryan in Scotland.

He returned once more to the Mediterranean to become AD TN, GHQ, MELF early in 1956 at a time when the Headquarters had been set up in Cyprus, the civilian contractor-run base was beginning to operate in the Canal Zone and vast quantities of stores were being backloaded to Cyprus and to the United Kingdom and the British troops in Egypt were run down to a mere handful in Navy House, Port Said. Before the end of the year the ill-fated Anglo-French Port Said operation, which relied to a large estent on Cyprus as an advanced base, had been launched and withdrawn. Throughout this period the Transportation Branch was stretched to the limits, and for his outstanding work Williams was awarded the OBE.

On promotion to colonel in 1959 he came back as DD TN to the Transportation Centre, RE, at Longmoor.

He retired in March 1962, but this did not sever his connexion with Longmoor during the few years when it remained a Sapper Training Centre, nor when it was taken over in July 1965 by the newly formed Royal Corps of Transport as he became an author/editor of their Publications Section.

Gerry Williams had a great love of his Corps and its history. He became a foundation member of the RE Historical Society in 1963. He completed in 1965 a *Short History of the Transportation Centre, RE Longmoor* and in 1967 a work on the Reserve Army Transportation Branch in three parts, the first being a *Short Account of the Supplementary Reserve (Transportation) from 1859 to the Second World War*, the second covered *Docks from 1924 to the Second World War*, and the third part the *SR and Army Emergency Reserve from 1948 to 1965*. Although he used the adjective "short" in the titles of these works they were, in fact, most comprehensive and the result of an immense amount of work and research. Last year the Institution of the Royal Corps of Transport published his book *Citizen Soldiers of the RE Transportation and Movements and the RASC 1859–1965*, which was most effectively illustrated by one of his sons and was a worthy tribute to the dedication and competence of those splendid RE and RASC officers and soldiers of the Reserve Army.

Our deepest sympathies are extended to his widow, his three sons and his daughter. A Requiem Mass was said for him on 3 October 1969 at the Church of Our Lady of Lourdes, Haslemere, RIP.

MAJOR R. A. B. SMITH, MC

MAJOR RICHARD ALBERT BELCHAM SMITH, chartered civil engineer and a past Member of the Council of the Institution of Structural Engineers and of the Institute of Transport, died on 26 November 1969 after a long illness, aged 84 years.

During the 1914–18 War he served with the Royal Engineers, during which he won the MC. After that war he became chief engineer and a member of council of the British Portland Cement Association.

He was a former President of the Commercial Motor Users' Association and worked with the late Dr Stradling as chief technical intelligence officer in the Ministry of Home Security, being concerned particularly with the effects of bombs.

After the war, Major Smith advised the National Road Transport Federation, of which he was a vice-president. He was a member of the Government Committee for Road Safety and Chairman of the Royal Society for the Prevention of Accidents.

Major Smith was also on the management committee of the British Road Federation and a member of the general purposes and executive committee of the Automobile Association.

He was Master of both the Vintners' and Paviors' Companies. He was also a Governor of the Mermaid Theatre and a member of the Council of the City and Guilds of London Institute.

Book Reviews

SAFEGUARDING CANADA 1763—1871

J. MACKAY HITSMAN

(Published by University of Toronto Press. Price $7.50)

Dr Mackay Hitsman is a Fellow of the British Historical Society and a Member of the Society for Army Historical Research and of the American Military Institute in Washington, DC. He is at the moment a senior member of the integrated Directorate of History of the Canadian Armed Forces.

This, his latest work, follows his excellent, well-reviewed *Incredible War of 1812* and it is written in the same clear style and with the same masterly grasp of the political and military history of the time.

The story covers the period from Wolfe's capture of Quebec from the French on 13 September 1759 to the withdrawal of the last British troops from the historic Citadel of that city on 11 November 1871. The date of 1763, quoted in the title of the book, is that of the Peace of Paris which recognized the British conquest of all French territory in North America, except for the small Colony of St Pierre et Miquelon, and can thus be regarded as Canada's year of birth.

The opening chapters of the book include descriptions of operations carried out against the French and the Red Indians, the beginning of the quarrel between the British Government and the American Colonies over the latter bearing a proportion of the cost of their defence, and the part played by Canadians, of both British and French descent, and American Loyalists during the long struggle of the American Revolutionary years 1775 to 1783.

Then follows the story of the demarcation of the boundary between Canada and the newly formed, independent United States, and the development of a defence plan to safeguard it. The War of 1812–14 proved that the bastion of Quebec and naval superiority on the Great Lakes were of paramount importance for its successful prosecution, and demonstrated the value of using Red Indians as a terror weapon to scare the living daylight out of any American rash enough to set foot on Canadian soil.

Two further chapters describe the actions taken after the war to make more secure the widespread frontier defences. The Commission headed by Major-General Carmichael-Smith, Wellington's Chief Engineer at Waterloo, and Lieut-Colonel John By's Rideau Canal figure largely in this period, and indeed throughout the whole book there is constant reference to the important part played by Royal Engineer officers and soldiers of the Royal Sappers and Miners in the development of Canada and especially her defences.

The book closes with an account of the effects of the American Civil War of 1861–5 and the widespread fear felt by many Canadians, and also by certain members of Her Majesty's Government in London, that the Unionists, flushed with their victory over the Confederates, might send a strong, battle-hardened force to annex an almost defenceless Canada. As it turned out, however, the war-weary veterans of the Grand Army of the Republic had no desire for such a filibustering expedition. But as this threat evaporated another presented itself in the shape of the Fenian Brotherhood, an Irish-American secret society initially comprised of discharged soldiers of the Grand Army who were eager to strike a blow against the hated English in Canada. They planned an invasion for St Patrick's Day 1866 which resulted in a fiasco, but the Fenian threat continued for several more years and demanded the presence of British troops in Canada to guard against it.

The book concludes with an account of the Cardwell reforms of the British Army and the great reduction he proposed in overseas garrisons, including the Regular British Regiments in Canada, in order to build up at home a creditable Army for use on the Continent as a precaution against the menace from rising Prussian militarism. Thus British soldiers were repatriated and Canada started to build up her own Armed Forces to safeguard herself.

This erudite book deserved to be well studied and much will be learned about the views held by such diverse British statesmen as Pitt, Wellington, North, Castlereagh, Palmerston and Gladstone on the problems of North America and how the British Army was commanded and administered in the eighteenth and nineteenth centuries. Such study will not only be most rewarding and fascinating, but it will also show how over the centuries the pattern of our Imperial history appears to repeat itself.

J.L.

FALL OUT THE OFFICERS

SPIKE MAYS

(Eyre and Spottiswoode. Price 35*s*)

Spike Mays writes of life in the ranks in a cavalry regiment between the two World Wars. He relates all the tales, anecdotes, ruderies and half-myths that were known to any soldier in any barrack room in any unit of the British Army, and gives the impression that all originated from happenings in his own regiment—the Royal Dragoons. One he did not include, maybe because he himself was a "donkey-walloper", was the story of doubtful authenticity about the cavalryman who was so thick that even the other cavalrymen noticed.

His book gives a false impression of the "world of the other rank" of that period. The vast majority of soldiers were not drunken, half-illiterates nor riddled with VD. Intelligent conversation was not lacking in the normal barrack room and many men were a cut above their civilian counterparts in behaviour and manners and in their attitude towards women. One of the aspects of life in the ranks, that of immense pride in one's unit, is rightly emphasized by Mr Mays, but it is a pity that he did not lay a little more stress on the many intelligent soldiers who were later to prove their worth as Officers, Warrant Officers and senior NCOs in the Second World War. There were many shining examples of such men.

His book helps perpetuate the Press-inspired belief that all soldiers who served in the ranks between the two World Wars were foul-mouthed, brutal and licentious, and it highlights the one man who steps out of line and neglects the ninety-nine others who led decent lives. It could well be that Spike Mays set out to do just that, since a book about the normal happenings to ordinary soldiers might attract only a very limited reading public. But most soldiers of the 1920s and 1930s would agree that this book is a distorted record of life in the barrack room of those days.

H.J.

BUOYANCY AND STABILITY OF SHIPS VOLUME I

IR R. F. SCHELTEMA DE HEERE AND DRS A. R. BAKKER

Edited by PROF DR IR W. P. A. VAN LAMMEREN, MRINA

(Published by the Technical Publications H. Stam, Culemborg, The Netherlands)

This excellently produced volume is intended as a textbook for students and technicians already employed in shipyards and design establishments.

Ir R. F. Scheltema de Heere served for thirty-two years in the Navy Yard and in the Bureau of Naval Construction of the Netherlands Ministry of Defence. Drs A. R. Bakker has added a section on the application of the computer in shipbuilding. The text of the first part of the book has been based on the lecture notes of Professor Ir J. Gerritsma and Professors Harry Benford and John B. Woodward, both of the Department of Naval Architecture and Marine Engineering of the University of Michigan, have co-operated in producing the book in English.

Although this is mainly a highly specialized technical work, it contains many illuminating historical anecdotes about ships, both sail and steam, to illustrate the several stability criteria being discussed which would be of great interest to the more seriously minded members of the Royal Engineers Yacht Club.

L.

THE MAN WHO WAS BORMANN

DEREK BOYD

(Published by Robert Hale & Co. Price 18*s* net)

This book, written by a retired Sapper officer, tells how a Lieut-Colonel Michael Trench, DSO, OBE, MC, CRE of a British infantry division, and his ex-paratroop driver Sapper Nutt, MM, become involved immediately after the end of hostilities in the Second World War with others, including a Soviet defector, in an attempt to track down Hitler's deputy, the notorious and elusive Martin Bormann, and his ill-gotten treasure.

The story quickly jumps twenty years to 1965, when the quest for Bormann begins in earnest in Paris and in Cornwall, where high adventure follows high adventure and, although the resourceful and redoutable Colonel Trench and his gallant band triumph in all manner of desperate situations, we are left in the air as to Bormann's final fate. Indeed, the way remains open for him to reappear in a possible sequel.

The book is written in a breezy style and will appeal to those lovers of thrillers who do not bother too much if the plot is a little lacking in depth, nor worry unduly over how exactly the heroes overcame their difficulties, provided that right eventually conquers evil and, of course, that romance and the course of true love has a happy ending.

ALL RANK AND NO FILE

C. E. C. Townsend

(Published by the Engineer and Railway Staff Corps TAVR, Abbey House, 2 Victoria Street, London, SW1. Price £3 3*s*)

Major C. E. C. Townsend must be congratulated on this fascinating history of his Corps from its official foundation on 4 January 1865 to the present day. General Lord Robertson of Oakbridge, the Honorary Colonel of the Corps, has written the Foreword.

The Engineer and Railway Staff Corps is indeed a most unique Corps containing officers but no soldiers—All Rank and No File. Its members are gentlemen of eminence in the engineering profession and in British Rail and Port and Inland Waterway Authorities. The Corps gives its services to the Government free and its officers pay for the privilege of belonging to it. The Corps is a part of the T & AVR IV; its members are included in a special section of the *RE List*, and among its members is the only Royal Engineer now serving in the Active or Reserve Armies to hold the VC.

The lead towards the creation of the Corps was taken in 1860 by Charles Manby, at that time Honorary Secretary of the Institution of Civil Engineers, who proposed the formation of a "Volunteer Engineering Staff Corps for the Arrangement of the Transport of Troops and Stores, the Construction of defensive works and the destruction of other works in case of Invasion". Manby served as Adjutant of the Corps from its foundation in 1865 to 1884. The definition of the purpose of the Corps has not changed greatly over the years, the present definition being "A body of skilled engineers and transportation experts to advise the Government on such engineering and transportation matters as may be put before it". The threat of invasion was very real when the Engineer and Railway Staff Corps was formed, and it was again in 1940, and Major Townsend's book tells of the valuable contributions made by the Corps in those days and throughout its long history. It also indicates the close links that have existed between the Royal Engineers and the professional institutions. In this respect it is interesting to note that forty-five members of the Engineer and Railway Staff Corps have become Presidents of the Institution of Civil Engineers, eight Presidents of the Institution of Mechanical Engineers and fifteen Presidents of the Institute of Transport.

A centenary dinner was held in October 1965 in the RE HQ Mess and, to mark the occasion, the Officer Commanding the Corps presented to the Mess a most beautiful cut-glass chandelier which now hangs in the entrance hall—a glistening memento of a splendid and erudite Corps whose distinctive history should be read by all Sappers. J.L.

Technical Notes

CIVIL ENGINEERING

August 1969

Direct Reading Nomograms for Design of Anchored Sheet-Pile Retaining Walls, by G. M. Cornfield, MSc, FICE, ACGI, Technical Director, The British Steel Piling Co Ltd. This short article presents two nomograms intended for the direct design of anchored sheet-pile retaining walls in cohesionless soils with angles of internal friction of 30 degrees and 35 degrees. The use of the nomograms is limited to cases where the soil is homogeneous throughout the depth of the piling. The nomograms are based on the "equivalent beam" method of sheet-pile design—a method amply covered in the BSP pocket-book

The graphs illustrate clearly the variation of section modulus required and tie-rod load with varying water levels in front of the wall. Higher bending moments are induced in the piling at low-water conditions, whereas the tie-rod load is highest approaching high-water conditions. The nomograms should prove very useful for quick design studies, though it is a pity that all units are imperial, not SI. However, sheet-pile sections are unlikely to change in the immediate future and the nomograms will be useful for some little time.

GROUND INVESTIGATION FOR CONSTRUCTION OF HOUSING ON COLLIERY WASTE, by B. A. Walker, BSc (Eng), ACGI, FICE, MConsE. An interesting aspect of this article is the description of high-speed site-investigation techniques employed by the author. As an urgent decision was necessary on the suitability of the site, normal percussive boring methods were replaced by one using a large-diameter powered auger. A lorry-mounted Cheshire boring machine with an 18-in auger capable of drilling to 35 ft was used. Eight borings up to 35 ft were made in two days and undisturbed samples were recovered at the same time. As casing the bore was not possible and ground water caused the collapse of the colliery waste into the bore, success depended on speed and the maintenance of continuous progress. These high-speed measures were successful.

GEOTECHNICAL ASPECTS OF THE ABERFAN DISASTER, by Professor Bishop of Imperial College. Notes on this subject related to models and photographs exhibited at the 1969 Institution of Civil Engineers Annual Conversazione. The exhibits illustrated the occurrence and investigation of the disaster. The failure had three phases. Firstly, a rotational slip surface, which had been established a few years before, was reactivated. The resulting 20-ft movement caused the second effect of the tip material losing all shear strength and flowing down into the valley with disastrous results. The flow slide travelled up to 2,400 ft down the mountainside at a speed of 20 mph. The final effect was a mud run down through the flow slide.

JANUARY 1970

FLOATING CONCRETE CONSTRUCTION FOR AIRPORTS

MANY sappers will have read about the proposed floating airport at Foulness and perhaps have dismissed it as a crazy pipe dream. A. J. Harris of the Civil Engineering Consultants, Senior Partner of Harris and Sutherland, is a former sapper officer, an enthusiast for reinforced and pre-stressed concrete and has had a major part in the design of the Seadrome.

If the idea of floating concrete seems outrageous, we should remember the concrete barges for the Normandy landings. The concrete monoliths, which make up the airport raft, are 100 ft square and 40 in deep. Between the 5-in top slab and 3-in bottom slab purpose-made expanded polystyrene blocks provide permanent buoyancy should any seepage occur. The monoliths will be connected with 13/0.6-in strand prestressing cables.

The design is more than adequate for the Boeing 747 Jumbo jet and will permit the use of aircraft of 1,000,000 lb take-off weight.

The manufacture of the monoliths is envisaged behind collapsible inflated butyl bag dams. On completion, the bags are deflated and the monolith floated out of the casting bay at high tide. By any standard, the production of monoliths will be a mammoth task. A production rate of twelve monolith units per day will require 4,500 cu yds of concrete from a total mixer capacity of 18 cu yds. This enormous quantity of concrete will be delivered by conveyor to the casting bays.

The sea environment will provide unique problems. Protection from 8-ft-high waves will be by floating breakwater and a lightweight concrete wavewall around the raft perimeter. The design mooring forces are 2,000 tons longitudinally and 500 tons transversely.

In conclusion the author gives a detailed cost analysis.

As individuals we may be worried about whether the 3rd Airport is to be Stansted, Wing, Sheppey or Foulness. The authors are looking further than Foulness to Chicago, Los Angeles, New York, Tokyo and Caracas.

W.G.C.

THE MILITARY ENGINEER

NOVEMBER—DECEMBER 1969

Flood and disaster relief feature prominently in this issue. In "Some Hindsight on Foresight" is described the preparation of the defences against the Upper Mississippi floods of March 1969. There was a great deal of co-operation between the army engineers, who were responsible for the co-ordination of all defensive measures, local councils, and civilian contractors who carried out much of the work. Over 200 miles of levees were built, many of them reinforced with polyethylene sheeting weighted down by sandbags. A polyurethane foam spray technique, which looked excellent, proved to be unsound in practice, as this highly bouyant material floated away in spite of sandbag weighting. The use of bentonite sprayed on the water near levees is interesting. The expansion of this material makes it useful as a waterproofing agent; the seepage through several bunds was dramatically reduced in this way.

Another article on Hurricane Camile again emphasized the co-operation between army engineers and civilian contractors. The priorities here were

1. Open up communications.
2. Remove and dispose of rubbish.
3. Clear private property.

The use of a floating, submerged, fuel pipeline, made from epoxy fibre glass at Eniwetok Ltd, would be of interest to the POL enthusiast.

P.W.H.

Forthcoming Events

7 March	Army *v.* Navy Rugby Match	Twickenham
14 March	RE Draghounds Point-to-Point Meeting	Charing, near Ashford
14 March	RE Drag and Beagles Hunt Ball	RE HQ Mess
20 March	Assault RE Dinner 1970	London
24 March	REYC Dinner	RE HQ Mess
4 April	Army *v.* RAF Rugby Match	Twickenham
14 & 15 April	RE Golfing Society Spring Meeting	Woking
17 April	Airborne Engineers Officers Association Dinner	RE HQ Mess
19 April	Annual RE Memorial Service	Rochester Cathedral
24 April	Christmas Island Reunion	London
25 April	RE Dinner—Scotland 1970	HQ Mess, Scotland
15 May	QVO Madras S & M Dinner 1970	London
29 May	RE Surveyor of Works Dinner	RE HQ Mess
24 June	Corps Meeting and Dinner	London
25 June	Colonel's Commandant RE "At Home"	Hurlingham
3 July	RE Summer Ball	RE HQ Mess
22 & 23 July	RE Musical Extravaganza	Aldershot
25 & 26 July	Aldershot REA Weekend	Aldershot
26 July	RE Aldershot Garden Party	Aldershot

SPORTS AND GAMES FIXTURES 1970

RE RUGBY UNION FOOTBALL CLUB

11 March	RE *v.* RAMC	Mitchett
8 April	RE *v.* RMA Sandhurst	Sandhurst

RE HOCKEY CLUB

5 March	RE *v.* RA	Away
8 March	RE *v.* Villagers	Chatham
15 March	RE *v* Chimps	Chatham
18 March	RE *v.* United Hospitals	Away
4 April	RE *v.* T & AVR	Chatham
18 April	RE *v.* Southgate	Chatham
25 April	RE *v.* Spencer	Chatham

RE CRICKET CLUB

11–18 July	RE Cricket Week	Chatham
24–25 July	RE *v.* RA	Chatham
8–9 August	RE *v.* Band of Brothers	Chatham
12–13 August	RE *v.* Oxford Harlequins	Chatham

POSTSCRIPT

Major L. S. Wilkes, RE,
c/o 23 Base Workshop REME,
BFPO 20.
8 January 1970

GUNDULF

Sir.—The enclosed verse was placed on my desk by, I suspect, a REME officer of evident literary talent. Whilst possibly not strictly accurate historically, it is clear that at least one of the rival Branch recognizes that the Corps not only exists, but is well connected! I hope, sir, you may see fit to publish this unsolicited tribute.—Yours faithfully, L. S. Wilkes.

I'm Bishop Gundulphus a man of renown,
A buddy of William the First.
I had quite a hand in
His Sussex coast landin'
(Which was Op Overlord in reverse)

As Bishop Gundulphus my mandate was clear
My tasks were really divided
An LO to God
And a Sapper type bod
In my one corporate body resided

As Bishop Gundulphus I must carry the can
For a force that is still going strong
of Works men and Sappers
All going like the clappers
But I feel there is something that's wrong

As Bishop Gundulphus I'm sure that there is
At least it seems that way to me
Why can't I be shared
In a sense sort of paired
By the Chaplains as well as RE?

But as Bishop Gundulphus I've had time to reflect
So ignore the penultimate verse
Red facings suit me
More than purple you see
I'll stay HOLDFAST for better or worse