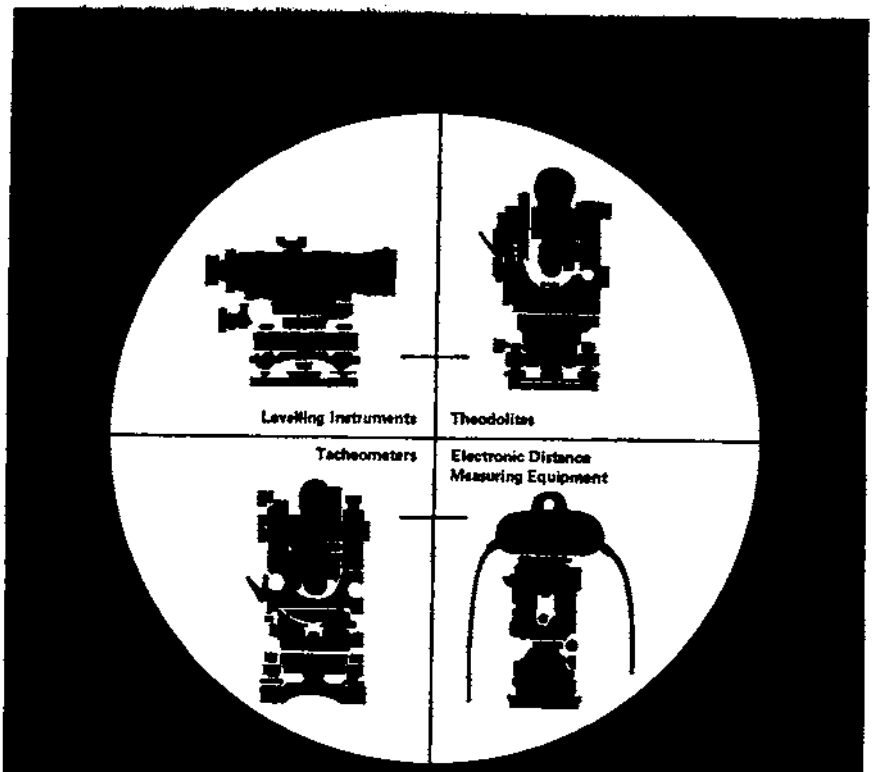
THE ROYAL ENGINEERS JOURNAL

Vol LXXXVII DECEMBER 1973 No 4

Published Quarterly by
The Institution of Royal Engineers, Chatham, Kent ME4 4UG
Telephone: Medway (0634) 42669

Printers
W & J Mackay Limited Lordswood Chatham Kent ME5 8TD
Telephone: Medway (0634) 64381



Swiss Precision surveying instruments - world wide

The WILD worldwide service is one of the reasons for the success of these instruments and for the fine reputation which they enjoy all over the world.

LEVELLING INSTRUMENTS

NK01	Builders Dumpy Level
NAKO	Builders Automatic Level
N10	Engineers Tilting Level
NAK1	Engineers Automatic Level
N2	Engineers Precise Tilting Level
NA2	Precise Automatic Level
N3	Geodetic Level

THEODOLITES

TO	Compass Theodolite
T1A	Engineers 20" Theodolite
T16	Engineers Scale Reading Theodolite
T2	Surveyors 1" Theodolite
T3	Precision Theodolite
T4	Astronomical Theodolite

TACHEOMETERS

RDS	Self-reducing Tacheometer
RK1	Self-reducing Alidade
DM1	Distance Measuring Wedge

ELECTRONIC DISTANCE MEASURING EQUIPMENT

DI 10	Medium Range Distancer
DI 3	Short range reduction Tacheometer

LASER ALIGNMENT EQUIPMENT

GLO	Laser eye piece for Wild Theodolites
GLA	Laser adapters for Wild Theodolites

Wild Heerbrugg (U.K.) Limited,
Revenge Road, Lordswood,
Chatham, Kent. ME5 8TE.
Tel: Medway 64471/5

WILD
HEERBRUGG

THE ROYAL ENGINEERS JOURNAL

Authors alone are responsible for the statements made and the opinions expressed in their papers

VOL. LXXXVII CONTENTS DECEMBER, 1973

4,100

THE COUNCIL OF THE INSTITUTION OF ROYAL ENGINEERS

(Established 1875, Incorporated by Royal Charter, 1923)

Patron—HER MAJESTY THE QUEEN

President

Major-General Sir Gerald Duke, KBE, CB, DSO, BA, C Eng, FICE, DL 1970

Vice-Presidents

Major-General M. E. Tickell, CBE, MC, MA 1972
Brigadier M. L. Crosthwait, MBE, MA, C Eng, MICE, MBIM 1970

Elected Members

Colonel B. A. E. Maude, CBE, MA 1968
Colonel W. C. S. Harrison, CBE, ERD, ADC, C Eng, FICE, MIHE ... 1970
Major W. M. R. Addison, RE, BSc 1970
Major D. McCarthy, MM, RE, AMBIM 1970
Brigadier J. D. Walker, OBE 1972
Colonel M. B. Adams, MA, C Eng, FICE 1973
Colonel D. G. Raschen, OBE, MA, C Eng, MIMechE, AMBIM 1973
Lieut-Colonel R. Jukes-Hughes, MBE, RE, C Eng, MICE, AMIHE 1973
Lieut-Colonel M. W. Knill, TD, RE (V), BSc, C Eng, FICE, FIWE 1973
Major F. G. E. Grainger, RE 1973
Captain P. G. C. P. Druitt, RE 1973

Ex-Officio Members

Brigadier B. C. Elgood, MBE, BA ... ... D/E-in-C
Colonel A. N. Brearley-Smith, OBE, AMBIM ... ... AAG RE
Brigadier J. I. Purser, OBE, BA ... ... Comdt RSME
Brigadier J. Kelsey, CBE, BSc, FRICS ... ... D Mil Survey
Colonel B. J. Coombe GM, BSc ... ... D/Comdt RSME
Brigadier P. F. Aylwin-Foster, MA, C Eng, MICE, AMBIM ... ... Comd Trg Bde RE
Brigadier J. R. E. Hamilton-Baillie, MC, ADC, MA, C Eng, MICE ... ... D. Engr Svcs

---

Corresponding Members

Brigadier P. Yonge, *Australian Military Forces* 1972
Lieut-Colonel J. M. Harman, BSc, C Eng, MICE
Royal New Zealand Engineers 1972
Brigadier-General N. C. Brown, DFC, CD
Canadian Forces 1971

Secretary and Editor RE Journal

Colonel E. E. Peel, BSc, C Eng, FICE 1972

Bankers

Lloyds Bank, Ltd, Cox's and King's Branch, 6 Pall Mall, SW1

The Sappers in Northern Ireland - A Personal View

LIEUT-COLONEL J F M GREAR, OBE, RE AMBIM

INTRODUCTION

SOME future volume of the Corps History will certainly deal in detail with the events in Northern Ireland since August 1969. It would be fitting if it did so, as this operation has engaged a greater percentage of the Corps than any previous internal security operation.

This article makes no attempt to provide an interim history. It is entirely a personal view of the Sapper operations during the period that I had the privilege to be CRE (September 1970–September 1972). The opinions expressed are mine and do not necessarily reflect official opinion. I have not attempted to cover the operations of Sapper units in the infantry role. Suffice it to say that they have done well and have shown that with adequate training the Sapper makes a first class infantryman.

Internal security operations have been the lot of the Army for many years. Northern Ireland is the latest entry in the catalogue, and it is unlikely to be the last. It has, however, a number of unique features that make it different from those that have gone before. These are:—

a The operation is within the United Kingdom. One does not need to spell out the difficulties that arise from this unpalatable fact.

b For the first time we are operating in a highly industrialized and principally urban European community.

c It is our first experience of operating in the full glare of world-wide publicity, and instant publicity at that. Propaganda aimed at the forces of law and order has had a wide distribution and a ready audience.

d The border with the Republic of Ireland is not, by international standards, a border at all. It is an administrative boundary such as exists between Hampshire and Wiltshire. To many of those who live there it has much the same significance.

It is against this background that the security operations must be viewed.

THE SEQUENCE OF EVENTS

The wide and constant coverage given by the news media makes it unnecessary to describe the sequence of events in any detail. It may however be of help to split the operations into a number of broad divisions:—

a August 1969–March 1971. The period of civil unrest and disturbances. The hardening of sectarian opinion. The entry and build-up of the Army, and the containment phase.

b March 1971–August 1971. Pre-internment. The start of the shooting and bombing.

c August 1971–March 1972. Post-internment. The escalation of violence.

d March 1972–August 1972. Stormont suspended and direct rule from Westminster. Violence continues. Military operations in low-key during intense political activity.

e August 1972–March 1973. Operation Motorman. The occupation of the "no-go" areas in Belfast and Londonderry. Political activity leading to the Border Referendum and, consequently, to the Assembly Elections.

It is immediately obvious that the removal of March and August from the Irish calendar could herald a return to normality!

THE SAPPER ORBAT

The first field squadron arrived in August 1969. A second was established in March 1971 and the third in November 1971. To relieve the load on the 3rd Division and 12 Engineer Brigade the third squadron was provided by BAOR. The length of tour of these units was four months, which on balance was correct.

The units from within UK were well used to moving around the world on emergency tours and exercises. Further, they were equipped to do so. The BAOR squadrons lacked this experience, and they were more used to operating from APCs than Land Rovers. The change from the mechanized role to that more akin to the Strategic Reserve was an interesting exercise and it is to the credit of all that it was achieved without undue drama. Whilst the Sappers settled in quickly there is some evidence to suggest that some people in command posts found it more difficult to adjust mentally to the very different mode of operation demanded of them.

Additional units and invididuals were provided for specific tasks, often at very short notice. For example, 8 Field Squadron came at less than a weeks notice to conduct Border Closure operations and a Tipper Troop RCT was flown in from BAOR, complete with vehicles, for Operation Motorman. The total Corps strength for this Operation was an RHQ, six field squadrons and a field support squadron. In addition a troop of AVREs was landed by the Royal Navy and before re-embarkation, twelve hours later, it had spearheaded the way into the Bogside and Creggan districts of Londonderry. It was certainly different from the normal run of exercises around Hohne.

The establishment of the post of CRE in September 1970 provided the continuity of command and engineer advice so necessary in an ever-changing situation. It took, however, a further year before an adequate staff was provided for HQRE. In fairness I should add that all command and staff branches suffered the same delay. I am led to believe that this happens at the beginning of all our operations. If this be the case it is high time that we got it right for the start of the next one.

COMMAND AND CONTROL

All Sapper resources were under the command of the CRE. From November 1971, when the third squadron arrived on roulement, each Brigade had its own squadron in support. The day-to-day tasking of these squadrons was a matter for the Brigade staffs.

The larger tasks were inevitably those emanating from HQ Northern Ireland. By retaining command I was able to task the appropriate squadron direct, after consultation with the Brigade concerned. This saved time, enabled me to influence the work and simplified liaison with other agencies, notably the DOE. The switching of our limited resources, particularly plant and RCT support, to meet a changing situation was a common requirement and was made the easier by having everything under one command.

That the system worked well is largely due to the sound good sense of the squadron commanders. There were always more tasks than resources and they gained much experience in the use of the priority system of tasking. It is pleasing to record that Brigade staffs very quickly discovered the need for allocating every task a priority.

TASKS

Although every phase of the operations posed its own engineer problems the following features were common:—

a The high incidence of artisan tradesmen's work, and

b the basic "sticks and string" engineering required. There was little call for the sophisticated.

Some comments on these two points and several specific tasks reinforce this observation.

As might be expected the work executed in support of and in conjunction with the DOE provided unit tradesmen with a most worthwhile, if not unique, opportunity to ply their trades. They took it eagerly. The standard of work improved steadily, and noticeably, as a tour progressed and it was on the whole good, bearing in mind the conditions under which they worked and the speed required of them. On the larger construction sites such as Long Kesh, a battalion camp used first as an internment camp and now as HM Maze Prison, the tradesmen's work reached a very high standard. This was largely due to the close and expert technical supervision and advice that was always to hand. This is not readily available in the field squadron, and it was noticeable that officers rarely had the knowledge to plan for, and control, the various tradesmen effectively. Of course they improved with experience but there is still little depth of knowledge. We expect much of our tradesmen, but apparently neglect to ensure that our officers know sufficient to employ and supervise them well.

The main "ingredients" of tasks, other than the purely constructional, are bitmac, concrete, timber, CGI, tubular steel, sand, sandbags, chain link fencing and barbed wire. The "recipe" differs but the method remains unchanged—basic skills and common sense. Speed is always vital. I was continually impressed by the ingenuity used to meet the needs of the moment. It is unfortunate that the basic skills in demand are those less thoroughly taught, and infrequently practiced. These skills take time to teach and develop, unlike those required to use our present range of modern engineer equipments which can be taught quickly, perhaps even on the job. I suggest that there is room for a thorough re-examination of our training priorities for both officers and combat engineers.

The demands on carpenters and bricklayers in this situation are such that every Sapper has, by force of circumstances, to become a professional handyman, capable of wielding a saw and a trowel with effect and without supervision. Until he can do so his output suffers. I consider that a thorough grounding in the elements of woodwork and bricklaying is one of the essential basics that must be given to every Sapper in his early training.

The one skill that has been found (not for the first time), to play a major part in IS operations is that of the searcher. Whilst luck and good intelligence play their part it is the searcher's skill that unearths arms, ammunition and explosives. The RSME teaches search techniques to eight teams from each battalion during its pre-Northern Ireland tour. The value of this training is clear, and the regular news of "finds" most heartening. It is obvious that this is a field in which we as a Corps must specialize. Our training, equipment and temperament suit the role well. Indeed, in Northern Ireland the field squadrons have continually provided back-up search teams using their trade and combat engineer skills to good effect. However, without a sound knowledge of the techniques and the organization required, as taught by the RSME, there is a distinct chance that the best use will not be made of our other skills. For this reason I consider that this is one more field in which our officers and NCOs must be trained as a matter of course.

The EOD role in Northern Ireland has been nobly shouldered by the RAOC. The skill and courage shown by the EOD teams has rightly received wide acclaim. We have been called upon to assist them in three main ways:—

a The search for and location of explosives devices, including the gaining of entry into suspect premises.

b The provision of combat engineer assistance during the neutralization of devices.

c Damage control operations after detonation of devices.

These tasks require no special training, other than up-to-date familiarization with the terrorist techniques and materials currently in use. We should, however, not lose sight of the fact that in different circumstances we may be required to play a more

active EOD role. It is for this reason that I now suggest that we should arrange to attach a small number of suitably qualified officers and NCOs to the RAOC teams. I am aware that the RSME does keep abreast of developments, but our knowledge must be on a more personal basis if we are to obtain and retain the practical expertise so painfully developed by the RAOC. The establishment of a QMSI (EOD) on the staff of HQRE was a step in the right direction, but did not go far enough.

A number of our construction tasks called for skilled design and supervisory assistance beyond the scope of my GE and CW(C). I was able to call freely upon the skills of 62 and 64 CsRE, and advice or a visit was always immediately forthcoming. Long Kesh Internment Camp, as it became known, was their star role. The design, the costing, the battles for finance, the stores lists, the initial contract work and the provision of supervisory staff were their contributions to a successful build. I am convinced that the professional and technical backing given by these units allows a normal field squadron to undertake major tasks without undue alteration to its internal organization or personnel.

Barricades are part of the Irish scene. They vary in form and size, but have one common feature—they must eventually be removed! This is of course a Sapper task, and one for which the Medium Wheeled Tractor is ideally suited. Little defeats it. The main problem is the provision of sufficient tippers to satisfy its appetite. When pressed we used 4 ton GS vehicles, upending them at the dump by crane. This works admirably, but it is wise to avoid using your own vehicles!

The attempt to restrict movement across the Border by demolition of all but the main and approved routes was an interesting, and oft-times dangerous, task which was undertaken with great gusto. The reaction of those who lived and worked astride the Border was predictably adverse and the repair and by-passing of blocked roads was swift, if rarely to County Council standards. We used explosives and plant, the latter ranging from the Light Wheeled Tractor to a Caterpillar D8H. Each operation was under the command of the local military commander, who was responsible for the security of the task and working party, liaison with the RUC (and on occasion the Garda) and clearance of the route to the site. The Sapper was thus enabled to concentrate upon his task. Two technical innovations were evaluated. The first, a prototype of the Rapid Cratering Kit, was most successful and proved to be a radical improvement in terms of time and manpower over the conventional cratering technique. The explosive used was granular Torpex rather than the RDX provided for the in-service kit. The latter is chunky and I consider that there are advantages in the granular explosive despite the weight loss for a given volume. I should also record that ANFO (Ammonium nitrate mixed with fuel oil) made a most acceptable substitute, and had the advantage of being readily available. The second evaluation concerned an attempt to produce a de-stabilizing agent to counter the repair of craters and rooted road surfaces. The MVEE recipe worked, but it was logistically impossible to use in the field and was therefore not put to the test. The operation ceased when Direct Rule was imposed, and the first production models of the Rapid Cratering Kit which arrived two days later were never used. As far as the Sappers are concerned the benefits of the operation were twofold:—

a The Sapper gained valuable experience in cratering using large charges and proper targets, an experience he hugely enjoyed, and

b The infantry and cavalry were introduced to the AFW 4012B, that much misunderstood document that has caused so much misery on practical promotion examinations.

We spent much time, effort and money in providing security measures at RUC stations, public buildings and the premises of key public services. This was, of coure, in addition to similar work constantly in hand in and around our own military locations. One is led to question the wisdom of providing new buildings and facilities for use by public authorities throughout the UK without apparently taking account of the security measures that may be needed to ensure their continuing function in the

face of mob violence or the terrorist. Military barracks, headquarters and depots are equally vulnerable. Open-plan building and site development may be pleasing to the eye and to the planner, but it poses problems of security which are horrifying in their immensity. It would be rather self-defeating if one had to deploy a major part of ones military and police forces in time of emergency simply to secure their bases. Naturally "it won't happen here", but I suggest it would be imprudent to neglect contingency planning in this field.

ENGINEER STORES SUPPORT

Engineer stores support was provided by 325 Engineer Park. This civilian unit, with a military OC and 2IC, was more attuned to the leisurely issue of training stores than the urgent and complicated demands of operations. To its credit it reacted splendidly.

In 1971, when our operations escalated, a small military staff was established on roulement tours to assist with the increased load. This Special Resources Troop freed, as far as possible, the civilian staff to concentrate upon park management, equipment maintenance and internal stores handling. The troop grew bigger with the passing of time, but in retrospect it was too little and too late. A more substantial military effort was deployed at the end of 1972. Immediately prior to Operation Motorman I asked for a strong composite troop from a field support squadron to give added capacity during and after that operation. In the event I had the better part of a full support squadron, at least on the command side, but I think that this was a mistake as the abundance of "Chiefs" tended to fall over themselves in their struggle to command too few "Indians".

In addition to the stores of engineer and ordnance provision handled by the Park, great reliance was placed upon local purchase. General construction stores were always in high demand. To meet the urgency that always accompanied stores demands we purchased from local suppliers. This was controlled by the Park, in my name, but a large part the responsibility devolved upon the squadrons, who maintained a powerful resources section for this purpose. Obtaining local resources will always be vital in an IS operation and the resources section must be headed by a high class senior NCO, with a combat engineer rather than a stores background. The provision of such a man is yet another problem for the harassed OC, but it is vital. Never has the old adage "The right stores in the right place at the right time" proved more necessary than in Northern Ireland.

Plant spares have been the usual perpetual problem. The new range of wheeled tractors were placed in service before an adequate stores backing was available, and whilst it was pleasing to have the machines it was frustrating when they could not be repaired. To add to the confusion there was also a Punch-like mix-up between the makers "parts list and numbers" and those fed into the Ordnance computer, which had been NATO codified. We quickly found that so far as major assemblies were concerned the best channel of supply was our own. We were fortunate that the machines were new and robust, but it is obviously wrong to have to rely upon expediency to keep them on the job.

Of lesser importance, but of equal frustration, was the difficulty we experienced over the provision of nails, screws and bolts. Stocks held by Ordnance in Northern Ireland were understandably small, and we had to depend upon supply from the UK Base. Unfortunately the computer does not think to offer alternatives and on occasion it became a challenge to avoid running out of these necessary fixings. We were not helped by the gremlin in the machine who, in answer to our demand for a hundredweight of 4-in nails, duly and triumphantly delivered 112 such nails the next morning. The timber and the CGI was of engineer provision. It would seem logical to expect that the fixings should be provisioned from the same source.

EQUIPMENT

The field squadron has, in the Medium and Light Wheeled Tractors and the 400 CPS

tool kits, three splendid equipments. Their value in versatility and output is immeasurable. The same praise cannot as yet be extended to the general section and tradesmen's tools.

The new range of wheeled tractors was given its first major operational test in Northern Ireland. The tractors passed with flying colours. They are tough, fast and versatile. For this operation they have been fitted with armoured cabs, designed and manufactured by MVEE at very short notice. They have given the operator much needed protection, and have added to the machines' military beauty. The performance has not been noticeably affected despite the additional weight. The installation of radios in each machine proved very successful. I consider that there is a case to be made for the provision of armoured cabs wherever plant may be deployed in an IS situation.

The new range of 400 CPS tools and generators have also been given a thorough workout. They are invaluable. Whilst continuous running does pose a maintenance problem both tools and engine are more robust than was at first apparent. However, having had experience of the first generation Bosch diesel generator I regret the move to a petrol engine, logistics apart. I consider there is still a strong case for introducing the Land Rover-mounted 17·5 KVA generator as tested by MVEE (then MEXE) in 1966-67. Apart from being in line with the concept of APC mounted power units it would prove invaluable in route maintenance and damage control duties, let alone on major construction sites.

So much for the praise. The state of the remainder of the squadron G1098 leaves much to be desired. In general terms it is old, unnecessarily heavy and cumbersome. In this connection it should be remembered that modern materials preclude weight being the criteria of robustness. There is an urgent need for a radical and complete review of the many tool kits which presently encumber the squadron, as well as of the general section tools. In some areas the introduction of new tools is so urgent as to demand crash action. For instance, the "Tape, Metal Woven 100 feet' is notoriously inaccurate and prone to breakage. Accurate measurement is the basis of much of our work and we would benefit by the immediate introduction of a glass fibre tape as recently tried and approved in Northern Ireland. Much advantage would be gained by the introduction of a general-purpose section tool kit, containing tools that at present can only be obtained by robbing specialist artisan toolkits. Elementary carpentry, plumbing, painting and bricklaying should be catered for. Above all I would suggest to those responsible for review that they disregard the stocks of outdated tools still held on the Ordnance shelves. These could perhaps be sold, in the manner of other outdated military equipments, to an emergent nation.

CONCLUSION

I have touched on the tasks, stores and equipments, whilst almost neglecting the most important factor of all—the Sapper, his NCOs and Officers. I can say little that is not already known. We have top-rate Sappers, our NCOs are among the best in the Army, and the young Officers, whilst short in practical experience, lack nothing in endeavour and energy. All benefit from a tour in Northern Ireland, and their increased stature is apparent when they return for a second visit. I would also mention the REME, RAPC, and ACC supporting elements. Their skill, dedication and sense of identity leave nothing to be desired. They, in common with their Sapper colleagues, have done a man-sized job, and done it well.

Northern Ireland has given us the opportunity to show that the Sapper role is to help the Army live, move and fight. We have once again proved that the field squadron is an indispensable part of the fighting machine. The image, fostered by many years of BAOR soldiering, that Sappers play with boats and draw white lines on bridges whilst others toil manfully has been shattered. It is pleasing to reflect that, at the first hint of trouble the infantry now shouts for the Sapper, in the sure knowledge that he is close to hand and able to help.

The Corps in its turn has benefitted greatly from the experience. We have learnt, and re-learnt, the basics of our art. Our commanders at all levels have gained experience in operations. Some deficiences, now to be remedied, have been highlighted. And most important of all, the young men of the Corps have found for the first time that our true role is the close and intimate support of the other teeth arms.

The Dhekelia Swimming Pool—Phase 1

CAPTAIN C L ELLIOTT, MBE, RE, BSc (Eng)

FOREWORD BY CO 22 ENGINEER REGIMENT

This report was written by a young substantive lieutenant (now a Captain), a field troop commander, who was set a somewhat complex design and construction task after just over a year in his first tour following university.

It will be of particular interest to those young officers who fear—or hope—that engineering challenges do not come the way of subalterns in field squadrons. It may also serve to surprise those older officers who believe the young unqualified to compete with such tasks, or who consider "real engineering" to be the province solely of highly qualified specialists.

Should the report appear in parts to be claiming merit, it is because I have forced the author to overcome his natural diffidence in order that the reader may be given a clearer feel of some of the problems which had to be recognized and solved by a junior officer.

Above all, the report demonstrates yet again the value of the inquisitive and enquiring—ie engineer's—approach when faced with an unusual Sapper task.

INTRODUCTION

PROJECTS within the Royal Engineers are often stunted during growth, if not actually strangled at birth, by a lack of funds. When 22 Engineer Regiment was given the chance, in November 1972, to take on the design and initial construction work for an interesting civil engineering project, to which there was already a generous allocation of funds, the task was accepted enthusiastically. Money had been set aside to build a large amenity swimming pool in Dhekelia Garrison, Cyprus, and CRE NEARELF was anxious to start the project, but due to pressure of priority work 62 CRE (Construction) was unable to undertake the design. 8 Field Squadron were assigned the task in December 1972 with orders that construction was to start at the beginning of a Regimental exercise due to be held in Cyprus in April/May 1973. A full time Design and Construction team of one officer and five was established by OC 8 Field Squadron on the 3 January. By the 4 January we began to realize the size of the problem.

THE PROBLEM

We quickly learned that swimming pools are disaster prone. Those whose sides do not fall outwards under pressure of water can collapse inwards, as a result of pressure from the surrounding earth or a passing groundsman taking a short cut round the edge on his tractor. A small leak can rapidly destroy the strength of the subgrade and it matters little whether this causes the base to crack across the middle or the whole structure to cant and point like an accusing finger to the sky. Finally, a rise in the water table can cause the empty structure to float. Failures are frequent and, as a result, civil engineering firms normally prefer to leave construction to specialists in the art.

THE REQUIREMENT

A pool was wanted which would provide for a wide range of activities. It should be

50 m long for international competitions, yet provide for learner and junior swimmers. It was to be sited in an area alongside the sea that did not easily allow digging below 2 m. A design was rapidly sketched out and, by 1 February, it became apparent that several of the requirements were incompatible. However, by the end of February the requirement had been satisfactorily readjusted and, almost of more importance, an accurate soils analysis had been done. The pool was now to be 25 m long, 14 m wide and from 1 m to 2 m deep. The size would satisfy all the requirements less that of international competitions.

THE DESIGN

The time for design was critically short. The Design Team spent early January visiting experts and discussing the problem of the design of the pool. Letters were sent to sixty companies asking for advice. In particular, frequent visits were made to the Cement and Concrete Association, RMCS Shrivenham, 62 CRE (Construction) and the RSME. Our ideas began to take shape and a reinforced concrete structure was decided upon. *Military Engineering*, Volume 14, Reinforced Concrete Design, includes a design for a large water-retaining structure such as an open reservoir or pool. It is based on the idea of a perimeter of free-standing walls with a large area in the centre of thin, unstressed slab. The horizontal forces on the wall are counteracted by the toe, rib and heel of the wall and no stresses are transferred to the central slab. So long as the subgrade is stable the central slab has no bending forces to resist and is merely an impervious membrane. Thus there is a large area in the centre of cheap, thin slab. This concept was adopted and a design, including costs and quantities, published by 1 February 1973. The cost of a pool 50 m long was found to be beyond the funds available. Whilst a smaller pool was being agreed, the pell-mell rush of ideas had had time to mature. The design concept had been discussed with a number of civilian structural engineers and pool designers in particular. In addition, a design library was built up and the subject widely read. It became clear that the concept of *ME* Volume 14 was not the one now generally adopted. However, the actual methods of design in use today are based to a surprising degree on the experience of the designer. They are largely empirical, amended when failures occur, and very little is written down. There were many instances of where "the expert's" ideas were in mutual conflict. It became clear that there were innumerable approaches to swimming pool design and that whichever route we chose we could find an acknowledged specialist who would not only support it but claim it to be the only true way.

One encouraging consultant told us that he would not attempt the design with less than nine months to work on it!

At Dhekelia, a subsoil of silt was particularly worrying, since changes in moisture might exert varying pressures on the base of the structure. Also, several civilian contractors appeared surprised by our quaint method of knitting in the steel and water-bar jointing strip at the base of the wall. Consequently, the design concept was changed to that of a straight monolithic tank which could be likened in section to an unrestrained portal bridge upside down. This would certainly be simple to construct and rigid when built, but broke all rules by having concrete sections 14 m long without a joint; that is, double the size allowed in the British Standard. After much discussion a satisfactory solution was arrived at. Firstly, great care was to be taken to ensure that the structure as a whole could slide over the base to relieve stresses. Secondly, deformed steel bars at close spacing for the concrete reinforcement would be specified, to ensure that tension stresses were transferred to the steel and not taken by the concrete.

The benefit of a "tank" design was that the toe and rib at the base of the wall could be done away with; the steel and water-bar in this area was much simplified; and the central slab was now rigid and could resist any local subsoil volume changes. These advantages were at the cost of a thicker and more expensive central slab of structural concrete. The design of this central slab was difficult since the deflection of the subgrade under load was not sufficiently predictable. Professor J M Hawkes at

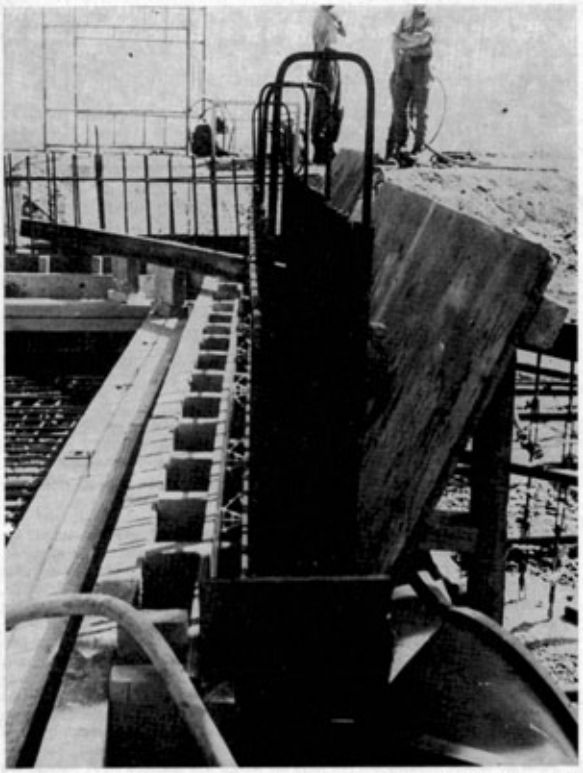


Photo 1. Corner bay base prepared for pouring. Note the steel channel used to support the inside formwork from above and the scaffold tower to provide lighting for the night pouring.

RMCS Shrivenham kindly tried to find a solution by making and loading a perspex model, but the results were inconclusive. The slab was eventually designed to carry the worst, and therefore most expensive loading.

THE MOUNTING PHASE

The final design began on the 28 February and the next four weeks were crucial.

The Design Team had been well tutored during its training about how "Engineering Disasters" could occur. If the construction was to be started by 8 Field Squadron during April/May, certain design decisions were now being pressed for so that, for

The Dhekelia Swimming Pool- Phase 1 (1)

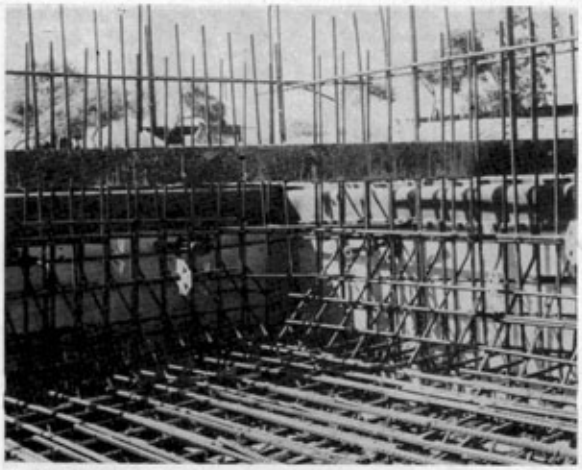


Photo 2. Detail of steel and fixing systems in a corner bay shown before fixing fillet formwork in front. The water-bar is nailed to the rear formwork.

instance, stores could be ordered. It was a tightrope between holding back until the design had been thrashed out and intuitively forecasting what that design might be.

Forunately, our masters showed an encouraging confidence and the advance party of twenty, under Lieutenant C H Scott RE, left for Cyprus on the 12 March, with only one-third of the design resolved. Their task was to excavate the hole, set up the site administration and to place orders for stores.

A 1 m horizontal layer of limestone proved harder to break up than was predicted from previous local experience and explosives had to be used to excavate. Even so, the advance party made lightning progress and were constantly badgering Tidworth by the satellite telephone link for more design data. By the 1 April the site was ready to receive the main construction party, with the excavation complete and the batching plant established. The advance party had achieved much by good planning and long hours of work.

After an almost frenzied last few days the design was finalized on 31 March. We ended deeply in the debt of 62 CRE (Construction) who, in spite of their other work load, were always ready to check, guide, encourage and give approval to our design.

THE CONSTRUCTION PHASE

The main body arrived in Cyprus on 1 April, bringing with it three tons of special stores from the UK. The steel bar bending schedule had been drawn out on the floor of the Air Mounting Centre at South Cerney whilst waiting to board the aircraft! However, on arrival, all was complete and, whilst the Regiment settled in, three days were spent reorganizing and deciding the final plan and sequence of construction. The planning was attacked aggressively and the "cascade" diagram made to work by constant updating. It proved to be a most useful tool.

The labour force was to be about half the working strength of 8 Field Squadron,

The Dhekelia Swimming Pool- Phase 1 (2)

in rotation, and up to thirty Pioneers as required. It was made clear to us that our work force was to be constantly changing, since every man was to have a balanced share of project work, military training and adventurous training. The team worked in shifts dictated by the sequence of their tasks. The design team expanded to become the construction control team, with Lieutenant C H Scott as the Site Engineer responsible for works and WO2 A P Sowerby as the Clerk of Works (Construction).

It had been apparent from the outset that the demands of constructing a totally impervious, heavily loaded structure on a suspect subsoil and the requirements of an exercise aiming to stress high quality craftsmanship were similar. Rigid controls were imposed and every batch of material incorporated in the work was checked and better checked for dimension and quality.

The subgrade was sealed with bitumen to protect it by forming a bottom waterproof membrane. The formation level was produced with crushed rock to the shape of the base of the pool. A necklace of porous drains was strung around this base and led away to the sea. These measures ensured that the pool structure would not float away and that as little ground water as possible percolated down to the subgrade siltstone.

The reinforcing steel was a high tensile, deformed bar, manufactured in Italy. Although it was not required to be high tensile, it was the only type locally available that came with any sort of specification certificate and was not made behind the Iron Curtain! The bars were cut and bent by Sappers on site, laid out so as to ensure a flow line of material from receipt to use. The amount of steel to be placed in the concrete to meet the design load meant that some quite intricate shapes were required and that all bending had to be extremely accurate.

A 75 mm layer of oversite concrete was accurately poured to produce a clean working surface. Concrete to the specification of the structure was used in this to prove and practice the batching plant. Working for the first time with local aggre-

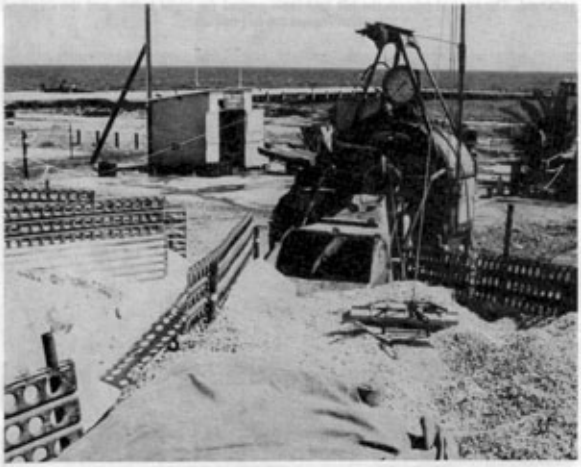


Photo 3. One of the two 14 cu. ft. concrete mixers with improvised aggregate feeds. A third mixer was kept in reserve and could be crane lifted into position in half an hour, since once started, the pouring of a bay could not be interrupted.

The Dhekelia Swimming Pool- Phase 1 (3)

Photo 4. General view of the deep end of the pool. The centre bay in the picture has just finished its last stage of curing, ie ponding, and the sandbag dam and hessian are being removed. The central bay on the left had been poured the night before and the stand off hessian frames are in position.

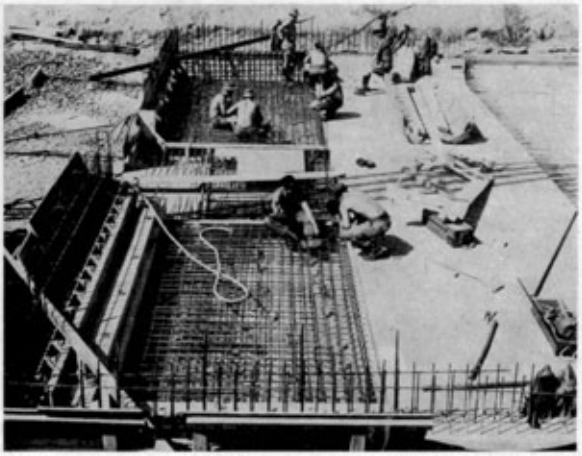


Photo 5. Showing the three stages of construction. On the far right, a bay prepared for steel fixing, on the left a bay ready for pouring concrete and in the centre a bay of mature concrete that has been cured.

gates our design mix was rather less workable than we had hoped. At this state 62 CRE (Construction) once again came to our aid and suggested how the mix design might be adjusted. The base of the pool was then poured in sections of the whole width of the pool and about 3 m of its length. A typical section contained 17 m^3 of concrete, took six hours to pour and was carried out in the cool of the early evening. A 0·5 m high kicker, or upstand to the edge of the base, was poured at the same time as the base, to locate the future wall pour and take the construction joints away from the point of maximum stress. The kicker required complicated formwork and very close supervision when pouring. The formwork for the kicker had to be arranged so that it was rigid over 4 m and yet had no fixings that would subsequently anchor the slab to the base and resist sliding. The whole formwork was the theory of Lieutenant Scott and the practice of Corporal B Parkin. It was the most exacting task of the whole project and one of the most professionally done.

Pouring the steeply inclined centre section, where the pool deepened rapidly between shallow and deep ends, was the last base section to be done and hung as an ominous cloud in our thoughts. Hours of discussion between ourselves and with local contractors who had swimming pool experience made us gloomier as to its problem. However, by the time we came to pour, we had bred an excellent concrete ganger in Sergeant C Wood and the pour passed almost unnoticed. Any slumping that occurred was shovelled by hand to the top of the section.

At all construction joints a flexible PVC water-bar was cast into the outside and a groove with polysulphide sealant formed on the inside. The water-bar made the fitting of formwork finicky and time consuming.

The walls were formed by using "Acrow U-Form" formwork. They were rapidly poured, since the base and kickers alone represented 85 per cent of the construction. Early in this phase 8 Field Squadron left for the UK, being replaced by 62 (NEAR-ELF) Support Squadron in mid-May, as planned. The construction control team left two weeks later.

IMPERVIOUS CONCRETE

To be impervious, the concrete had to be to a tight specification. It did not need to be particularly strong but it had to be dense, homogeneous and crack-free. The concrete was weigh-batched on site and was painstakingly controlled from the selection of the aggregate to the final curing. As a result, concrete was obtained that, when tested, had an adjusted standard deviation of under 3N/mm^2 and was crack-free. It may be of interest to record some of the precautions taken to stop the concrete cracking.

Cracks occur during curing due to two main effects. Firstly, thermal contraction when the rate of evolution of heat of hydration of the cement decreases, ie about 24 hrs after pouring the concrete. The concrete is weak and has little ability to resist stress. This effect is most acute in a climate where hot days are followed by cool nights, eg Cyprus. Secondly, shrinkage contraction—occurring once curing has stopped. Shrinkage is caused when water is lost to the atmosphere rather than used in hydrating cement. If curing is efficient this effect is reduced to a minimum and will not occur until curing has ceased, by which time the cement will have gained enough strength to resist satisfactorily the stresses arising.

These cracks were prevented from forming by minimizing any movements and ensuring that unavoidable movements occurred only at predetermined positions. Waterproof joints were provided at a spacing sufficiently small to allow reasonable contraction stresses to be relieved without forming intermediate cracks, ie by having a maximum longitudinal bay length of 3·5 m. Slots were sawn over the water bars to weaken the concrete at these point so that any cracking that occurred would be induced at a point where water could not escape and extra distribution steel of a deformed bar type, at a close spacing, was used to transmit stresses into these joints. The concrete was placed at as low a temperature as possible, to minimize later contraction, by:

a Introducing ice into the mixing water and burying the supply pipe line.

b Painting the mixer drums, water tanks and skips with silver paint to reflect the heat.

c Shading and, if absolutely necessary, spraying the aggregate piles, with subsequent adjustment to the water/cement ratio.

d Mixing and pouring at night.

e Retarding the set by using a retarding mixture.

f Using an aggregate with a low specific heat, ie limestone.

Elaborate precautions were taken in curing to control cooling and moisture loss by:

a Spraying the freshly placed concrete with a resin curing membrane.

b Keeping the concrete moist, but without shock cooling, by providing moist hessian at a stand off af 50 mm under a sealing layer of polythene sheet.

PHASE 2

At the time of going to press 62 (NEARELF) Support Squadron have completed the walls, so finishing Phase 1. They are about to start Phase 2, which consists of testing the tank and installing the water filtration and circulation system. The pool will be commissioned in 1974.

LESSONS LEARNED

This paragraph is the hardest of all to write, since this complexity of design and construction was unique to all concerned. Thus we were learning from scratch and the lessons learned were legion.

However, several aspects of the way the project was tackled were lessons in themselves. The Squadron Commander, Major E G Willmott RE, had insisted on and organized extensive pre-training of our artisans at the RSME and at the Construction Industry Training Board. Trial sections of wall and base were built at the RSME and again in Cyrprus. These preparations ensured that artisans used to field engineering were reminded of their skills and our "Engineering Disasters" occurred in trials and not in the main structure. Again the efforts taken to cosset our concrete at all stages were financially expensive and time consuming, but did produce concrete of the required standard. More important, they produced it consistently and within an unusually small deviation.

The character of the Regiment's exercise meant that there was a high rotation of labour. To the control team this was exasperating and, on occasions, produced substandard work that had to be replaced. However, a great number of Sappers had a chance to gain experience of tightly controlled, high quality construction work.

CONCLUSION

The success of the pool can only be assessed if inspected in use after a number of years. What can be judged is that a complicated construction project was satisfactorily designed and constructed to fine tolerances in a very short time. The project provided excellent constructional training and a great stimulus to a Field Squadron that had been heavily involved in combat engineer tasks and in Ulster in the previous eighteen months. It was clear that the project was very popular with all who were involved in it and that the enthusiasm thus generated was the winning factor.

* * * * *

Exercise Himalayan Venture III being the Pre-Everest Training Expedition to the Kulu Himalaya Himachal - Pradesh State PART ONE - MENTHOSA

CAPTAIN M G LEG BRIDGES RE, BSc (ENG)

WITH the confirmation of the acceptance of their application to climb Mt Everest in 1976, the Army Mountaineering Association (AMA) is embarking on a series of training climbs and expeditions to assess both equipment and possible team members for the Everest attempt. The first of these took place between April and July this year, and a total of twenty seven climbers went to India to climb mountains of up to just over 21,000 ft. The Royal Engineers were represented by Captains Henry Day, Peter Page, Meryon Bridges, Lieutenant Simon Eskell and Sergeant Andy Anderson. Of the remaining twenty-two climbers, five were from the 7th Gurkha Rifles, one was a Surgeon Lieutenant-Commander, one a Royal Marine Lieutenant and one a Sergeant from the RAF.

The team left UK on 25 April and flew, courtesy of the RAF, in a C130 to Delhi, taking three days over the journey. The problems started in Delhi when the Customs insisted that we should pay 120 per cent import duty on all consumable items, a bill that they assessed at £2,500. They were quite within their rights to do this but we on our part could not let this go unchallenged as this substantial claim would have absorbed the bulk of our meagre funds. Patient negotiations were the order of the day. The Customs officials were not uncooperative, after all they were only doing their jobs. Some rather "tongue-in-cheek" assertions had to be made and were accepted with good humoured "belief". It took nearly a week to resolve the difference of opinion. However with this settled to our satisfaction, we hired a bus and two lorries and headed off northward from Delhi. We staged at Chandigarh and the next day drove through miles of foothills, past Simla and Kulu to an estate in the Kulu valley just south of Manali. This was owned by one, Jimmy Johnson, who was kindness itself to us. Here, after two days of sorting kit into porter loads etc, the party split. One team, ten strong, including Day, Eskell and Anderson, headed off almost due east to the area of Mt Indrasan, some three days march away. The remainder of us drove north to the foot of the Rhotang Pass (13,100 ft). This was to remain blocked with snow until early July this year, and from here on it was Shank's pony.

Our objective was the area of Mt Menthosa (21,160 ft), the highest mountain in the Kulu Himalaya, and our base was to be at Udaipur. This was some sixty miles away to the northeast down the Chandra Valley, and to reach this valley we had to cross the pass. There followed ten days of exceedingly hard work as we had to get fit, acclimatize to an altitude of 8,000–10,000 ft, and carry loads of up to sixty pounds, all in one easy operation. There were good days and bad days, we had porters and their attendant troubles, we had mules without troubles, but eventually we reached Udaipur, having left small caches of food behind us at strategic intervals for the return journey. The weather had been grey and cloudy and the scenery rather disappointing. The Chandra Valley is a harsh contrast to the wooded, rather Mediterranean Kulu Valley. It is stark and barren, flanked by beautiful mountains and offering only a hard living to the inhabitants. The damage wrought by the winter snows was dramatic. Whole sections of the road were washed out by the thaw or swept away by avalanche, steel telegraph poles crushed flat, and above, the bare rock faces rose for thousands of feet. A most inhospitable place.

On arrival at Udaipur, we held a Council of War, or Chinese Parliament, to

Photo 1. Menthosa 21,160 ft; from advanced base camp, the route lead up the right hand ridge to the summit.

decide what we should do. There were two adjacent areas in which we wanted to climb, but each was two days march away in different directions. To the north was Menthosa and to the west were a number of mountains, the chief of which was Bahaili Jot. As we wished (a) to gain maximum altitude experience and (b) to make certain of success on Menthosa, it being the highest, we all set out to climb it first of all. It was an overlarge party for a straightforward peak of this height, but our object was to put every man on the summit.

A two-day march up a lovely side valley, vaguely reminiscent of British Columbia, took us to Gumbah, a village at 10,000 ft, and a further day of very stiff going up 4,500 ft of boulder moraine brought us to our advance base camp. From here the mountain looked magnificent. Like a huge slice of cake, it sloped, from twin summits on the left, down to a col on the right. The face was a dramatic series of grey brown curtains of rock that rose to the gleaming white "icing" of snow, whose whiteness was intensified by the deep, deep blue of the sky behind.

In general terms the route was obvious. That was to go straight up to the col, and then to turn left and climb an ice shoulder on to the ridge, following this to the summit. With this object, Camp I was established the following day, two men being left behind on the col with a few day's supplies while the support party returned to base. The next day the whole team ferried loads to I, and Bridges and Mike Kefford, a lieutenant from 7GR, remained at the camp to provide support for Noel Dilly and Geordie Armstrong in breaking out a route to Camp II. The route up to I led over easy snow for two miles and then up a murderous slope of 2,000 ft to the col. From I to II, the route was blocked by the ice shoulder. Part of the route was threatened by overhanging ice cliffs on the left, but the alternative on the right involved scaling a large ice bosse, some of which was at 60° and did not represent a practical route for

ferrying up loads to the higher camps. In all, it took four days to establish Camp II, in the course of which 1,400 ft of fixed ropes were placed on the 50° snow slopes below the shoulder. From there the route to the summit was visible. It wandered left through the base of an icefall that came down from the peak, and gained the left hand ridge (the one visible from advance base), at around 19,200 ft and then followed this up a knife edge of ice to the proposed site for Camp III. Here there was a small nick in the ridge at 20,600 ft, some 2,000 ft above Camp II.

Two tents and four climbers were left at Camp II, and no sooner had the remainder returned to I than the weather broke. For four days a cycle set in of fine mornings which clouded over at around 1200 hrs, so that by 1300 hrs, a blizzard of new snow and spindrift was shrieking round the tents. Nothing could be done apart from attempting to improve the general standard of literacy in the party, nearly all of whom were now at Camp I. When the weather cleared on 1 June, six of the better acclimatized members set off to rebreak the trail up to II, while those at II started to work on the next leg up to III. It was terribly hard work for the new snow was thigh deep, wet and heavy. The leading pair were unladen, while Kefford, Bridges and two Gurkhas, Pasang and Bassant, brought up loads of food, ropes, hardware etc. The leader, Major Jon Fleming, and one of the doctors, Major John Swanston, now based themselves at II, to direct operations and to conduct medical tests respectively.

The leading four, including representatives of the Navy, Marines, Gurkhas and Air Force, made splendid progress and on 3 June, established Camp III and went to the summit, making the second successful ascent of the mountain. They spent that night at III and then went right through to advance base the next day. There now began a circuit in which parties of four went up to II, spent a day there on medical and oxygen tests, and then went up to III and the summit, returning to advance base on the fourth day. Thus in the course of the next six days, the entire party reached the top; no mean achievement considering that a normal Himalayan objective is to

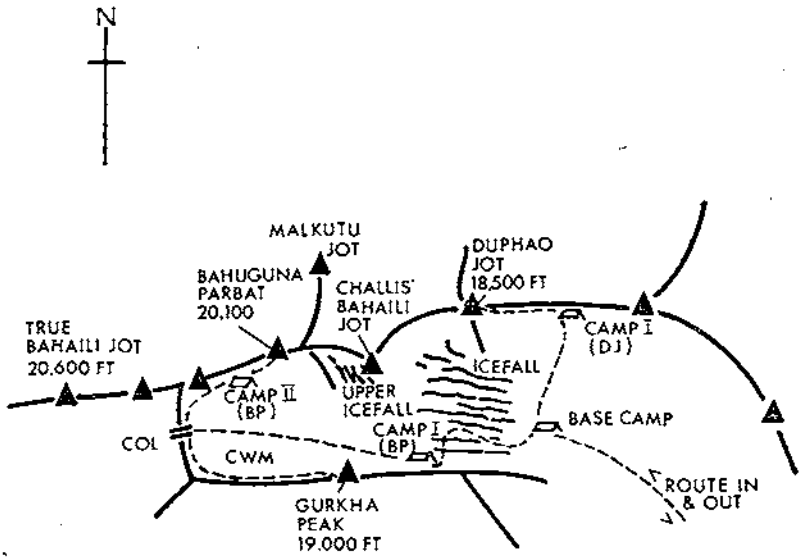
Photo 2. John Peacock at 21,500 ft on the final ridge below Camp III on Menthosa.

Photo 3. The summit of Menthosa 9 July 1973. Left to right Captain M Bridges RE, Lieut-Col J. Peacock REME, Captain J Lynch PARA, Lieutenant P West RA.

put just two men on the summit, any others constituting a bonus. The scenery from the top was sensational; northward could be seen the vast plateau of Tibet; over two hundred miles to the northwest the peaks of the Karakorum were visible; south-west and close at hand were the peaks and ridges of the Bahaili Jot complex—very striking in the slate and silver light of a gathering storm; and finally, away to the east over the shoulder of the neighbouring Phabrang, rose the great peaks of Nanda Devi, and Dhaulagiri.

By the evening of 10 June the whole party was back in advance base with every-thing but 1,220 ft of fixed rope recovered and all the camps stripped. Three days later we were back in Udaipur with a day to wash, rest, etc before setting out for the Bahaili Jot area. We were now running short of time. We had bid to the RAF for the aircraft to pick us up in Delhi on 10 July and, in order to ensure that we made this date with a safe margin, allowing time for packing up etc, we calculated that we must leave Udaipur on 28 June, with a day to pack up there. It was now 15 June and we had twelve days to march in, climb, and march out again.

At this point a word of explanation must be given on the names of peaks in the area. We had two works of reference. One was a map issued by HMSO and the other was a rather sketchy report on climbing in the area by a mainly British party led by David Challis. Taking the latter to be the more accurate of the two, we followed it until we found that it was as inaccurate as the map. The map showed a plateau, five miles long and ringed by a 20,000 ft contour, with the two names, Bahaili Jot and Duphao Jot, written against nothing in particular, the former being at the west end, the latter at the east. Challis on the other hand showed a photograph, taken below the icefall, of two apparent peaks, the right hand of which he labelled Duphao Jot and the left hand one he called Bahaili Jot. The actual layout as we found it was as shown on the sketch map.



But to return to 15 June. Our march to the new advance base camp took two and a half days. The first of these was an idyllic walk through pine trees and wild rose bushes beside the rushing Chandra River. The air was hot and heavy with the smell of resin and flowers. Branching left away from the river then, we turned into the Ur Gao Nulla and moved uphill through lush Alpine type pastures crowded with flowers. After passing through a number of small hamlets, we pitched camp on a small grassy ledge above Arat. Beyond this point the nulla narrowed and steepened, and the following day and a half were more like work. Advance base was set up below the icefall after lunch. It was decided that the party could afford to split: four with another four in support were to attempt Duphao Jot, and four with six in support were to go for "Bahaili Jot" (BJ). At this stage we still thought that BJ meant Challis' BJ and to get to it we had first to push a route through the icefall. The BJ party consisted of Lieut-Colonel John Peacock, Captain Tom Lynch, Lieutenant Phil West, and myself, with a support party of Fleming, Swanston, three Gurkhas, and our Sirdar, Riksin, who was a marvellous character. Getting through the icefall took two full days, despite a recce on that first afternoon. This icefall was about 2,000 ft high and was a mass of tumbled seracs (ice towers), crevasses, snow bridges and ramps. The evening of the first day found us within 400 ft of the top with the way beyond barred by a continuous line of ice cliff, defended by an equally continuous line of crevasse which ran right across the lip of the fall. There was clearly no alternative but to try to traverse to the left on to the rocks and climb up the side. After a night in the icefall, disturbed by the rumble and crash of falling ice, we made this traverse successfully but had no alternative than to pass directly below an enormous serac about 250 ft high. This serac, aptly named Ronan Point, was to indulge in a partial collapse a few days later, timing its demonstration to coincide with the passage of Bridges and West on their way down. We were extremely lucky to get out of it unscathed apart from a radical sense of humour failure which lasted for about an hour afterward.

By the evening of the second day we were settled into Camp I with thick "clag" in the Cwm, a steady light rain falling, and deserted by the support party who had very sensibly returned to the comfort of Base Camp. The rain dampened not only our spirits but also the sleeping bags of Peacock and Lynch as their tent, though prettier than ours, leaked persistently. The next day was also cloudy and damp and,

Photo 4. (left) In the icefall during the ascent of Bahuguna Peak. This serac, nicknamed Ronan Point, later collapsed on two members of the expedition.
Photo 5. (Right) Steep ice climbing during the assault on Bahuguna Peak.

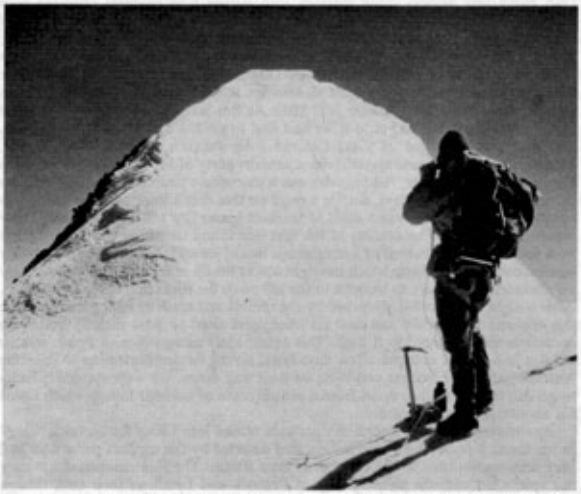


Photo 6. The virgin summit of Bahuguna Peak 20,100 ft, which was climbed 24 June 1973.

Exercise Himalayan Venture III, 4, 5,6

after a morning of drying out, a half-hearted recce was made which revealed a vast chasm cutting right across the top of the upper icefall.

Morale settled a little lower. Time was now becoming critical and with the probability of further problems in the upper icefall, our chances of success seemed to shrink away. The next day was better and two recces went out. Peacock and Lynch went up the upper icefall to get a good look at the big crevasse and Bridges and West went up to the col to evaluate the idea of making an assault along the ridge. It was from the col that we first saw the true Bahaili Jot. This, combined with the information from the DJ party that there was a snow peak behind our objective which appeared to be considerably higher set us thinking. The upper icefall proved quite impassable and so on the morning of 23 June, both assault and support parties set off in brilliant weather to establish a camp as high above the col as time would allow. The going was heavy in deep, rotten snow. Above the col a small but rotten rock buttress barred the way and a fixed rope was left here. Camp II was established at around 18,500 ft, again in thick cloud, and our "porters" returned to Camp I. The 24th dawned fine and cold, and we set off up the ridge to the east. A bergschrund and a steep ice pitch delayed us for a while but once over these, the route to the summit was clear—and much shorter than we had expected! Meanwhile our support party, not to be outdone, had made a very early start from Camp I, climbed up to the col, and then followed the ridge to the left to reach what they called Gurkha Peak, a second first ascent for the expedition. The peak climbed by Peacock's party was, at the time of writing, believed to be a first ascent, and the name Bahuguna Parbat was suggested to the Indian authorities in memory of Major Harsh Bahuguna who was tragically killed on the 1971 International Everest Expedition. He had also been with Challis as a liaison officer in this area in 1969.

Two days before, Duphao Jot had fallen to siege tactics, that party having sat out four days in their Camp I awaiting safe snow conditions. And then the descent began. Advance base camp was cleared on the morning of 26 June and from there we travelled on foot and by bus to the Kulu Valley. The aircraft was finally confirmed for the 14 July and so we split up to explore as much of India as time and the heat permitted. Altogether it was a highly successful expedition for which much of the credit must go to Jon Fleming and the AMA organization.

Early Days

MLC

IN the *Supplement* of May 1873 appeared the notice "Lieut Chermside from Curragh to leave". In November 1873 a similar notice states "Lieut Chermside has joined the SME upon return from the North Seas". An account of this leave is printed in the December *Journal* under the heading "Outline of a Voyage in the Polar Seas". Chermside had gone on the expedition as its photographer. Incidentally the Editor seemed very reluctant to let on as to who his contributors were. Articles were either unsigned or appeared over initials. In this case it took some research to identify the author—who signed himself merely as H C C.

Chermside joined a private expedition formed by Mr Leigh Smith, which had the sole object of sailing as close as possible to the North Pole, which at that time had never been reached. The pack ice was continually shifting and its exact configuration at any one time was a matter of chance. Thus an expedition of this nature had to cruise around ready to seize—and risk—any opportunity that should arise. The area of operations was NE of Spitzbergen.

Previous investigations had shown that in Lat 80 the temperature at 600 fathoms was 64°F, while at the surface it was 31°F. It was thought that this submerged branch of the Gulf Stream in its flow to the far north must ultimately hit land and come to the surface, thus providing large areas of ice free water during the summer. In the event no way through was found. The paper is very well written and Chermside

recounts many other areas—zoological and botanical—which proved rich in scientific discovery.

He is sad that "the English have of late been very indifferent as to Artic exploration" but records that the growing interest shown by other nations was also increasing attention in the United Kingdom. He complains that the Government seems to have listened to Naval opinion "It is by no means certain, as Naval officers declare, that their discipline etc is indispensable for such work" and that "private expeditions, fired by the wish for scientific achievement, could be as good". Such expeditions would also have the advantage that scientists could appoint men of their own choosing to be in charge. Finally he reminds his readers that we would be indeed sorry "if any but the British flag waved first over the North Pole".

Ironically enough, Chermside was later to make his name nearer the equator. He took part in the Tel el Kebir expedition and the operation to relieve Gordon in Khartoum. He became a Political Agent under the Egyptian Government and was Governor of Suakim in the Sudan, an area on the Red Sea Littoral.

Ever since the death of Field Marshal Sir John Burgoyne, the *Journal* frequently contained appeals for subscriptions for a memorial, and for suggestions as to what form this should take. At one time the favoured solution was to erect a "handsome" church near the present HQ RSME. "The great advantage of the proposal is that such a building would, year by year, become of greater interest to the Corps, whereas statues and monuments are often lost sight of in the course of a few years."

In the event the decision was to erect a statue on the same site, until a forceful correspondent wrote to the *Journal* in August 1873 stating that, to erect a statue in Brompton Barracks would "most imperfectly serve" the object of the memorial. "He was a great public character . . . and must take his proper place beside Napier, Havelock, Outram and men of that stamp." Only Trafalgar Square or the Thames Embankment, no less, would satisfy. The result was, as we all know, the statue was erected in Waterloo Place near the Athenaeum. The idea of building a church showed, perhaps, a far too rosy optimism as to the amount of money likely to be raised by public subscription. This fell far short of the requirement.

The *Corps Papers* for 1873 include an address given by Major-General H Y D Scott to the Royal Institute of British Architects on the construction of the Albert Hall. An article on the Royal Albert Hall appeared in the June 1971 *Journal* so there is no need to recapitulate the background here. In his talk, Scott comes over as a very likeable and competent individual. As with so many lectures given before learned societies the main interest is likely to have lain as much in the discussion as in the paper itself. Unfortunately the discussion is not reprinted.

The Albert Hall and the Great Exhibition of 1851 both illustrate the willingness of the Government of the time to use Royal Engineers on civil work. The then President of the Board of Trade was a strong advocate for doing this, and the opportunities presented by this climate of opinion were avidly seized by the Corps. Although no sapper units, as such, were used on the Albert Hall, over two Field Companies worked on buildings for the Great Exhibition. In addition, many officers were employed in various important administrative capacities. Richard Cobden, having achieved respect and honour as a result of his long and bitter campaign against the Corn Laws, held equally strongly that the promotion of peace and the reduction of naval and military armaments was the logical complement of free trade. But even Cobden (so we are informed by the *Corps History*) stated that in his advocacy in Parliament for military retrenchment and reductions in strength, he would never seek to carry out his view in the Corps of Royal Engineers. Although these words were uttered some years before the period now in question, the spirit of them still remained.

The frequent appearance of articles reprinted as translations from foreign sources was mentioned in the last edition of "Early Days", and another—this time from an Austrian journal—conceived the possibility of transferring the "shock of the explosion" by using 1¼ in gas pipe rather than a detonating fuse. Experiments appear

to have demonstrated that "it was sufficient for one of the charges to detonate in the usual way to cause the others to detonate also, by the transfer of the explosive force by means of the hollow tubes." This discovery was greeted with some enthusiasm. Not only would it make the "tedious preparation of the numerous necessary electrical connections superfluous", but it would also mean that built-in mine chambers could easily be permanently connected. BAOR please note!

An account of a demonstration given "near the Flagstaff at the end of the Rifle Range of the Royal Military College" appeared in the November 1873 *Journal*. This, amongst other things, showed an attack on a fortified position with much firing of artillery and simulated bursting of shells. The pièce-de-résistance was the firing of a giant fougasse. This fougasse was to cover a piece of dead ground, which made an ideal forming up place for the attackers. The fougasse was to propel no less than 5 tons of stones. It seems that the stones, some of them 10 to 12 lbs in weight, were thrown over an area 300 yds and the whole effect was "uncommon nasty"!

An interesting technical article concerned the removal of a dangerous outcrop of rock from Hells Gate (not far from the present UN building) which lies on a part of the river connecting Long Island Sound with the East River, a channel much used by shipping. This outcrop was of solid granite. The project entailed driving an intricate series of galleries, some 20 ft high by 12 ft broad, and 230 ft long, in a fan shape under the outcrop. These radiating galleries were then successively connected at intervals of about 8 ft. All galleries were then deepened, the end result being that the outcrop was honeycombed with tunnels. Thus in effect most of the rock had been removed by the tunnelling. The whole was then charged, as necessary, with dynamite so that the remaining pillars and roof collapsed into the excavation, leaving the river about 25 ft deeper. This was a costly project and no mean achievement, taking into account the drilling machines of the period. The articles does not make clear who was doing the work. The inference was that it was done by contract ("the average expenditure was £3,000 per month")—probably because it took about three years, a long time to tie up troops on a project which could not have provided much variety.

1871 was the year in which Cardwell, amongst his other reforms, finally abolished the purchase of commissions. Thus it is strange to read in the September 1873 *Journal* with no acknowledgement to the achievement of Cardwell, a bitter attack on the purchase system. The article in question was reprinted from the "Daily News" of July 1873. The chief object of attack was the "shameless partiality shown to those who paid for their commissions, as against those who merely earned them by study in a military academy and by undergoing a thorough training for their profession". One "distinguished staff officer", when he heard of the fall of Magdala, is quoted as saying "I am sorry for it; for now those Ordnance Corps men will be for ever claiming the commands that we bought the right to with our money." The article goes on to say, "In this case of Abyssinia, Napier, though an Engineer, happily stood too strongly in the favour of the Indian Authorities to lose the command". It then goes on to ask why Chinese Gordon had been neglected for high command, "for never did a general have better claims. But no; Gordon happened to be an Engineer. In short, he was one of the non-purchase, worst still, one of the scientific services . . . it needs the tremour of an Ashantee War, and the cry of the Press, to call the War Office to the remembrance that we have ready for such needs the best leader of irregulars that the world contains!" The Royal Engineers, as already pointed out in this series, did not lack for frustrations whether it was by neglect of what they had to offer by Divisional Staffs on manoeuvres or paltry recognition of their intellectual qualities, as measured by the allotment of vacancies to those highly placed in the Staff College exam. The purchase system, the results of which no doubt were slow to fade, may well have been a fundamental reason for this lack of status.

This lack of status was not, however, peculiar to the British Army. The French Engineers fared no better—although in their case there could have been much more cause. In the introduction to an article on the Corps du Genie, translated from the French, the author remarks that "it is worthy of remark how much discontent

appears to exist among Engineers of the French and German armies as to the parts they played in the recent war." However, a subsequent article by a French Engineer, writing about his own Corps, describes an army which seems to have deserved all the criticism it received. The "Works" side seemed to have been an inefficient bureaucracy and the combat side much neglected. ". . . It is now, we believe, being recognised in France that Military Engineering is a branch of war . . ." The French seemed, if this self criticism is true, not to have taken to heart a remark by the Duke of Wellington, concerning the engineers, which was quoted in another translation from a French author. ". . . One could not have too many of them, the engineer soldier being available as an infantry man when he is not engaged in executing the works for which he alone is sufficiently expert".

A nice turn of phrase is always acceptable. The following, chosen from the pages of the 1873 *Journal* have their appeal. "12 noon. The Troops will dine", which item appeared on the programme of the Great Demonstration of Siege Warfare, which was staged at Chatham during 1873, rings a trifle incongruously when one remembers the standards of the times. "The spectators found it difficult to repress their feelings in favour of the home team" appeared in the account of the defeat of Uxbridge, a firm favourite for the FA Cup, by the RE team which was playing away. Certainly Soccer crowds do indeed seem to find difficulty in repressing their feelings!

For feliciticious phrasing, which so exactly and nicely conveys the meaning, the following written by the Commanding Officer of the Corps of Commissionaires to Lieut-Colonel Wrottesley, Sir John Burgoyne's son-in-law, is worth repeating. It should be remembered that Sir John was instrumental in founding the Corps and the following extract appears in a letter asking Lieut-Colonel Wrottesley to be a Honorary Governor of the Corps. ". . . I must add on my own part, not only a sincere wish that you will accept the compliment this office is intended to convey, but that you will not diminish its effect by thinking it necessary now, or at any time, to offer us any aid or assistance beyond a few minutes of your time, when you are able to spare it."

* * * * *

HISTORY OF THE CORPS OF ROYAL ENGINEERS

VOLUMES IV, V, VI and VII have now been reprinted and Sets of the History are once more available.

Because of increased costs since the last printing the new prices are:

		Members' Rate	Non-Members' Rate
Volume I	Covers period from Norman times to 1860	£ 1·50	£ 3·00
Volume II	Covers period 1860–1885	£ 1·50	£ 3·00
Volume III	Covers the period 1885 up to the outbreak of the First World War	£ 1·50	£ 3·00
Volume IV		£ 2·50	£ 5·00
Volume V	Covers the First World War and the period between the two World Wars	£ 5·00	£10·00
Volume VI		£ 5·00	£10·00
Volume VII		£ 2·50	£ 5·00
Volume VIII	Covers the Second World War	£ 2·00	£ 4·00
Volume IX		£ 2·00	£ 4·00
	Complete Set	£18·00	£36·00

Sets for Members may be purchased:

1. By single payment of £18·00
2. By Bankers' Order of:
   a. 9 monthly payments of £2·00
   b. 4 quarterly payments of £4·50

The set will be despatched on receipt of Bankers' Order.

Sets for non-members by single payment of £36 only.

Exercise "Revolt 2" Gibraltar 1973

CAPTAIN M R GIBSON, RE(V), C ENG, MIEE

INTRODUCTION

EXERCISE "Revolt 2" was the second in a series of practical exercises for 504 STRE (Power Station) (V), the first having taken place at Bassingbourn in 1969.

The choice of codename gives a clue to the aim of the exercise, and an explanation of the various connotations will provide a suitable introduction to this account.

"Revolt" immediately suggests defection, mutiny, rebellion or uprising. The original terms of reference for 504 STRE catered for employment in Aid to the Civil Power, or with an Intervention Force; thus the above settings are appropriate to the team's role when called in to restore power supplies or to rehabilitate a defunct system under difficult conditions. A second connotation follows on from this: "Re-volt", it can be assumed, means "to volt again", or "to regain volts", that is, to repair equipment from which voltage had previously been obtained. The third meaning of "revolt" ie "to nauseate", has not to date been invoked on either occasion! Thus the background to this exercise was one of civil unrest, followed by the repair of electricity generating plant.

LOCATION

The choice of Gibraltar as a location for Exercise Revolt 2 was made on the availability of Calpe Hole's unique facilities. It is very rare to find an obsolete, normally unmanned, but still operable Station, attached to a power system whose operating regimes can be modified to permit intermittent generation, and where technical and industrial constraints are minimal. The custodians of this valuable RE asset, 1 Fortress Sqn under Major D L Mackay, were most helpful, and anxious that our exercise should be a success.

ORDERS

The exercise narrative described a situation in which the existing electricity supplies to RAF installations at North Front, Gibraltar, were likely to be insecure from 8 September, and, in order to maintain essential supplies, the temporary recommissioning of the redundant Calpe Hole Power Station would be required, with an estimated maximum output of 650 kW.

504 STRE was ordered to carry out the necessary repairs and recommissioning, followed by the preliminary operating period. With typical masterly understatement, the orders pointed out that "although the power station is understood to have been test run within the last six months, it may have been tampered with"!

Thus it was that on Monday 3 September 1973, OC 504 STRE (Power Station) (V), Major R J Sage RE (V), issued to me his Operations Order; we were at the time flying over the Atlantic in a Britannia off the coast of Portugal, a singularly difficult situation from which to back out and go AWOL!

SELECTION OF PERSONNEL FOR THE EXERCISE

The orders for the exercise called for an initial recce stage, in which the operational state of the station was to be ascertained. The criterion for the selection of personnel to man this recce task was merely no previous knowledge of Calpe Hole. Thereby the realism of the situation could be maintained, and as I was attached to the Team for this camp, the job of OC fell naturally in my direction! The other hapless members of the Recce team were Second Lieutenant Hendry, S/Sergeant Shilling (attached from 64 CRE), S/Sergeant McAllister, Corporal Jones and Corporal Lambert. A follow-up team under WO2 Balshaw would be provided from the STRE to cover the

later operational stage of the exercise. However, this stage would not be reached until the Directing Staff, Major Sage and WO1 Brown, were satisfied that all fault clearance and repair work had been completed.

PLAN

At 041800 September I held my "O" Group at our borrowed office accommodation at Governors' Cottage Camp, Gibraltar, home of 1st Fortress Sqn.

My plan was to carry out the exercise in three phases as required by my Orders, these were:—

Phase I	Recce and issue to the OC an Initial Operational State Report.
Phase II	Locate and repair faults on the selected equipment and issue to the OC a Final Operational State Report.
Phase III	Operate the repaired equipment on load for 24 hours.
Timings	Phase I was to be complete by not later than 041230. Phase II was to be completed not later than 052359, to allow Phase III to be started at midnight 05/06 September. This would give 24 hour running prior to my deadline for completion of 062400.

EXECUTION

Phase I

Morale was high as we waited for transport to take us to the Site. Pints of beer had been wagered on the number of hours by which we hoped to beat the schedule. The remainder of the Team had been to Calpe Hole before, some had even spent a considerable part of the previous evening applying electrical and mechanical faults to the equipment. It was rumoured that two fitters had spent a day and a half working on the engine under the direction WO1 W J Brown, now WO1 in 504 STRE (V) who was previously employed for two years at Calpe Hole as a Regular WO1 when the station was Operational!

Spirits drooped somewhat when we entered the Power Station and were faced by four very large engines inside the vast rock cavern. "This will take more than five minutes", said the usually super-optimistic S/Sergeant; the remainder of the Team were silent.

We organized into an Engine Party of S/Sergeant and Corporal, an Electrical Party of S/Sergeant and Corporal, and a Co-ordination Section consisting of 2nd Lieutenant Henry and myself, as OC, writing the Operational State Reports and checking out the high voltage switchboard, switchgear and protection.

The object of our initial recce was to ascertain which of the four machines could be made operational; this presented a problem since inspection provided the following information by 0930:—

Machine 1	English Electric "Fullager" diesel engine, two stroke opposed piston, airless injection type of about forty years old with a 1030 kW alternator. No obvious defects.
Machine 2	Similar to No 1 Machine, Major mechanical defects.
Machine 3	Similar to No 1 Machine, Minor mechanical and electrical defects.
Machine 4	Ruston gas turbine with 1000 kW alternator, Major mechanical defects.

This eliminated Machines 2 and 4 but which of the other two should we attempt to recommission?

We were required to repair only one machine, since we were ordered to make 650 kW available. We were soon confident that Machine 3 was the one which had been deliberately tampered with, not only because it was the only one with a name ("Lady Samantha"), but also because it was apparent that sections of fuel piping, fuel injectors and the like had been removed.

To prove that Machine 1 could not be made serviceable was difficult. A search was made for records which might clarify the situation and when some of these were eventually located, they showed that only *Lady Samantha* had been run since July 1971. This, together with evidence of oil in places consistent with it having been recently used, gave us the proof we required.

The Initial Operational Situation Report was then issued at 1230 hours. This confirmed serviceability of:—

1 *The Building*:
Apart from some water leaks and crystallized deposits from the roof panels, the building was sound and safe for working.
2 *Services*:
The following services were available and adequate:
a piped water
b electricity—some repairs required
c drainage
d lighting—some repairs required
3 *High Voltage Network*:
The 6·6 kW distribution network was operational.
4 *Power Station Switchboard*:
The layout of the switchboard was recorded together with position of switches and load details at 041200.
5 *Fuel*:
The type of fuel and amount of fuel stocks were reported.
6 *Diesel Generators*:
The following operational state was reported.
a Machine No 1—Unserviceable—repairs estimated to take at least one month.
b Machine No 2—Unserviceable.
c Machine No 3—Unserviceable but repairs estimated to take 24 hours.
d Machine No 4—Unserviceable.

Phase II

Phase II started at 1230 hours and each of the mechanical and electrical systems were systematically checked out. The list of faults and corrective action grew and were all carefully recorded. A major problem at this stage was that of not having enough tools, torches or test equipment. We had brought with us two Fitters basic kits and some test instruments, but these were not available to us until mid-afternoon of Day 1 so that tools had to be "scrounged". Sapper initiative led to the temporary appropriation of some spanners from a civilian who was working on his car just outside the tunnel entrance. Similar appropriation of a kettle from the Security Police, and an excursion to the shops enabled a coffee point to be set up. Another difficulty to overcome at this time was to obtain batteries for the electrical test equipment which are, naturally, packed without their essential power sources.

During searches of the premises to find tools we also found lengths of fuel pipes, fuel injectors and the like, which fitted exactly on to our engine, and which saved us from dismantling the pieces from one of the other engine.

At 1800 hours a progress report concluded that about two-thirds of the faults had been located and repaired, and it was considered that the majority of the remaining third were known. It was therefore decided not to work an evening shift, but to finish for the day and restart promptly at 0800 hours on Day 2.

There was much discussion in the various Messes that evening, with nothing given away by those who were familiar with Calpe. Convincing rumours circulated that we were working on the wrong engine, with tales of a Sapper still entombed in the crankcase.

Work started again at 050800 with considerable enthusiasm as systems were made serviceable. Compressed air, cooling water, fuel systems, lubricating oil systems,

Photo 1. 2nd Lieutenant J M G Hendry and S/Sergeant P E R Shilling (64 CRE) checkin the high voltage protection.

Exercise revolt 2nd Gibraltar 1973. 1

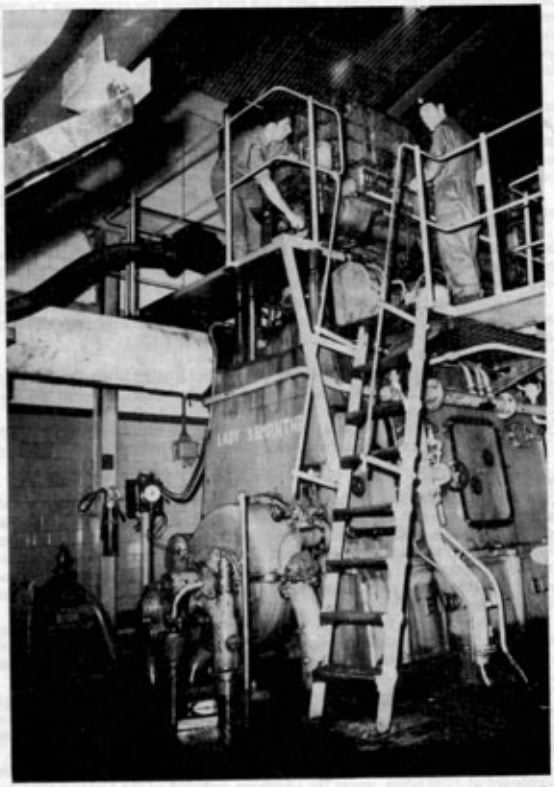


Photo 2. S/Sergeant G J McAllister and Corporal R G Jones fault finding on the diese engine.

Exercise revolt 2nd Gibraltar 1973.

electrical supplies, and the exciter system were now all apparently working, and I was being badgered to give permission to start up the engine. This I was not prepared to do until I had compared my faults list with the master list held by the OC. However, the enthusiasm and the confidence were such that turning the engine over on compressed air was eventually authorized, although the exciter brushes were removed to prevent generation of high voltages. It was quite an exciting moment when the huge flywheel rotated a dozen times to the accompaniment of the hiss of compressed air escaping from leaks (pre-arranged faults)!

As a safety precaution, the comparison of our fault list with the master list was carried out at 1200 hours; we were delighted to find that we had located all but one, a blocked fuel filter, which would have become apparent on start up. In addition we had located a number of faults which were not attributable to the exercise, but which were corrected or noted for later attention. An extract from the list of some thirty-five mechanical and electrical faults is given in the accompanying Table 1.

Permission was given for start-up, and without further ado, start she did at 1227 hours.

The afternoon was spent clearing up electrical faults, many of which were of a maintenance nature, together with an extended engine test run with the exciter circuits made live. A rapid fault diagnosis led to the clearance of blockages on both fuel filter inlets—faults not revealed by the DS earlier!

The Final Operational Situation Report was made ready at 051600, when *Lady Samantha* was available to be run up and operated on load. Arrangements had been made to bring forward Phase III, the Operational Stage.

The Report read as follows:—

1 No 3 Diesel generating set at Calpe Hole Power Station is in working order, complete with auxiliaries, and including electrical connections to the high voltage switchboard.

2 The set may now be put into operation to supply a maximum output of 650 kW into the high voltage distribution network through the 6·6 kV switchboard.

Phase III

Perhaps the more heroic part of the exercise had now been successfully completed. Six people, strangers to each other and to the equipment, had in eighteen hours probed the mysteries of Calpe Hole, and prepared *Lady Samantha* for action with no help from outside, no maintenance manuals, very few records and with the minimum of tools; a creditable achievement. But the proof of any pudding is in the eating, and there still remained the requirement that we should supply load for a period of twenty-four hours.

The Station was handed over to WO2 Balshaw, NCO i/c Operations Section, who arranged to start up and take load at 051730. A shift system of two operators on duty for four shifts was introduced, with the necessary arrangements made for transport and meals.

The Operations Section had experience of operating under supervision at Calpe Hole on a previous camp, but this was vitally different, in that they were now on their own. If anything went wrong on their shift, there was now nobody from whom assistance could be sought, other than our own team.

Lady Samantha was run up by the first shift, and synchronized on to the main switchboard at 1730 hours, under the telephone direction of the Control Engineer at the Inter Services Power Station in HM Dockyard. All the hangers-on departed to celebrate, leaving the two operators to cope by themselves.

But *Lady Samantha* was not to give in so easily; she still had a trick or two to play and was soon to show a noticeable fall in lubricating oil level. At the same time several oil and fuel leaks made themselves apparent. All this stretched the two-man team to the limit. It was decided that with control duties, operating duties and now maintenance duties, two men were insufficient. An additional fitter was drafted in on each shift to assist with the maintenance work.

To his credit the S/Sergeant who had tamed *Lady Samantha* during the previous two days, stayed with her for most of the night, gently patting her crankcase and making various adjustments for her comfort until she settled down. Once settled, she ran beautifully and without further tantrums.

The Operators were kept busy clearing fuel pipe leaks, transferring fuel from the bulk storage tanks to the ready tanks, and adjusting load and frequency to the system requirements until 061730 when *Lady Samantha* was disconnected electrically and shut down.

A steady load of about 500 kW had been supplied, and a total of 10,450 kWh were generated during the operational period.

Phase III of the exercise was complete and we were all now able to disperse to the various other tasks to which we had been allocated for the remainder of Camp.

CONCLUSIONS

What are the lessons to be learned from Exercise Revolt 2?

1 It demonstrated the expertise within an STRE (V) composed of practising engineers, who can be transported to a strange environment and are prepared to accept the challenge of resuscitating old equipment in a "for real" situation.
2 It highlighted the flexibility required within such a team, to enable the various skills to be deployed in the solution of problems as they arise, and to adapt other sections to fill gaps in the manning.
3 Deficiencies in the holdings of tools, test instruments, and other equipment had been revealed; the G1098 scale must be examined, and its availability for exercises of this type ensured.
4 It justified the retention of Calpe Hole as a unique training facility both for Regular and Reserve Army teams; there is no doubt that it constitutes a valuable Corps asset.

ACKNOWLEDGEMENTS

504 STRE Power Station (V) are indebted to Major D L Mackay and the members of 1 Fortress Sqn RE for their hospitality and help in making Exercise Revolt 2 possible.

TABLE I

Extract from the list of 35 faults put on the equipment by the Directing Staff and Advance Party prior to commencement of the Exercise.

Fault	*Action Taken*
Air leaking from compressor head and air start lines.	Joints remade and leaks repaired.
Lub oil drain line missing.	Pipe found after search, refitted.
Nos 2 and 4 Injectors missing.	A number of injectors were found in search; two selected and fitted.
Input side of both fuel filters blocked.	Blockages removed.
Air compressor motor tripping.	No oil in dashpots, refilled.
Fuel Transfer pump reverse rotation.	Connections changed over and checked.
Fan Chamber lighting unserviceable.	Fuses replaced.
Governor Speeder motor not working.	Cables found cut, rewired.
Exciter brushes insulated with paper.	Paper removed and connections remade.
Field Suppression OCB trip inoperative.	Insulation found between button contacts.
Alternator OCB PBO Relays incorrectly set.	Relays adjusted to 0·68 and 75 per cent.

The Ordnance Board

A SAPPER ON THE BENCH

INTRODUCTION

FEW members of the Corps are called to serve at the Ordnance Board, yet the Board have[1] a considerable influence on many Sapper activities. Therefore some notes on the History and Functions of the Ordnance Board should not be out of place in this *Journal*. Indeed with Royal Engineer Officers concurrently filling the appointment of Master General of the Ordnance and senior posts in the Ordnance Survey and the Ordnance Board an article on the least known of this Ordnance trio would seem timely.

HISTORICAL NOTE

All three organizations can trace their history many centuries back to 1414 when Henry V appointed Nicholas Merbury as the Master of Ordnance and John Louth as his clerk to "take and provide, by yourselves or by your sufficient deputies, as many stonecutters, carpenters, sawyers, smiths and labourers as may be necessary for the works of engines, guns and ordnance aforesaid, together with sufficient timber, iron and all other things likewise necessary for the works aforesaid, and also with carriage for same when there is reasonable need for it, so long as you shall continue in your said offices. And we shall therefore direct you to busy yourselves diligently about the premises and perform and execute them in the form aforesaid . . .".

Although in 1823 the Ordnance Board was granted Arms (Photo 1) which contains many now familiar features and the motto "SUA TELA TONANTI" (To the Thunderer his Weapons), our modern history really starts in 1855 with the creation of the Ordnance Select Committee, which was managed solely by the Army until a Naval Vice-President was included in 1858. This Committee continued to function under various titles until 1908, in which year it became known as the Ordnance Board. An RAF Member was included in 1919 and the first RAF President was appointed in 1945. The history of the Board is a fascinating one particularly in regard to the number of occasions on which attack and even abolition has been survived.

PRESENT FUNCTION

With the passage of time the executive role of the Board in respect of weapons research, development and procurement has passed to other authorities and the Board is now solely an advisory body. In essence, they advise the Systems Controllers of the Procurement Executive, usually through the Approving Authority, on the safety and suitability for service of any weapon or part of a weapon system in which explosives are used. Used in its widest sense weapon systems can include such seemingly unexpected items as explosive bolts, aircraft ejector seats, control severing devices and fire extinguishers but the majority of the work concerns the obvious armaments such as shells, bombs, mines and warheads. The term "suitability for service" is used in the context of the Board's assessment of the weapon to function safely and satisfactorily in its service environment. Except in so far as it may affect weapon safety, such an assessment does not necessarily include either a quantitative assessment of functional reliability or the ability to meet all the Staff Requirements; these latter aspects are, rightly, the responsibility of the Project Manager.

The advice of the Board, given without fear or favour, is aimed at obtaining the highest possible standards of safety not only from the viewpoint of the users, be they sailors, soldiers or airmen, but also that of the general public, by ensuring that they, too, are not exposed to any avoidable hazards during the storage, transportation and use of explosives.

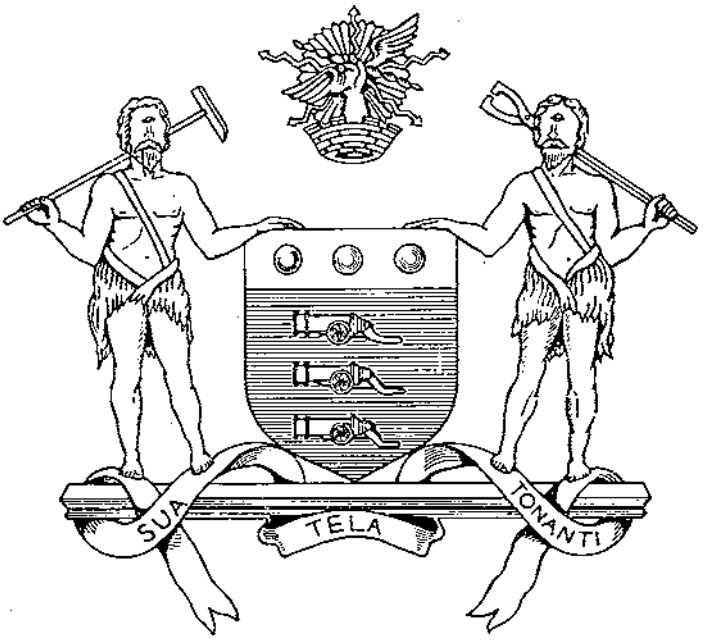
The Arms

granted to

The Right Honourable and Honourable
The Board of His Majesty's Ordnance

on

18 May, 1823



The Blazon

Arms	Azure – 3 Field Pieces in pale, or on a chief, argent, 3 cannon balls, proper
Crest	Out of a mural crown, argent, a dexter cubit arm, the hand grasping a thunderbolt, winged and inflamed, proper
Supporters	On either side a Cyclops, in the exterior hand of the dexter a Hammer, and in the sinister a pair of Forceps, resting on shoulder of each respectively, all proper.
Motto	Sua tela tonanti.

CONTROL

Although the MGO's Department administers the Ordnance Board, the work is functionally directed collectively by the Controller of the Navy, Master General of the Ordnance and Controller Aircraft. The bulk of the Board's work comes as requests for advice from the Approving Authorities of the Procurement Executive, who are directly responsible to the three Controllers for ensuring that weapons being developed meet the service requirements.

Professionally, the Board are independent and give advice on standards of safety and suitability for service and ensure that associated trials are conducted in accordance with Ordnance Board standards. It is this independence from outside pressures which is the very core of the unique value of the Ordnance Board. The tri-service structure provides a solid rock on which single service onslaughts can break in vain.

COMPOSITION

The present Board comprises a President and two Vice-Presidents (The Bench), the Secretary, full Members and Associate and ex-officio Members, supported by a number of Technical Staff Officers from the Military and Civilian Services.

Members of the Bench, consisting of three two-star officers, one from each service, each serve two years as Vice-President before becoming President for their final third year. The posts of Secretary and Deputy-Secretary are currently filled by a Colonel and a retired Squadron Leader. The fourteen Members of the Board include three Captains, RN; one Colonel, RM; five Army Colonels; three RAF Group Captains and two Senior Principal Scientific Officers of the Civil Service. Each Member of the Board is supported by two or more Service Technical Staff Officers, normally in the equivalent rank of Major, and by civilian scientific grades. Together with the ex-officio and Associate Members these officers bring a wealth of professional knowledge to the tasks of the Board.

ORGANIZATION

Members and their staffs are organised in Divisions grouped broadly to deal with conventional weapons, guided weapons and nuclear weapons, together with a Support Division which is manned by scientific staff to advise on Explosives Chemistry, Nuclear Physics, Environmental Testing and Statistical Analysis.

Located within the Board is the Applied Ballistics Department, headed by a Superintendent, who is a full Member of the Board. The Department has modern computing facilities and, in addition to Range Table production, is concerned with assessment of risk to the service user arising from fragmenting projectiles. Another important task is the study of the risk of fragment damage to aircraft from their own weapons.

OPERATION

Advice given by the Board must be based on factual data. To this end, the Board are associated with R & D Trials and may also call for any additional trials which they consider necessary to ensure that the production version of any explosive store is safe for transportation, storage and use—in training and in operations—and that it functions satisfactorily when used in a service environment. In the first instance, the results of trials are assessed by the Member most concerned, who then presents his assessment to a weekly meeting of the entire Board for critical examination and discussion. The results of these deliberations are published in a printed document known as an Ordnance Board Proceeding (OB Proc), which includes the corporate opinions, recommendations and advice of the whole Board. This method of operation not only ensures meticulous attention to detailed aspects of safety and suitability for service but also makes full use of the widely experienced Members, whose appraisal is essentially objective, informed and constructively critical.

The early involvement of the Board in any new requirement is necessary in order to influence design for safety, to allow preliminary appraisals to be completed before production commences, and to avoid duplication of subsequent R & D and OB trials of the production store so as to save time, money and effort. The latter point is particularly important in the light of the increased cost of weapons and the limited range facilities now available for trials.

POWERS

In pursuance of the above duties the Board are authorized:—

a To obtain assistance of trials, research, design and other Establishments in connection with their work. Similarly, all Establishments concerned with trials and development may consult the Board direct.

b To consult any other official bodies, firms or persons associated with scientific or technical development.

c To consult with representatives of the Naval, General and Air Staffs and to advise them directly on matters of their particular concern. Where the subsequent decisions or actions arising are the concern of an Approving Authority the advice will be directed through him.

d To establish a close liaison with the Service Staffs to enable the Board to appraise shortcomings arising in Service of weapons and weapon system safety.

e To consult and collaborate with Commonwealth and foreign countries as they may be directed.

f To order and account for materials required for trials when such materials are not supplied through the Approving Authority or from service sources.

COMMITTEE WORK

The Board are responsible for, or associated with, a number of committees, which include the following:—

a *Explosives Storage and Transport Committee.* This is a Government inter-Departmental Committee responsible for prescribing the safety conditions to be observed during the storage and conveyance of Government explosives by land, sea or air. It is under the chairmanship of one of the Vice-Presidents of the Board and is served by a small Secretariat, located in and administered by the Board.

b *Attack of Armour Committee.* This Committee is under the chairmanship of the Army Member of the Bench and its members are drawn from DGW(A), DGFVE, DA Arm, Army, RAF and Scientific Members of the Board and R & D Establishments. It arranges trials concerned with attack of armour, the results of which are assessed and published in Board Proceedings.

c *Ships Magazine Safety Committee.* The Board provides members of this Committee, which is under the chairmanship of DG Ships.

d *Electrical/Explosives Hazards Committee.* This Committee is responsible for establishing design philosophy, developing trials techniques and arranging Board trials relating to electronic radiation and in-system electrical hazards to explosive stores.

e *Nuclear Warhead Safety Committee.* This Committee is under the chairmanship of a Member of the Board and its recommendations are published in Board Proceedings.

f *Aircraft Safety Committee.* The function of this Committee, sponsored by DA Arm, is to co-ordinate all studies of the risk of damage to aircraft arising from their own conventional weapons, after release. Board Members sit on this Committee.

IMAGE

Although over the years the Board have acquired a reputation for appearing

deliberate and cautious in their behaviour, as indeed they have every right to be, some noteworthy examples do exist which show that they can be as quick and free thinking as anyone. Not so long ago an Approving Authority very urgently required the advice of the Board, fortunately not involving trials. The Board met at once and the appropriate Proceeding was in the hands of the Approving Authority inside twenty-four hours. During the First World War there was trouble with a field artillery piece whose barrel apparently was drooping and the user wrote for advice to the Ordnance Board. The advice given was, rather surprisingly, to keep firing and the barrel would straighten itself out. The advice was taken and it was later reported that the barrel behaved as predicted.

RELEVANCE

What perhaps is more important is the relevance and overall value of the Board's activities. Two extremes of weapon safety policy could be postulated as, prohibiting the use of live ammunition in peacetime or, taking weapons as they come and compensating accident casualties as they occur. Neither course is to be commended. Some alternative approach must be evolved after weighing all the factors involved. The OB's independence ensures that the sailor, soldier and airman are given full consideration. The public too have a right to be protected even against the most improbable hazards. The chance in a million is taken seriously by the Board as its occurrences can have deep repercussions. The probability of rogue guided weapons, inattentive drones and ricocheting bullets causing damage or injury all have to be assessed in advance. The value of this work is not confined to our armed forces or even the inhabitants of our territories but spreads into the arms sales field where the reputation attributed to UK safety standards has a strong influence on overseas customers.

THE FUTURE

The increasing cost, complexity and lethality of new weapons and weapon systems, coupled with their increasing inter-service and multi-national employment, reinforces the need for a truly independent professional organization able to look objectively at weapon safety and serviceability through the eyes of many users. The aim of the Ordnance Board is to continue to meet this need. The achievement of the aim will be directly related to the confidence and efficiency with which the Services are able to employ their weapons and weapon systems; and inversely related to the number of hazards and incidents experienced with explosives in these equipments.

[1] Note. It is an established custom to treat the "Board" as a plural noun; e.g. "the Board are" or "the Board have".

* * * * *

THE FINGER OF SUSPICION—DOES IT POINT AT YOU?

"Gone away" "Not known" "Left" "Moved" "Posted" "Try xxxx"

Over the last five months 347 publications and letters posted to Members have been returned to the Institution because of out-of-date addresses.

Although the main culprits are Serving Officers they are by no means the only offenders.

PLEASE notify change of address to the Institution as soon as practicable.

A Cable Profile Design Method for ¼ Point Stage Construction of Multi-span Continuous Prestressed Beams

CAPTAIN J A JENNINGS-BRAMLY, RE, MA, C Eng, MICE

INTRODUCTION

THE author of this article had the good fortune to be attached to Messrs Harris & Sutherland, Consulting Engineers, whilst on his Long Civil Engineering Course. During that attachment he developed a direct design method for the cable profile of bridge decks in the special case where the joints between pours are located at about ¼ span (see fig 1). In the past, the approach has been to select a random profile within the allowable zone (see fig 2) and to check that it was satisfactory under all conditions. This new method leads to the best profile under the given conditions, thus requiring one computer stress analysis rather than several as was previously the case. The method is unusual because it requires that the stages of construction be designed in reverse order: ie that the final ¼ span pour be the first section of the deck cable profile to be designed. It is the purpose of this article to explain the problem and its solution.

The allowable zone is a zone within which the cable profile must be located. Its general shape depends upon the dead and live load moments, foundation settlement and temperature differential effects. The zone width depends upon the concrete crushing strength and the selected cable tension. The cable profile must be selected to avoid tight curves and to lie withing the zone.

In ¼ point stage construction the cables in each stage are connected to the ends of the cables in the previous stage and tensioned from the free end after the concrete has attained sufficient strength. Each stage is thus effectively joined to the last to form a continuous beam. The allowable zone for each stage will be altered by the addition of subsequent stages and by the change from construction equipment loads to road traffic loads. The overall allowable zone is that narrow zone which satisfies all conditions.

'CONCORDANCY'

Any prestressing cable set at a constant or varying eccentricity will induce bending moments in the beam which will, therefore, deform. A multi-span beam resting on support bearings would, in the absence of gravity, deflect in such a way that probably only two of the bearings would remain in contact (see fig 3). In practice any such tendency to lift off is thwarted by gravity and the flexibility of the beam. The effect of this deformation is a change in the value of the support reactions and a system of moments throughout the length of the beam not unlike those due to the unequal settlement of supports. Such a change is undesirable, mainly because under the effects of concrete creep the beam continues to try to deform over a number of years causing a continuously varying set of bending moments and support reactions, all of which should be allowed for in the design. The only way of preventing this deformation would be to stress the beam uniformly with straight cables centred on the neutral axis. However, it is not necessary to prevent all deformation of the beam so long as there is no potential deflection at those points along the beam where the bearings will be situated, because then there will be no change in the support reactions. A cable profile having this property of not causing a change in the support reactions is known as a "Concordant Cable Profile".

It may be seen that the bending moment diagram due to a prestressing cable is of the same shape as the cable profile (in the absence of cable tension loss due to friction), because the moment is the cable force times its eccentricity. It also happens

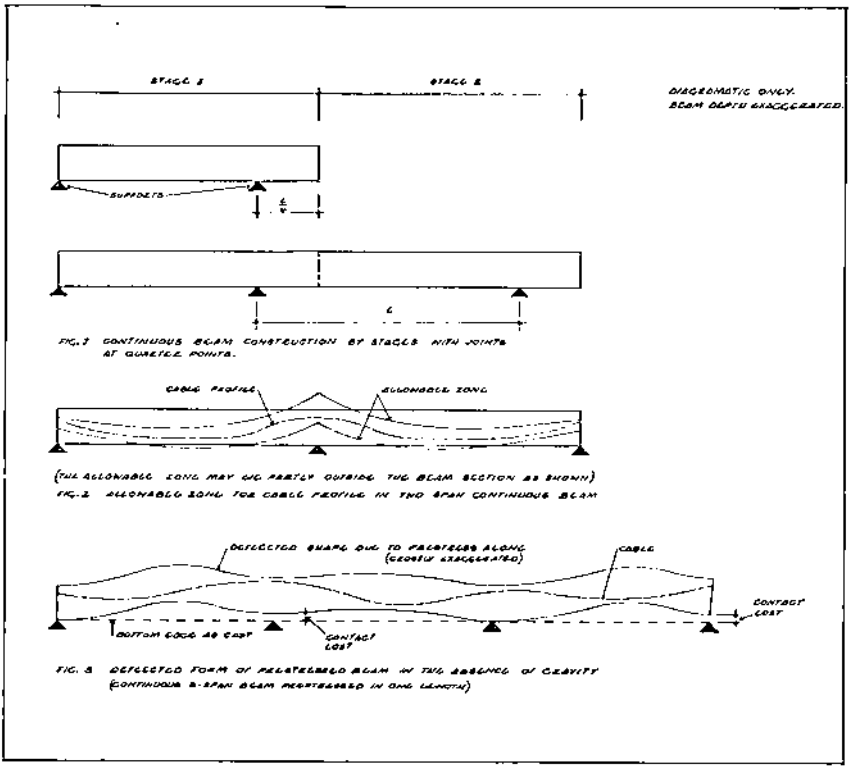


FIG. 3 CONTINUOUS BEAM CONSTRUCTION BY STAGES WITH JOINTS AT QUARTER POINTS.

(THE ALLOWABLE ZONE MAY BE PARTLY OUTSIDE THE BEAM SECTION AS SHOWN)

FIG. 4 ALLOWABLE ZONE FOR CABLE PROFILE IN TWO SPAN CONTINUOUS BEAM

FIG. 5 DEFLECTED FORM OF PRESTRESSED BEAM IN THE ABSENCE OF GRAVITY (CONTINUOUS 2-SPAN BEAM PRESTRESSED IN ONE LENGTH)

that any system of loads on a continuous beam will produce a bending moment diagram compatible with zero deflections at the supports if the usual methods of analysis are used because no allowance is made for such deflections. A concordant cable profile may be designed for the beam, therefore, by applying any system of loads to the beam and using the resulting bending moment diagram as a model for the prestress cable profile. Such a profile may or may not fit within the allowable zone specified above, but trial and error should produce a satisfactory answer. This design method, while being useful for continuous beams stressed in one operation, is not the most appropriate for ¼ point construction as will be shown below.

¼ POINT CONSTRUCTION

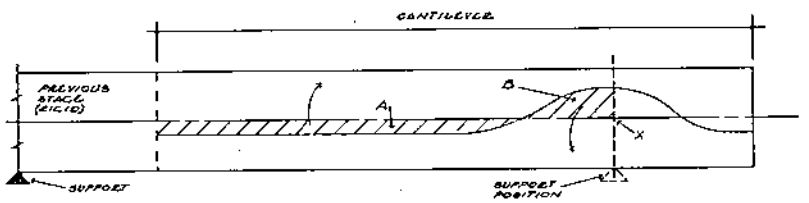
Let us consider that several spans have already been constructed and stressed and that the construction joints are about at ¼ span beyond each support. We erect falsework and shuttering, fix the reinforcement and the cable in its duct to follow the design profile and pour the concrete. After some days the cable is tensioned and this last stage of construction deforms. Unless the cable just stressed is concordant, it will cause the previous spans to be deformed as well. This means that when a span is designed it must be borne in mind that subsequent spans to be erected may alter its bending moment distribution. This is true of both the dead load of the new stage and its prestressing; the former would have been allowed for when defining the "allowable zone" but the latter is apparently unpredictable. However, if the cable is concordant at each stage of construction, then the whole will be concordant and the stresses predictable.

How can one select a cable profile for each stage such that it is likely to be concordant or nearly so? Consider each stage as a cantilever protruding out from the existing part of the structure (see fig 4). The cable is concordant if there is no tendency

for the cantilever to lift off or to depress the support ¾ of the way along its length. There will be no such tendency if the moment-areas between the cantilever root and the ¾ point balance to zero when taken about that point (Moment-Area Principle). It is not difficult to estimate concordant cable profiles "by eye" when given that hint.

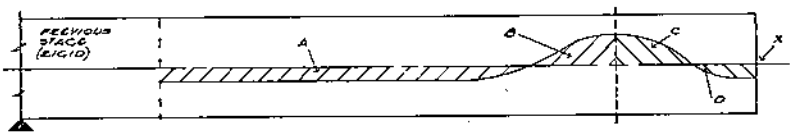
The fact that the free end of the cantilever may deflect due to prestress is irrelevant if concrete creep be ignored, but not otherwise. If the free end of the cantilever has an angle of rotation due to prestress, then this angle will increase under the influence of concrete creep and cause the next construction stage of the beam to be lifted off its bearing or depressed. Vertical displacement of this free end will have the same effect. To eliminate the angular displacement the positive and negative areas of the cable profile between construction joints should balance to zero (see fig 5). This may also be achieved "by eye" at the design stage. These two problems may be combined by considering the potential vertical displacement of the cantilever centreline at some other point. It is suggested that this point be taken at the free end of the next stage of construction. This will work well for the penultimate stage, the problem does not arise in the last stage, and for all other stages it should work adequately.

From figs 4 and 5 it can be seen that to achieve a cable which lies within the allowable zone and satisfies the above conditions may be difficult without giving up some of the economy inherent in a narrow allowable zone. It may, therefore, be preferable to forego the advantage of full concordancy and settle for some variation in the support reactions and in the bending moments imposed by succeeding stages of construction. Nevertheless, some attempt at achieving the former aim will be worthwhile.



CONCORDANT IF MOMENTS OF SHADED AREAS A AND B ARE EQUAL AND OPPOSITE ABOUT POINT X

FIG. 4 THE PROFILE CONDITION FOR CONCORDANCY IN QUARTER POINT CONSTRUCTION



CONDITION FOR NO ANGULAR DISPLACEMENT AT X : AREAS A+D = B+C
CONDITION FOR NO VERTICAL DISPLACEMENT AT X : MOMENT AREAS A+D = B+C ABOUT POINT X

FIG. 5 THE EXTRA PROFILE CONDITIONS OVER THOSE IN FIG. 4 FOR CONCORDANCY UNDER THE EFFECT OF CREEP

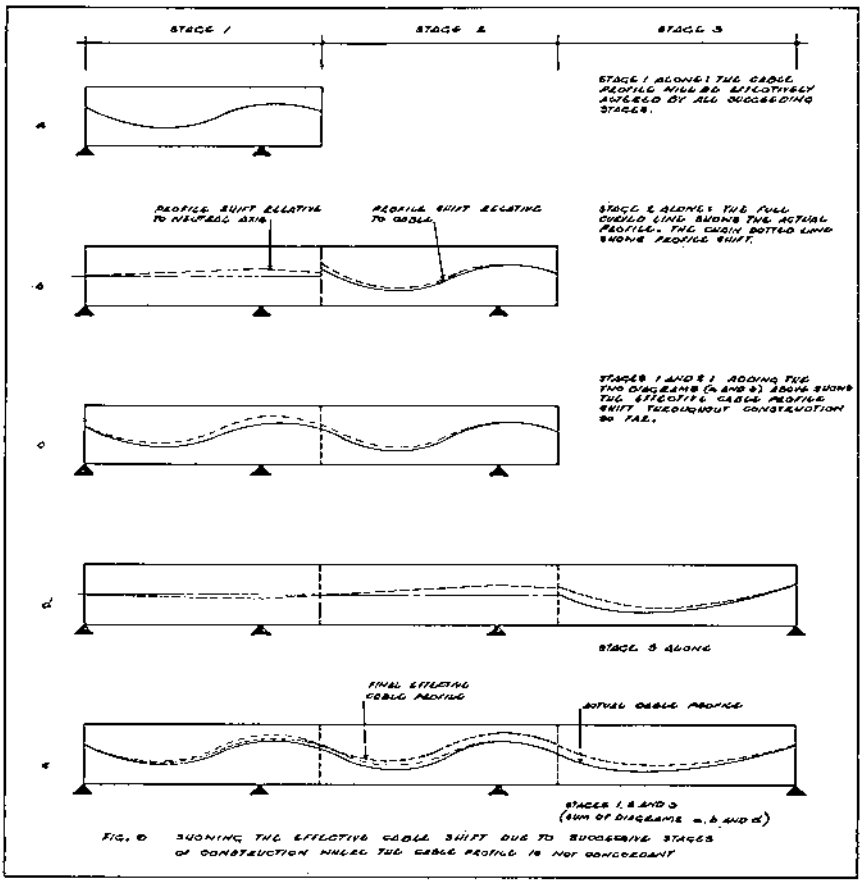


FIG. 6 SHOWING THE EFFECTIVE CABLE SHIFT DUE TO SUCCEEDING STAGES OF CONSTRUCTION WHILST THE CABLE PROFILE IS NOT CONCORDANT

Fortunately, the variation in the bending moments due to lack of concordancy can be expressed simply. If a certain profile is selected for a multispan beam then the actual bending moment diagram due to that cable will not be exactly similar in shape to the cable profile unless it happens to be concordant. The actual bending moment diagram will generally not be very different because the moments induced by lack of concordancy are usually small (see fig 6c). This bending moment diagram is the true effect of the cable and is called the effective profile, giving values of effective eccentricity at all sections. The effective eccentricity is thus the same as the real eccentricity only for a concordant cable.

Now, when considering the $\frac{1}{4}$ point constructed continuous beam the effective eccentricity of the cable within any stage, and the change in the effective eccentricity of cables in previous stages, can be calculated. A way of doing this is to find the potential deflection at the last support from moment areas as above and to use that deflection to find what moments would be caused throughout the beam in removing it. Thus, each stage of construction causes a calculable shift in the effective profile in the previously constructed stages (see fig 6b). This shift is independant of the actual profile or earlier effective profile in the previous stages. The effects of creep due to prestress may also be studied by calculating the shift at each stage after some years. Dead load creep may, however, have mitigating effects.

The argument developed suggests that the last span profile should be designed first because it will not be altered subsequently by other stages. When the penultimate span is designed the effect of the last span upon it is known, so the profile is merely

shifted by that known amount to the optimum position. However, if the prestressing force is different in the various stages, then the shift should be in proportion. The temporary condition should be checked if it now lies outside the overall allowable zone, It will often be satisfactory because the temporary allowable zone does not include the effects of all stages of construction and all conditions of use and is therefore wider than the overall allowable zone.

So far friction losses have been avoided in this article. Their effect in this type of construction is to reduce the cable tension with distance away from the free end of each construction stage. This will often reduce the lack of concordancy as may be seen by studying fig 2 where the clockwise moment is reduced. Similarly, friction will reduce the potential deflection at the supports as calculated by moment areas in fig 4 and this will reduce the effective profile shift portrayed in fig 6. A calculation of the actual cable tension expected at each section of the "cantilever" will enable a modified bending moment diagram to be produced, thus allowing calculation of the modified deflection and its effects which will be changed in proportion. In general it may be said that friction will reduce any change expected due to lack of concordancy.

WHAT THEN IS NEW?

It is thought that "moment-areas" as a means of reducing the lack of concordancy may not have been used previously in this way. Similarly, and more probably, the method of starting at the last span and working backwards, against all natural inclinations, is thought to be new. It should be emphasized that this is only a means of selecting a cable profile, and that the contents of this article are not necessarily fully endorsed by the consultants in whose time the method was conceived. The stresses due to the selected system may, however, be checked in the usual way.

This article was prepared from handover notes left to explain an apparently illogical design approach. It was thought that the philosophy behind it could be of general interest. The lowest pair of bridge decks at the Mertham Interchange on the M23/M25 near Redhill, Surrey, had their cable profiles selected partly in this way.

Once in a Windward Island

LIEUT-COLONEL R S HAWKINS, RE (Retd), MA, C ENG, MIMECHE

THE old British Empire in North America and the Caribbee area was crumbling. In alliance with the rebellious American Colonies, France, with local naval superiority had gained possession of most of the Windward and Leeward Islands; only Barbados, St Lucia and Antigua remained in British hands. The French fleet blockaded the American coast between Newport and Chesapeake Bay, and Lord Cornwallis surrendered to General Washington in October 1781. Five months later, Admiral de Grasse's ships were at Martinique, preparing to support the proposed Spanish recapture of Jamaica.

In desperation, Admiral Sir George Rodney was sent out with more ships from England. On 12 April 1782, Rodney breached de Grasse's line of battle in a great naval encounter in sight of Les Saintes Islands, South of Guadeloupe; in the resulting confusion the French fleet took appalling punishment, and there was terrible carnage among the Spanish troops on board bound for the conquest of Jamaica. Ship after ship struck her colours, and at last the Flagship *Ville de Paris*, of 104 guns and largest ship in the World, struck to Admiral Hood. French and Spanish aspirations in the Caribbee were annihilated; the American Colonies were lost, but on that day a new British Empire was born.

By the Treaty of Versailles of September 1783, France was awarded her old possessions of Tobago and St Lucia. England regained her Islands of St Kitts, Nevis,

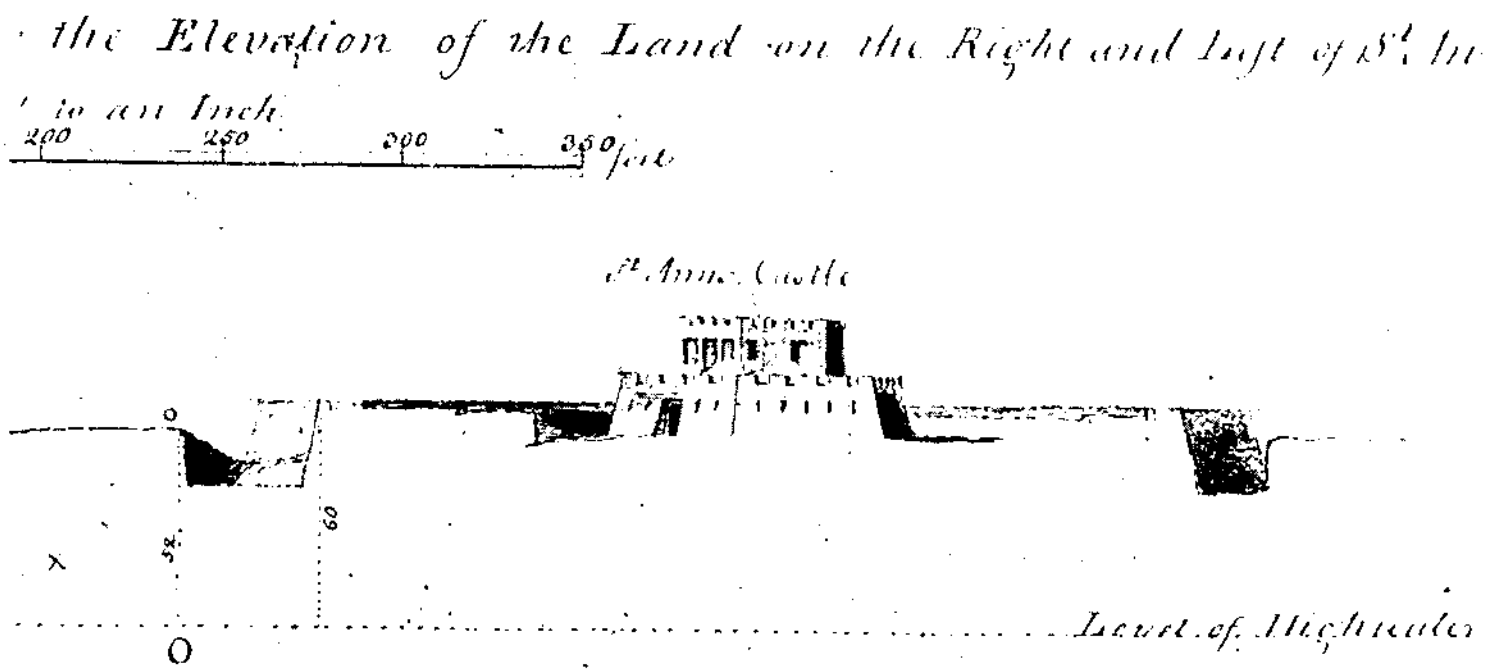


Photo 1. Part of ground section (1786), scale 50 ft to 1 in, by Robert D'Arcy, Lieutenant of Engineers.

Dominica, St Vincent and Grenada, and in the next few years, British garrisons re-occupied all these Islands. There was a pressing requirement for the barracks, hospitals, forts and defences to be repaired or rebuilt after years of neglect. By 1786, there were nine Officers of the Corps of Engineers in the Caribbee area, of whom the Commanding Engineer of the Windward Islands was Colonel Harry Gordon, on Grenada.

Windward of the Windward Islands, a hundred miles away, lay Barbados. British merchant ships sailed from the Caribbee with rich cargoes of sugar to Liverpool and Bristol, following the Northerly trade route. They then sailed South in trade goods or ballast to the Guinea Coast of Africa, took on cargoes of slaves from the barracoons, and then, with the Easterly trade winds, took the "middle passage" to the West Indies. Landfall was generally Barbados, the established centre of slave trading for the whole area, and a major producer of sugar and rum.

Largely owing to its unique windward position, Barbados had survived the wars as a British possession. The only harbour was magnificent Carlisle Bay, in the South West, on which stood the town and commercial centre of Bridgetown. The defence of town and harbour, and indeed the defence of the whole Island depended on St Ann's Castle, dominating the Bay. It was a picturesque but rather outmoded fort with battlements, built in 1703; it was neither strong enough to resist investment, nor large enough to contain an adequate garrison. Colonel Gordon outlined plans for the enlargement and strengthening of the fort, and instructed Robert D'Arcy, Lieutenant of Engineers, to carry out a survey and prepare detailed designs.

With all the skill of an artist, cartographer and engineer, D'Arcy presented in 1786 his first survey, sections and plans, at a scale of 50 ft to 1 in, delightfully finished in water colours (photo 1). In those days fortifications followed certain precise geometrical rules, originally propounded by M Vauban and, perpetuated in John Muller's text books, used at the Royal Military Academy. D'Arcy however discarded the time honoured "toise" of six French feet, and staunchly clung to English dimensions.

Early in 1787, Colonel Gordon returned to England, and his place was taken by Lieut-Colonel Andrew Frazer, Corps of Engineers, from Jamaica. Over the next few years, Robert D'Arcy produced several proposed plans for strengthening the defences of St Ann's Castle, as instructed by his Commanding Engineer. Here was a fine layout (photo 2) of glacis and covert-way, parapet and banquette, ditch, counter-scarp, bastion and redoubt. The plans were nicely coloured in accordance with the text book, carmine for sections of masonry and plans of buildings, and umber for dry ditches, sand and "all things of earth". The other approved colours were "gum-bouch, verdegrease, sap-green and indigo".

The Island of Barbados was composed of hard coral rock, with only 8 in of top-soil. This led to certain engineering problems in fortification, and D'Arcy annotated his plans accordingly; for example on one plan he wrote, "As the rock will admit to be cut to this profile, I hope it will be thought in this situation a sufficient defence for the Covert Way". His last plan of July 1790, "To render the Peninsula between Maycock's Gully and Needham's Point a secure Place of Arms", was addressed amid a grand flourish of curlicues:—

"To His Grace, The Duke of Richmond &c,
Master General of His Majtys Ordnance".

Lieutenant James Fiddes RE[1] reached Barbados in June 1791, after a ninety day voyage in a hired transport from England. D'Arcy then proceeded to the Bahamas, where he carried out surveys of New Providence Island, and planned defence works at Fort Charlotte for the Colonial Government. James Fiddes continued enthusiastically with detailed plans for a Powder Magazine, a Moveable Hospital, Privates Barracks, Ordnance Stores etc (photo 3). His "moveable hospital" was an ingenious venture in wooden hutting, about 18 ft wide, of standard fabricated parts; provision was made for forming a double roof on a single-roof hut, and the whole was clearly designed for ship transport to meet the demand for sanatoria on the Islands. Very

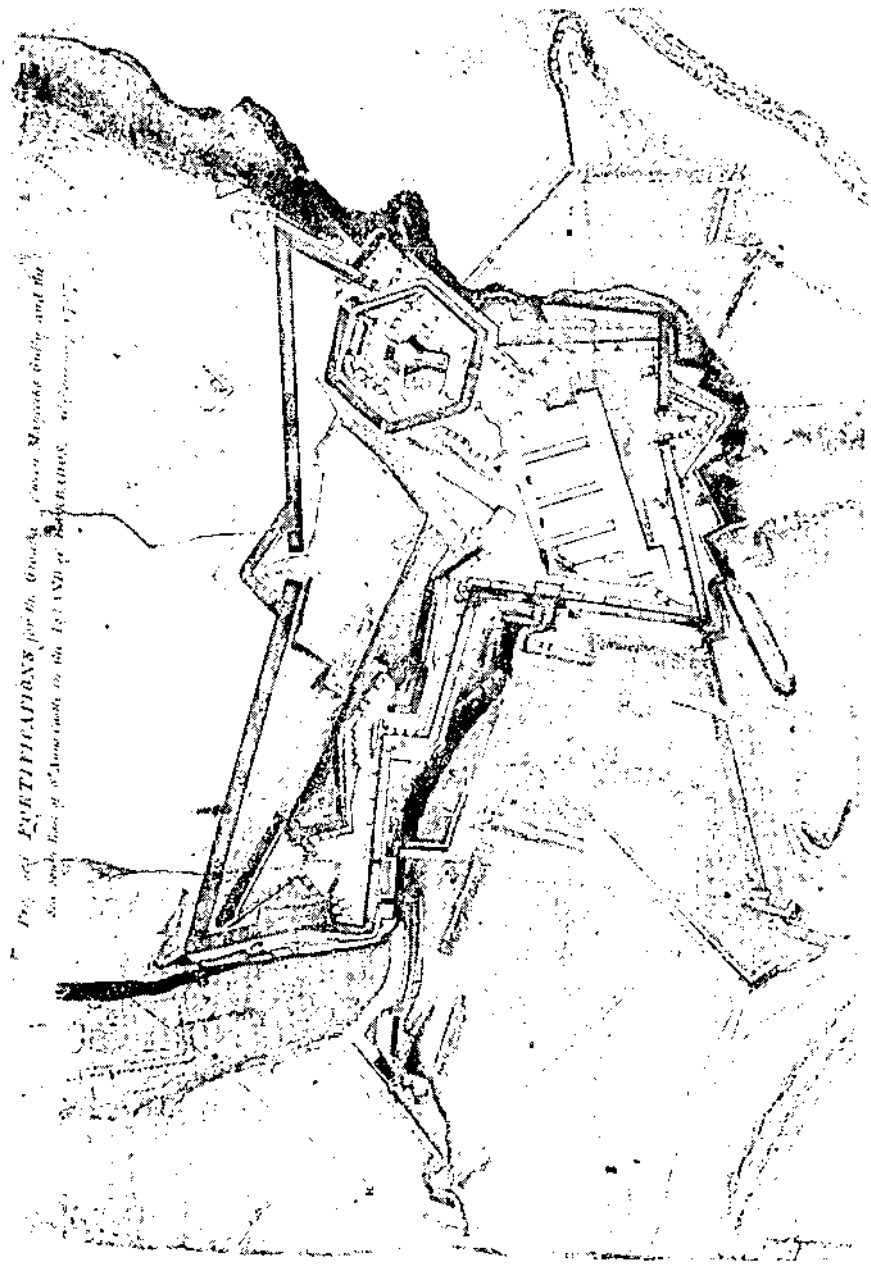


Photo 2. Survey and proposed new defence works (1787) scale 100 ft to 1 in, by Robert D'Arcy, Lieutenant of Engineers. The hexagon shape is St Ann's Castle.

few of the new proposals were ever constructed, on account of the shortage of finance; the Legislative Assembly of Barbados could ill afford to allot money for the Island's defences, and precious little was forthcoming from England. Lieutenant Fiddes had a hard task patching up the existing Barracks and Ordnance buildings as best he could. Skilled labour was hard to come by, and his workmen were about fifty Ordnance owned slaves, who had to be paid subsistence allowance and provided with quarters, in accordance with the civil regulations on the Island.

This torpor was shaken when the Convention of France declared war on England in February 1793. The fear of attack of a decade before, was allayed by the arrival in Carlisle Bay on 6 January 1794 of a squadron of ships under Sir James Jervis, bringing troops from England under the command of General Sir Charles Grey. This force included ten RE officers and a Company of Royal Military Artificers, ninety-four all told, under Sergeant-Major Matthew Hooey. It was joined by Lieutenant Fiddes and, in due course, successfully captured Martinique from the French on 25 March. St Lucia fell on 1 April, and Guadeloupe nineteen days later; the latter however was retaken by the French on 3 July, and thereafter remained under the domination of the Republican Brigand, and self-styled General, Victor Hugues. In the following year St Lucia, too, succumbed to his Republican partisans.

Late in 1794, a Government stores ship from England was captured by a French corvette off Barbados. All the passengers, including Captain Charles Shipley RE, his wife Mary and their three small daughters, were taken to Guadeloupe and there interned, among 1400 destitute fellow countrymen, in prison ships off Point-à-Pitre. The conditions were abominable, and after nearly a year of this, Mary, as a civilian was importunate enough to obtain a release for herself and her daughters, who were despatched to St Pierre, Martinique, then British HQ in the West Indies. Here she so pestered the British Commanders that she was allotted a small boat, a Naval Officer and four seamen; then, with a female slave she set sail on 10 October 1795 back to Guadeloupe! "She had the resolution", wrote Charles three weeks later from St Pierre, "without the protection of a flag of truce, or any letters, to go to an enemy's country, in order to interest the French representative in favour of my liberation; and this Victor Hugues, whose atrocities have been such as to impress all the world that he was incapable of a generous sentiment, was so struck with her fortitude, and uncommon conjugal affection, that he treated her in the most liberal manner and consented to crown her extraordinary efforts by giving me my liberty. Her having succeeded has been a subject of astonishment to the whole Army and Navy here".

Early in 1796, Sir Ralph Abercrombie with his expeditionary force reached Jamaica, and, in the course of the year, took or recaptured St Lucia, Demarara, St Vincent and Trinidad. He did much for the soldiers' health by altering the uniform for the hot climate, and establishing hill stations and sanatoria. Major Shipley RE, became his Commanding Engineer in the West Indies in October 1796, a post which he held for the next fifteen years.

James Fiddes, aided by a handful of Royal Military Artificers, continued as Engineer Officer on Barbados till early in 1798, when he was relieved by Lieutenant T R I'Ans RE, bringing with him from England thirty Artificers as reinforcements for the already depleted company. At that time, the Assistant Engineer on Barbados was Mr William Baillie, and the most important new construction on the Island was the Ordnance Sick and Convalescent Hospital for seventy inmates, near St Ann's Castle, to the design of Captain Fiddes. Major Shipley wrote to the Board of Ordnance on 28 January 1799 on this subject:—

"The deviation from Capt Fiddes' plan consists in substituting Masonry for Carpenter's work and omitting the cellars; to which it may be added that a construction in stone is not only more permanent than a wooden building, but also cooler and less liable to retain Infection, should it take place. As paving the galleries of the Ordnance Hospitals will be preferable to boarding, I am to request that 1500 British paving stones may be sent from England to Barbados by an early conveyance. Lieut I'Ans has recommended a brother of Mr Baillie, who served 3 or 4 years as

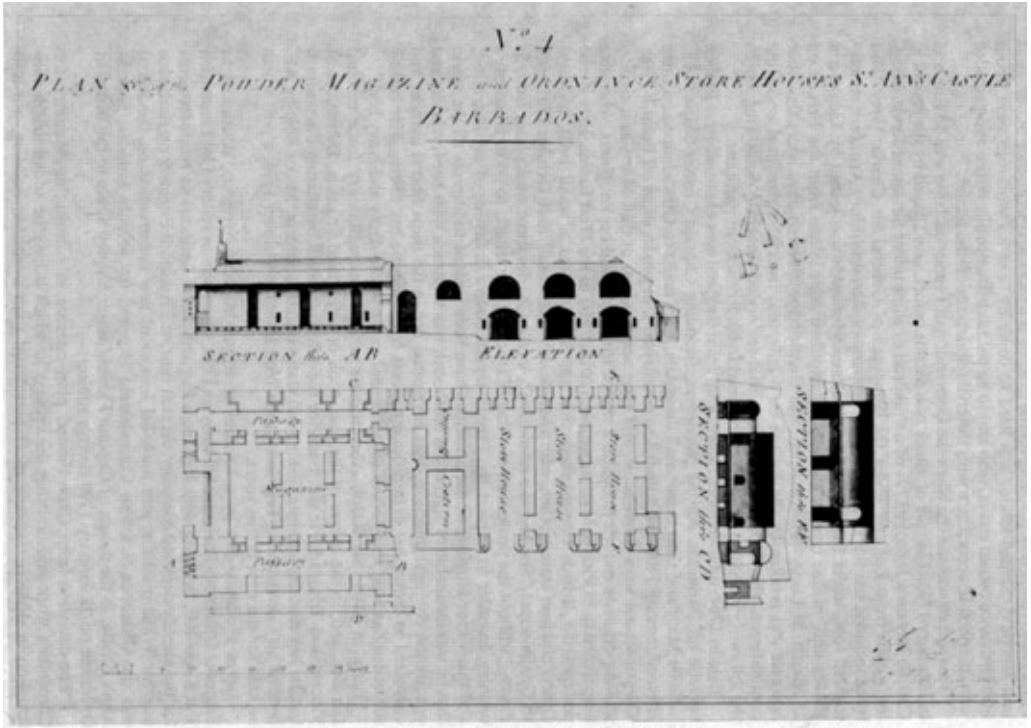


Photo 3. Design proposal (1796) scale 15 ft to 1 in signed "JAS FIDDES, Lieut Royl Engineers".

Once in a Windward Island

Clerk in the Ordnance Office at the Tower, to be Clerk of Works at Barbados, which I hope will meet the Board's approbation".

It normally took five or six months to send a letter to England and get a reply; even so, the hazards of storm and tempest, enemy ships and privateers, made the transit of mail somewhat precarious. An official letter was written by an officer in his own hand, and then fair-copied by a clerk; both letters were signed by the officer, and dispatched on two different ships. Such mail was handled by the Admiralty, who had power to enforce the carriage of mail on merchant ships.

The "Barbados Estimate of Works and Repairs for 1799", prepared and signed by I'Ans on 22 October 1798, gave some idea of engineer maintenance work on the Island. For the "necessary repairs to Ordnance Buildings &c", a slave labour force of thirty (and two horses!) was to be employed. The list showed one Master mason @ 12s 2d per day, six black masons @ 2s 6d per day, smiths, painters, carpenters and labourers, to which I'Ans added the note "Employed occasionally for 180 days a year, it being proposed to sell those belonging to the Ordnance when the Hospital is finished".

The list of materials for "General Repairs" included lumber, locks, hinges, nails, glass, 300 lbs of iron, 25 galls of paint, 15 Hhds lime and 10 Hhds Coals. The major single item was a Roof to the Magazine and Storehouses; this required 125 squares carpenters work, 24,000 ft pitchpine, 50 brls lime, 25,000 tiles, and among other items, 2,000 twenty-penny nails and 15,000 tenpenny nails. Under "General Service" in the Estimate was "Extra pay to the Commanding Engineer—£134.4.3¼ (currency)",[2] together with allowances for labourers, clerks, and "keep of a house". Major Shipley received this estimate at Martinique, and, on forwarding it to the Board of Ordnance, added very sensibly:—"Upon examining the foregoing Calculations, I find an error of 3s/6½d undercost in the pay to the Commanding Engineer, which should be £103.8.4, sterling".

All military buildings and ancillaries on the Island were on the charge of the Barrack-Master General of the Ordnance Department. Their maintenance and repair was a RE responsibility, and a list by Mr Baillie showed what existed in December 1799. There was accommodation for one General, eighteen Captains and Field Officers, thirty-six subalterns and 2,700 Privates. There were Hospitals for 470, and six huts for married soldiers. Water supply came from "8 pumps"—a pump being either a well or a very English looking windmill which drew water up from considerable depth below the coral formation. Other items were six ovens, one bake-house, one bathing house, and a "black hole", shown on the plan as a rather horrifying rectangular pit, adjoining a guard room! Over the next few years, Engineer works increased the available accommodation; additional items were a Commissary Store for 3,500, seventeen kitchens, seventeen "necessaries", a Powder Magazine for 1,700 barrels, various sheds and stores, and water cisterns to contain 4,000 gallons. There were also two bridges, one wharf and a "dead house".

At the end of 1801 hostilities temporarily ceased; by the Treaty of Amiens, signed in March 1802, Martinique, St Lucia and Tobago were returned to France, while Trinidad was ceded to Great Britain. Headquarters of British troops in the West Indies was therefore shifted from Martinique to Barbados; the newly appointed Military Commander was Lieut-General William Grinfield, his Commanding Engineer still being Lieut-Colonel Shipley. There were at the time nine other RE officers either in the West Indies or on sea passage between the Islands. Death from disease and wastage due to ill-health took a continued toll, so that the numerical strength of officers on effective duty only averaged about six.

The defences and military accommodation on Barbados left much to be desired; there had always been a shortage of money, and local labour, both skilled and unskilled, was hard to come by. The situation was well explained in a letter dated 6 November 1802 from General Grinfield to the Governor, Lord Seaforth:—

"The necessity of putting this Island in a state of defence is obvious. The present fortifications are in ruins, and I cannot with any degree of propriety direct the Com-

manding Engineer to form a plan of defence, or an estimate of expense, without your Lordship's concurrence; if done, it might prove burdensome for the Island.

"The King is the General Protector, and the present defences might be offered to the King, and a provision made to allow additional defences by paying to the individuals a proper price for the ground. My plan is to raise on the Island 4 Regiments of Infantry, one of Cavalry and a Corps of Registered Pioneers, which last Corps would be particularly useful in opening communications, erecting works and making up roads, few of which are passable".

The Legislative Assembly of Barbados, a self-governing Colony, had on several occasions turned down proposals for a Black Labour Corps. The defences were the responsibility of the Island, a burden it could ill afford financially; little or no assistance was ever received from Parliament in London, except for the essential accommodation of British troops. General Grinfield's proposed Black Pioneer Corps consisted of twenty Officers (Directors), twelve Warrant Officers (Overseers), 800 Pioneers and eight conch-horn blowers. The men were to be hired, a slave Labour Corps being anathema to the Assembly, intent on ameliorating the lot of slaves.[3] Charles Shipley, however, put forward his ideas to the General:—

"Reasoning from the belief that the Government will maintain a strong force in the West Indies, I think that in the Article of Hire of Black Artificers, Pioneers and Labourers for the various yet constant wants of the Army, a large sum might be saved annually and the service be infinitely better carried on, if, instead of hiring, the number found to be necessary were purchased and the property of the Government. This Corps indeed requires much time for its formation, as they are boys only which are bought, or proposed to be bought for this use, it being judged in vain to endeavour to teach trades to grown men".

The important tradesmen were carpenters, masons and blacksmiths, whose current rate of hire was 4s 6d a day. The proposal was to raise a Black Pioneer Corps for the Engineer Department, and a Black Artificer Company under the Quarter and Barrack Department, but subject to the General Service of the Army. Lieut-Colonel Shipley showed by a careful analysis that the purchase of slaves was a cheaper proposition than hiring black men. A slave labourer was paid, on an average, 1s 2d a day, the initial cost of one Black Man being £60; hired labour cost much more. In his analysis, Shipley allowed for "1st cost of 500 Black Men (& deduct for 150 already paid for)", interest on capital, pay, clothing and barrack allowance, and "purchase of 150 recruits in 5 years". His proposal, on the scale envisaged, undoubtedly represented a saving of about £5,000 out of £20,000 in a year. The proposal was strongly supported by the General and the Governor, but turned down by the Assembly. Until the end of the war, hired black labour was used on Engineer defence works, the cost being borne very largely by the Island. The shortage of skilled and semi-skilled labour was a great handicap; it was but little alleviated by the few available Military Artificers who were normally employed as supervisors.

Hostilities in Europe broke out again in 1803. In July of that year, General Grinfield set out from Barbados with two Battalions of Foot, the Company of Royal Military Artificers under Captain Edward Rogers RE, with a squadron of ships under Commodore Hood. The French Island of St Lucia fell to his onslaught, and thereafter remained a British possession; a few weeks later Tobago surrendered with negligible resistance to the same force. Edward Rogers succumbed to ill health, and died on Trinidad in August 1803.

The impact of the war in Europe had little effect in the British West Indies until 29 May 1805, when General Bereton, Commandant of St Lucia reported to Lieut-General Sir William Myers, Military Commander on Barbados, that a strong French fleet under Admiral Villeneuve had "passed to the windward of Gros Inlet, Guadeloupe, their supposed destination being Barbados or Trinidad". The news of the impending attack reached Myers four days later, and Lord Seaforth immediately declared Martial Law on the Island. Lieut-Colonel Shipley redoubled his efforts on the rather feeble fortifications on Barbados; there is no doubt that his active presence

and preparations gave unbounded comfort to the very frightened population.

On the morning of 4 June an unforgettable sight greeted the inhabitants of Bridgetown. Five British ships-of-the-line gracefully entered Carlisle Bay, led by a venerable three-decker of 104 guns wearing a red and white pennant and thundering out a salute in honour of the King's Birthday. The unbelievable had happened—Admiral-of-the-White Lord Nelson had arrived! The country was saved!

In less than twenty-four hours, two battalions of troops under General Myers had been embarked, and the ships sailed away, to many people's astonishment, South towards Trinidad when the enemy was believed to be off Dominica and heading for Antigua—which was in fact true; Nelson had been badly misinformed!

The excitement and fear of invasion died down, but on Tuesday, 17 December, Charles Shipley was greatly moved to read in the *Barbados Mercury & Bridgetown Gazette*:—

"VICTORY OVER THE COMBINED FLEETS AND DEATH OF LORD NELSON!

"The ship *Venerable*, of and from Liverpool in 45 days, arrived here on Saturday afternoon, and brought accounts of the above glorious, and at the same time melancholy tendency, which we the same evening issued in an Extraordinary Gazette. The authenticity of this account has since been very satisfactorily corroborated, by the report from the American Brig *Sally*, arrived here yesterday evening. Lord Nelson on the 21st October off Cadiz engaged the Combined Fleets, consisting of 36 sail of the line, His Lordship's of 34, and, after an obstinate contest, captured 18 sail, and sunk, burnt or destroyed almost the whole of the remainder.

"During the height and fury of the battle, our intrepid and gallant Chief received a wound, which obliged him to go below; but, still eager for the fight, he returned on deck, and while yet the enemy kept up a feeble fire, was seen to direct his conquering fleet; but most unfortunately, when now the battle was all but won, this unparalleled Hero fell by a ball, to rise no more!—Closing a LIFE OF GLORY, by a DEATH in the MIDST OF VICTORY!"

Since his appointment as Commanding Engineer in 1796, Colonel Shipley had achieved much. His attention to Engineer works and defences, which involved long and arduous travelling between the Islands, had done much to improve the security of the Colonies, and to maintain the confidence of the civil population. Just before his departure for Jamaica, on a mission of inspection and exploration for the Board of Ordnance, he received a remarkable presentation with this accompanying letter:—

Barbados, July 1st 1806

"Sir,

Understanding the honourable service, to which your life has been devoted for the good of your country, calls you from hence to the station of Jamaica, we the undersigned, in the names of very many respectable Members of this Community, cannot but avail ourselves of the occasion, to express the high opinion entertained of your zealous exertions for many years, whilst commanding His Majesty's Corps of Royal Engineers, for the defence of these Islands. In doing this, you will permit us to add our acknowledgements for your unremitted and indefatigable attention to this Colony, particularly whilst under Martial Law, and threatened with depredation from a rapacious Enemy.

It is pleasing to us to be deputed to solicit your acceptance of a Piece of Plate, of the value of Two Hundred Guineas, as a small tribute of remembrance for your Public Services; whilst the mildness and urbanity of your manners, during the different periods of your residence in this Island, will impress all that have had the pleasure of your society with sentiments of lasting esteem, and regret for your departure.

Sincerely wishing you every mark of His Majesty's favour, with prosperity, health and happiness.

We have the honour to be,

Your most obedient humble servants,

JAMES MAXWELL, JOHN HIGGINSON, GEORGE REED Junr."

The Colonel replied on 11 July:—

"Gentlemen,

It is with the most heartfelt pleasure I have this moment received the honour of your letter. Nothing can ever be more gratifying to my mind than the approbation of so respectable a Community, although conveyed in terms most suitable to their kind partiality than my deserts.

I request the Merchants of Barbados will accept my most earnest good wishes; and in taking leave of them for the present, it gives me pleasure to observe, that when the objects are accomplished, which occasion my proceeding to Jamaica, I shall return to these Colonies, conformable to my instructions from home.

I have the honour to be, with truest regard,

Gentlemen,

Your most obliged and faithful servant

CHARLES SHIPLEY."

Since its first arrival from England in 1794, the Company of Royal Military Artificers under Sergeant-Major Hooey, underwent numerous changes. Deaths from disease, mainly yellow fever, took an appalling toll; its mustered strength varied from about one hundred to as little as twenty, and there was a continual flow of men invalided home. The wastage of about a quarter of their number every year was partially made good by reinforcements from England and Nova Scotia. Lieut-Colonel Shipley made great and successful efforts to replace losses by tradesmen from other regiments, in which he was always supported by the OC Troops. The Company Officers, of the Royal Engineers, were continually changing location; they too suffered deaths from disease, and wastage through ill-health.

The men were perforce scattered in small numbers throughout the area, both as skilled tradesmen and overseers of black labour on Engineer works. There was no place that had not enjoyed the handiwork of Military Artificers, from the little islands of Antigua and St Kitts in the North, to Berbice and Surinam on the Southern mainland. On all expeditions against the enemy, Artificers, often far too few, were present; they were used as "General Labour on the trenches and park", they built breastworks, emplaced the guns and destroyed the forts. The men became, in 1810, the 11th Company, Royal Military Artificers under Lieut-Colonel William Johnston RE, and, in 1813, the 6th Company of the 4th Battalion, Royal Sappers & Miners. Battle Honours of the Company were as follows:—

Year	Force Commander	Artificer Strength	Places Taken
1794	Sir Charles Grey	94	Martinique, St Lucia and Guadeloupe
1796	Sir Ralph Abercrombie	77	St Lucia and Demarara
1797	Sir Ralph Abercrombie	21	Trinidad
1798	General Trigge	14	Dutch Surinam
1803	General Grimfield	77	St Lucia and Tobago
1804	Brig-General Hughes	23	Dutch Surinam
1807	General Bowyer	?	St John, St Thomas and St Croix
1809	General Beckwith	74	Pigeon Island and Martinique
1815	Sir James Leith	33	Martinique, Marie Galante and Guadeloupe

Sergeant-Major Hooey was present on nearly all of these expeditions, with his Military Artificers, up to the fall of Martinique in 1809. This stalwart Warrant

Officer had then served twenty-two years in the Corps, preceded by seven years in the Royal Marines. At Bridgetown he had gained great prestige, not only by his military prowess, but by his acquired wealth and ownership of carriages, horses and servants; the scabbard and the hilt of his sword were of silver, and he wore costly ornaments. This magnificent character died at Bridgetown on 14 July 1810, an unforgettable and unique asset to the Corps to which he belonged.

Reports on the progress of the war in Europe were always two or three months out of date, and, at first, generally in the form of misquoted information passed from ship to ship. In June 1814, news reached the West Indies that the Great War appeared to be over as Paris was occupied by English and German troops, a Bourbon king was on the throne of France and Napoleon was banished to the Isle of Elba. The first Treaty of Paris was signed on 30 May.

The end of the war was rather an anti-climax for the Army and Navy. The services had expanded to about three times their size at the beginning of the war, and it was a national necessity to reduce the strengths drastically. The Government had made no previous arrangements to reduce the numbers, and the measures they were forced to employ caused considerable distress and disappointment. Most of the rank and file however were only too pleased to accept a discharge, and return to their farms and cottages. For most officers, any enforced "removal" meant a considerable drop in prestige and the loss of an apparently assured career. In the Navy, thousands of officers were relegated to half-pay by an Order in Council of June 1814. In the Army various measures were introduced, leaving the country with quantities of unemployed Senior Officers and an intense promotion blockage among the others, which lasted for two decades. One procedure was to retain a Senior Officer in his Army rank, while removing him from his Regimental rank; such a man found himself unemployed, with little chance of promotion or further employment. He was in effect on "half-pay", though it was not so called.

In the Royal Engineers, Army rank afforded no priority in Regimental promotion, which was based on seniority in the Corps only. By Command of the Prince Regent, on 20 December 1814, General Officers below the rank of Colonel Commandant RE had to remove from the Corps with the pay attached to the rank of General (25s 0d a day for a Maj-General). They could however retain their Corps Commissions by waiving their General's pay. The instructions were remarkable for their lack of clarity, and the IGF, Lieut-General Mann protested strongly about this and the apparent implications on the future of RE officers. He also had to inform the affected officers personally; in the West Indies they were Sir Charles Shipley, then Governor of Grenada, and Maj-General William Johnston, the Commanding Engineer on Barbados.

The remoteness from home, the intense emotions inspired by loyalty to the service, and uncertainty due to vagueness of the instructions, gave rise to some impassioned letter writing. Now it so happened that Maj-General John Mackelcan (Lieut-Colonel RE) had gained about four years Army seniority by his previous employment in a Militia Regiment, later the Newfoundland Fencibles, founded in 1782 by Captain Robert Pringle, the Commanding Engineer; his case was but one of the many anomalies of the Prince Regent's Commands.

Johnston wrote to General Mann from Bridgetown on 31 March 1815:—"I deeply regret the adoption of a measure which admits for traitors to blast the hopes of so many officers, who, under similar circumstances, would have proved no less worthy than their more fortunate competitors. As Senior Officer of the Corps whom the measure affects, I speak in behalf of those below me as well as for myself. I shall merely narrate that, after having served more than forty years as an Officer, nearly twenty-seven of which were in the West Indies, during the whole of this time I have been looking steadfastly to the goal at which I might at last arrive.

"I find, when old age is making rapid efforts to arrest my progress, a man, both in years and service, considerably my junior, steps between me and my best prospects; a man to whom fortune has not favoured with opportunities to display professional

Photo 4. Major-General Sir Charles Shipley wearing the Army Gold Medal awarded to him for Martinique (1809) with gold clasp for Guadeloupe (1810).

skill or brilliant exploits, but merely from having been lucky enough to obtain the rank of Captain in a Corps of Fishermen, raised by Col Pringle in Newfoundland, and not having the most distant relevance to anything connected with the duty of an Officer of Engineers. What man can with patience behold his birthright thus destroyed, and his ultimate prospects delayed and finally smothered, by the reflection that he could only arrive at the summit of his profession, by the dissolution of his brother Officers, and perhaps his best friends and companions?"

By 1816 the War was several months over. A pathetically small number remained of the 6th Company, RS & M; the pay list of the Ordnance agents, Messrs Greenwood & Cox, showed only two Sergeants and fourteen Privates on Barbados. Of these, three were noted as "pensioned 1st January" and two died during the year. The remainder of the Company was on Guadeloupe and Antigua, under the command of Captain Alexander Brown RE; Sub-Lieutenant Patrick Whelan RS & M was on six months leave on account of ill-health, and his place as Adjutant and Quartermaster was taken by Lieutenant Alexander Le Quin of the Royal Foreign Artillery. Johnston penned this epilogue to General Mann:—

Barbados
4th July 1816

"Sir,

Allow me to ask the attention of your leisure to the ranks of the Company of Sappers & Miners in this Command. Our files are reduced to thirty-nine, including non-commissioned Officers, out of which four or five have claimed their discharge, due to them at the expiration of six months from the Peace, and our effective strength as Artificers, from climate, length of service and other circumstances, has dwindled away to almost nothing.

I need not point out to you, Sir, the advantage derived from these men in this country in enabling us to carry our Estimates into execution with more dispatch, economy and superiority of workmanship, as well as increasing our numerical effective strength generally in this Command. We are much in want of Carriage-Makers, Wheelwrights and Blacksmiths, and I beg leave, one or two Plumbers. Our plumbing business here is frequent, and, except where new or regular work is to be executed, that can be performed by Contract and Measurement; but we are wholly at the mercy of the person employed, whose charges it is difficult to control or check. We are not either well provided with non-commissioned Officers, and we have now been long without a Sub-Lieutenant.

I have the honour to be, Sir,
Your most Obedient Humble Servant
WM JOHNSTON
Colonel of RI Engrs"

Charles Shipley had spent practically all of his service in the West Indies, from his first arrival as Ensign and Practitioner Engineer on Jamaica in 1780, to his time as Commanding Engineer, Windward and Leeward Islands, 1796 to 1811, and then as Brig-General to the Forces in the West Indies. He was knighted in March 1808, during a brief visit to England, and took up his appointment as Governor of Grenada in February 1813.

Napoleon broke out from Elba in February 1815, and marched on Paris. In a few months the news had reached the French West Indian Islands, where the population hoisted the tricolour in rebellion against the lawful King of France. General Sir James Leith, the new Governor on Barbados and Commander of the Forces, assembled two Regiments of Infantry, some gunners and thirty-three RS & M under Captain A Brown RE; he also sent for Sir Charles as his second-in-command and Brigade Commander.

HM Brig *Fairy*, of 16 guns, arrived at St Georges, Grenada with General Leith's summons on 6 July and Sir Charles sailed the following day on this ship.

Before he left, he wrote a hasty despatch to the Colonial Secretary, asking His Lordship to "plead my excuse to His Royal Highness, the Prince Regent, for my temporary absence from the Government on this occasion, in which I hope to be in some degree instrumental in contributing to the success of His Majesty's arms". He arrived at Bridgetown three days later, where he found the instructions about the removal of Senior Officers of the Corps; his feelings were in no doubt when he wrote to General Mann:—

"It is not my intention to remove from the Corps. This decision is as perfectly conformable to my wishes and feelings, that no pecuniary considerations would induce me to remove my name for one moment from the List of the Corps".

The expedition, in ships of Admiral Sir P C Durham, sailed Northward; in a few days the rebels on Martinique and Marie Galante submitted with little trouble. The seaward defences of Point-à-Pitre were then examined from shipboard by General Leith, accompanied, in the Admiral's own words, "by that distinguished and indefatigable engineer, Maj-General Sir Charles Shipley". After two days of stiff fighting the republican insurgents on Guadeloupe capitulated on 10 August. The Great War was thus brought to a close, not by a famous General on the field of Waterloo, but by a Military Governor and his sixty year old RE Officer on the Island of Guadeloupe!

Sir Charles returned to his post in Grenada, but fatigue from the great exertions on his last expedition proved too much for his indomitable spirit. In the still small hours of 30 November, His Excellency, Sir Charles Shipley, died. The following day, commencing at nine o'clock, minute guns sounded alternately from Richmond Hill and Fort George. Through the narrow streets from Government House to St George's Church, lined with men of the 50th (West Kent) Regiment, the Royal York Rangers and St George's Regiment of Militia, the funeral procession passed. Led by the band of the York Chausseurs, playing the traditional Dead March from Saul, it was followed by all principal citizens and a vast gathering of inhabitants of every age, colour and creed. Captain George Barney RE was there, to pay the last solitary tribute from the Corps. Then, with the rites and ceremonies of the Established Church, the remains of His Excellency were committed to the ground beneath the Chancel; in due course the grave was sealed by a slab of stone, the inscription in time hidden by the gentle patina of the passing years. To the end on a Windward Island he remained on the List of the Corps.

[1] The Corps was accorded the title Royal Engineers by a Royal Warrant of 25 April 1787.
[2] The exchange rate was £130 (Barbados Currency) to £100 (Sterling).
[3] It was however no felony to kill a slave; the culprit had only committed a "destruction of property"!

Thirty Years After

BRITISH WAR PRISONERS RE-VISIT "DEATH RAILWAY"

ROBERT S GRIFFIN

"THE Bridge Over the River Kwai? I didn't know that was in Thailand."

Not many people do. But a fraternity of veterans know it and will never forget it: the former British prisoners of war who were forced to build the bridge and the railway line it was on—the infamous "Death Railway". The Japanese constructed the line during World War II linking Bangkok and Rangoon to supply their Burma Campaign and to prepare for a full-scale invasion of India.

A group of twenty-four former prisoners, all members in good standing of the Far East Prisoners of War (FEPOW) in Great Britain, returned to Thailand to pay their respects to their fallen comrades and to reminisce about their wartime experiences.

Tour leader Peter G Dunstan, a former Royal Marine, had the dubious distinction of surviving not only three and a half years hard labour on Death Railway, but also the sinking of HMS *Prince of Wales* off Malaya in 1941.

"After the sinking, the Marines formed in with the battered Argyle Highlanders and became the Plymouth Argyles. We fought in the defense of Singapore until the surrender on Feb 15, 1942" Mr Dunstan explained. After the capitulation, they worked on public works in Singapore, but after a few months they were loaded thirty-five-to-a-cattle-car for the six-day journey to Ban Pong, a camp near the beginning of the railway in Thailand.

On their return visit, the former prisoners stopped at the site of the Ban Pong camp, the war memorial cemeteries at Kanchanaburi and Chungkai, the famous bridge—still in use and now a minor tourist attraction—and rode what's left of the line as far as it goes from Kanchanaburi to Tarsao, about eighty miles. (After the war, the Royal State Railway of Thailand took up the tracks from Three Pagoda Pass where the line crossed into Burma, back down to Tarsao, either for lack of traffic or fear of the Burmese.)

The Kanchanaburi cemetery, luxuriant and beautifully kept, is indeed "a credit to the War Graves Commission" as a British diplomat has written in the guest register. About 5,000 Commonwealth and 1,800 Dutch soldiers who died working on the railroad are buried there, each under a small cement marker with a brass plaque that identifies the man and states a Bible verse or a personal epitaph ("Sleep tight, Dad, we won't forget").

Sir Arthur de la Mare, British Ambassador to Thailand, made the trip to Kanchanaburi to be present at the prisoners' memorial service conducted by the British Embassy Chaplain. In front of the stone cross at the rear of the cemetery, the men lined up in a ragged military-style formation and sang a verse from "O God Our Help In Ages Past". All wore the navy blue polyester ties printed with the flaming torch symbol of the FEPOW. The youngest almost fifty, balding and greying, well-rounded and wrinkled, the men looked like anything but the soldiers they once were. A half dozen had a line of colourful dangling medals pinned incongruously on their white business shirts.

After prayers, the men came to attention and a Thai soldier blew reveille. Wreaths of red cloth flowers brought from England were laid at the base of the cross.

"We who were spared are proud to have known you", read the card on the wreath of the Coggeshall and North Essex branch.

Waiting for the boats to go up the River Kwai to Chungkai cemetery, bearded Peter Allen, formerly a truck driver in the Royal Engineers, now a lecturer in Electrical Engineering at Imperial College in London, mentioned that he had spent the last six weeks of the war building the first airstrip at Takli, now a USAF base in central Thailand.

"The first planes to land there were RAF bringing us food. We had malaria so the pilots were quarantined after they landed." Looking back upriver at the famous bridge he remembered, "I only crossed over it once, when I was being evacuated. He's our local expert on the bridge, he was here about a year, I think," said Allen, pointing to one of the younger-looking men who was boarding the boat ahead of us.

At Chungkai, three more Royal Engineers, Messrs Brand, Saunders, and Edwards recalled their experiences as they walked up the long grass aisle between the rows of graves.

"They kept us moving up the river," began Mr Brand, "jungle clearing, rock breaking, bridge building."

"Rice and salt were what they gave us to eat—and more salt if you were misbehaving," added Mr Saunders. "Then there was the headache stick too, a piece of bamboo and they'd take it with both hands and smash it down on your head," he continued, enthusiastically demonstrating the technique.

"Reeves? Says he was an Engineer," called Mr Edwards who had fallen behind reading the names on the markers, "remember him?"

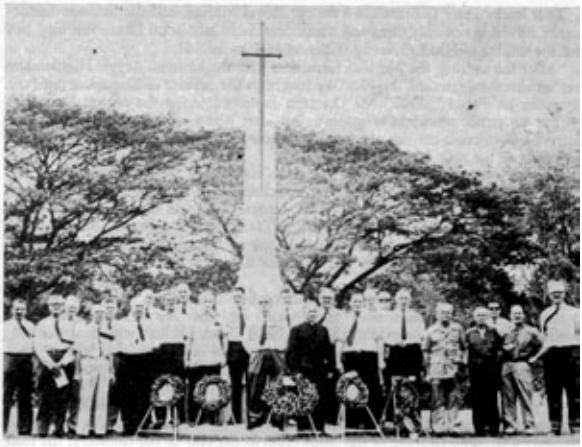


Photo 1. The FEPOW members posed for this group picture after the wreath-laying at Kanchanaburi War Memorial Cemetery.

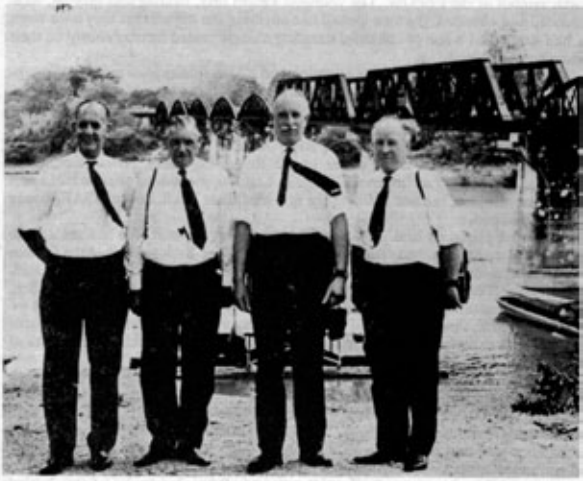


Photo 2. From left, Messrs Brand, Saunders, Halls and Edwards, all former Royal Engineers, with the Bridge over the River Kwai in the background. The two larger spans are replacements for three smaller ones which were dropped by Allied aerial bombardment in 1944.

Thirty years later

They didn't.

"The trains kept coming off the tracks after we got the line open and we'd have to set them back on by hand," said Mr Brand.

"One elephant equals ten men: that was the rule of the day. If the elephant was sick, use ten men," added Mr Saunders.

They stopped talking when they reached the cement cross at the end of the aisle where the other prisoners were gathering for the second memorial service.

"Gilmore?" called Mr Edwards, a few rows back.

After the Chungkai service, the man who was pointed out as the bridge expert introduced himself as Jack Halls, an official in the Department of the Environment in London today, formerly a bombardier with the Royal Artillery.

"Yes, I was at the bridge about a year. There were two bridges, a temporary one that took us three months to build and the permanent structure that took ten. We finished the big bridge late in 1943. There were 10,000 men in camp at the peak of the construction work. When the bridge was done, I got shipped off to Japan. I was working in a coal mine in Nagasaki when the war ended."

"I was a prisoner for three and a half years like everyone else from February 15, 1942."

"My birthday," put in the British Ambassador, who had overheard Halls' last remark, "I'll never forget that one. I spent it as a guest of the Emperor in Tokyo." Sir Arthur was a young diplomat in the British Embassy in Japan when the war broke out. "We didn't get out until late in 1942," he added, before being called away.

Halls claimed that he still hadn't completely gotten over his feelings against the Japanese. In fact, he "had gotten himself in a bit of trouble" last year protesting the visit of Emperor Hirohito to England.

"The Special Branch had me under surveillance for about four weeks—thought I'd throw a bomb or something."

But somehow Halls' and the other prisoners' attempts at hatred and bitterness were not convincing. Not that they were exaggerating their suffering of thirty years ago, but their recollectons of death, disease, punishment and hunger seemed detached and unemotional. Their words came out automatically like stories told hundreds of times already: stories told to inspire awe in grandchildren or to keep the conversation going in the pub.

Former Royal Artillery Officer E F Weare recognized some of his fellow prisoners' ambivalence when he commented that the trip "was not exactly an unhappy holiday".

At Chungkai only two or three of the men walked along the rows of markers searching for the names of fallen comrades.

The boats returned from Chungkai to the base of the bridge and the old soldiers climbed the embankment to an open-air Thai-style restaurant where a luncheon had been laid.

The men toasted each other with tall glasses of Singha beer.

"I drink more when I'm out," declared Mr Brand, who today runs a pub ("The Old Cellar"), in Southall, Sussex.

Someone mentioned the film, *The Bridge Over the River Kwai.*

"I don't remember seeing Alec Guiness out where I was," cracked Mr Saunders, grinning.

The Ambassador was late for an appointment in Bangkok so the men hurried to their places at the long table. Food was copious and the atmosphere convivial. The muddy waters of the Kwai sloshed against the pillars of the bridge in the distance.

At the souvenir shop behind the restaurant a booklet on the bridge and the construction of the railway is for sale. The gruesome history of the line is told in statistics. Of the 61,000 Allied prisoners who worked on the line, 16,000 died, mainly from disease and malnutrition.

In terms of numbers, the nearly anonymous Asian tragedy was far worse. Approximately a quarter of a million miscellaneous Asians were conscripted to work on the railroad, and of their number, 80,000 to 100,000 perished. The Japanese kept no records and their graves are not marked.

Mr Weare remembered burying the dead: "We'd bury the Indians (Tamils from Malaya) quickly to control disease, but they'd dig them up again for a ceremony."

Also in the booklet is a startling footnote in the history of East-West relations: after the war, the Allies sold the railway including the bridge to the Thai Royal State Railway for £2·5 million.

Back in Bangkok, in the lounge of the Royal Hotel, Peter Dunstan proudly displayed a giant 25th Wedding Anniversary card which had just arrived from his daughter in England.

In two days, the group would be flying back to London. Why had they come back to the site of so much past suffering? Had they found something they were looking for?

"We've been trying to sort that out ourselves, these past few days," Mr Dunstan began. "As prisoners we only knew the outside of a circle, but not what was in the middle. The perimeter of our camp and a hundred metres outside it, our work—that was all there was to our little world. Now we've found the centre.

"Reviving these memories, confirming these memories, we can now somehow go back with peace of mind. We can forget easier now."

LMR—The End of the Line

COLONEL J. G. A. J. O'FERRALL, BAI, CEng, MICE

SAPPERS, and more especially those who served with the Railway Training Centre Longmoor (changed in 1942 to Transportation Training Centre RE) may be interested and, no doubt, saddened to hear something of the final chapter in the life of the Longmoor Military Railway—its demolition.

The writer who had never aspired to be a railway engineer was introduced to Longmoor and the railway when, as a YO about forty years ago, he went with his Chatham Batch on a short course to Longmoor to learn something about this specialist and somewhat exclusive branch of the Corps. Memory tells me it was a very enjoyable course—not taken too seriously either by the Instructors or students. It was customary in those days for YOs to make the most of their opportunities when away from Headquarters at Chatham and the respite from strict discipline was welcome. The highlight of the Longmoor course for me was when I was allowed on the footplate and took over the controls for a spell—thus realizing every young boys dream of being an engine driver! Otherwise, I must confess, my recollections of that course were more associated with the golf courses and pubs in the vicinity—notably Liphook.

I was not then to know that, forty years on, I would preside over the demolition of the LMR.

On 1 April 1967, the Ministry of Public Building and Works assumed responsibility for the maintenance of railways and associated signalling equipment on behalf of their clients. Included was the LMR and with it, the maintenance gang (which was absorbed into the Bordon Works Depot), the stores, equipment and some repair shops. As Longmoor and Bordon came within No 4 Works District of the Bournemouth Area, I became associated (as District Officer) with the affairs of the railway.

It didn't come as much of a surprise when, in April 1969, at a meeting presided over by Mr M W Sackett of 1 Railway Home Gp RCT, much concern was expressed over the safety of railway operation at Longmoor and the need for considerable expenditure to bring the line up to modern standards. The meeting was informed however, of the probability that there would be no requirement to train military personnel in main line operation and it was on the cards that, before the year was out, the LMR would close down. A step forward in this direction was taken when a Closure Committee was formed which held its first meeting on 5 June 1969 under the chairmanship of Lieut-Colonel D E B Morrison RCT—GSO I Army School of

Transport, Longmoor. Its brief was to consider ways and means for closure and disposal of the railway. In fact, it was announced at this meeting that the closure would be in two stages; railway operation to cease on 31 October and run-down to be completed for a final closure date of 31 January 1970.

During this period Mr G R Dance played an important part in preparing plans and schedules for the disposal of the railway. These were incorporated into a document which became known as "The Redundancy Report". This report was issued by the then SPWO—Mr K Jenkins DCE(CE) 7 MPBW, Hounslow—and was attached as an appendix to the minutes of the 3rd meeting of the Closure Committee held on 23 September. Subsequently, this report was invaluable in drawing up documents for a demolition contract. Mr Dance has served with the Volunteer Reserve RE for the past twenty-two years and is currently a Warrant Officer with the Railway Specialist Team. He started with the Longmoor Railway in 1954 as a platelayer and, in 1964, was selected for the appointment of civilian Permanent Way Inspector. His last job at Longmoor was his major contribution to the Redundancy Report. He is now SPWO with DCED/ES8 in London.

All the recommendations in the Redundancy Report were adopted by the Closure Committee. Some of the main points from this were:—

i The main line connection at Liss (BR, Southern Division) would not be required after 31 January 1970.

ii The land on which the railway operated was an integral part of the MOD training areas and was to be retained, all except for that strip between Liss Forest Station and Liss Station (about 1·3 miles) which could be disposed of.

iii The demolition of the railway should include for the removal of all wayside structures including stations, bridges, signalling equipment etc and for the general clearance and restoration of the ground to the maximum extent possible.

iv As no labour from Army sources was available, the dismantling and disposal of the railway would be a MPBW responsibility for execution by Contract.

v Once cleared, the railway ballast on the formation was not to be removed, as there was a proposal to utilize the railway formation as a track for AFVs 432 between Oakhanger station to a point on the Hollywater Loop opposite Gypsy Hollow airstrip.

vi A working party under Colonel O C Radford was to consider and recommend items of equipment of historical interest for collection and preservation.

vii There were seven steam locomotives at Longmoor belonging to constituent Societies of the Association of Railway Preservation Societies: ARPS were to be given notice that their locos should be removed to the LMR siding at Liss by 30 November.

viii It was considered impracticable and unnecessary to lift track which was set in concrete or in road pavement wherever this occurred.

It was now clear that the Open Day, held on 5 July 1969, when members of the public could see the LMR operating, was the last of its kind. A member of the staff of the Area Office, Bournemouth and a railway enthusiast (Mr A Marriott) were present on that occasion and Photo 1 records a scene in the marshalling yard area.

The official closure of the railway took place on 31 October 1969 and, to mark the occasion, a ceremony was arranged by HQ Army School of Transport. The ceremony consisted of two trains drawing into Longmoor Downs station, Train "A" of 3 blue coaches drawn by 3–10–0 Gordon steam loco and Train "B" of 3 coaches headed by 0–6–0T Errol Lonsdale. A guard of honour was inspected by Major-General R C Turpin CB OBE, representative Colonel Commandant RCT, after which the trains, packed with VIPs, members and ex-members of RE and RCT and railway enthusiasts, moved out of the station in opposite directions to the strains of Auld Lang Syne, played by the RCT band. Train "A" moved to Oakhanger and train "B" to Liss. On their return to Longmoor station, the ceremony was completed. The last passenger train, drawn by Gordon, arrived at Longmoor Downs at 1522 hrs on 31 October 1969.

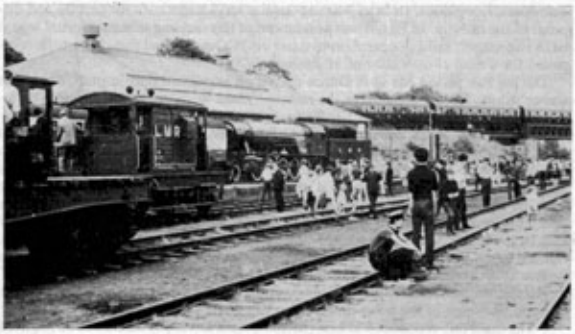


Photo 1. The last open day for LMR 5 July 1969.

The Retired Officers attending the ceremony included six Sapper Brigadiers—five of whom were past Commandants at Longmoor.

During 1970 there was a good deal of clearing up to be done as well as the disposal of assets—rolling stock, equipment, stores etc, prior to demolition. We were informed that DLA Aldershot was arranging for a six months lease of the railway section, Liss Forest to Liss Station to ARPS from 29 April. This section of land was subsequently sold by public auction under DLA arrangements on 28 July 1971. With the connection to the main line (BR) cut off there was no possibility of any demolition contractor using rail transport for removal of materials.

On 1 December 1970, the seven-year-old MPBW was absorbed, together with two other Ministries, into the newly formed Department of the Environment (DOE) and, more recently (1972) became the Property Services Agency (PSA) with DOE, under which title we now operate.

It wasn't until 15 March 1971 that the Regional Director DOE Southern Region instructed the Area Officer, Bournemouth to arrange for all necessary action to be taken to dispose of the railway in accordance with the advice and information given. Gross accounting was to be applied, whereby the gross cost of the actual work was to be debited to the Maintenance Works Vote (7D) and gross value of materials sold to the Contractor to be credited to Appropriations (7Z).

Financial approval to the service was given in June on the basis of our cost estimate:—

a. estimated actual cost to Contractor for demolition	£31,000
b. estimated value of materials	£59,000

or a net credit of £28,000.

The outline programme for the project was submitted to HQ South East District on 28 April. In broad terms the programme was:—

May	Ground reconnaissance by DOE staff to collect all information and data necessary for preparation of the Specification, Schedules of demolition etc.
27 May	A meeting, to be convened by HQ SE District at Longmoor, of all interested parties to finalize and agree the scope of the work, draft specification and outline programme for execution.
June	Working up and preparation of all contract documents.
July	Issue of tenders and acceptance of a contract.

August Hand over site and commencement of work with a contract completion period of six months.

This programme was adhered to in the main, but a delay of one month was imposed at the tender issue stage when we were informed that a Film Company (Open Roads Films Ltd) had been granted permission to use a part of the railway in the Liss Forest area for the railway sequences in the production of the film "Young Winston". Filming was supposed to take place on the 11 and 12 of June, but, in fact, was not completed until 14 October 1971.

Three of the five firms invited submitted tenders. The contract was won by George Cohen Sons & Co Ltd who tendered:—

a To be paid by the Department to the Contractor	£34,283
b To be paid by the Contractor to the Department	£78,790

or a net credit of £44,507 which was £16,000 more than we had estimated.

During execution, certain variations in scope arose and the final account resulted in a net credit of approximately £45,000. Due to the filming activities, it was deemed prudent to delay the date for site hand-over. The preliminary site meeting with the Contractor took place at the Bordon Depot Office on 11 October and the site was handed over for commencement of work on 18 October 1971.

To me it appeared as a very happy coincidence that the very last use to which the LMR was to be put was to enact an historical event which took place 72 years earlier during the Boer War. Longmoor as a military station, owed its existence to the fact

Photo 2. The set at Liss Forrest Station for filming "Young Winston". The Portuguese East African frontier post, with Komati Poort beyond.

LMR The end of the line 2

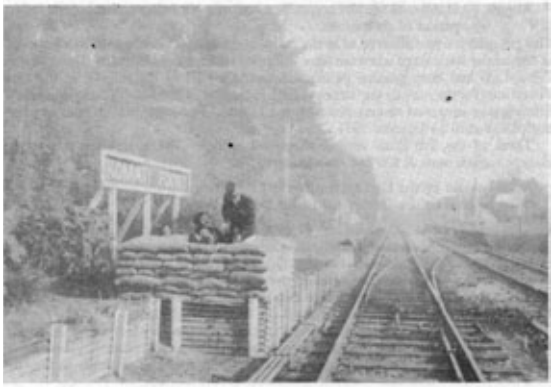


Photo 3. Liss Forrest Station—Alias "Komati Poort".

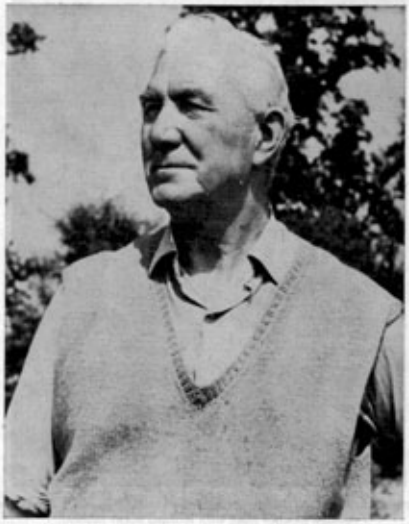


Photo 4. George Randall LMR 1928–1972.

LMR The end of the line 3 & 4

that, along with Bordon, it was chosen for the erection of camps to accommodate the British Army on its return from the Boer War. But for this, there might never have been a Longmoor Military Railway. The film company had transformed Liss Forest Station into "Komati Poort"—the last railway station in the Transvaal—through which Winston Churchill had to pass on his epic escape by train from the Boers at Pretoria. Having successfully eluded detection at Komati Poort, his train crossed the frontier into Portuguese East Africa. The frontier post and first station in Portuguese East Africa was conveniently set up for the film South of the Liss Forest level crossing—a few hundred yards distant from "Komati Poort". (Photos 2 and 3.)

Due to increases in scope and allowances for inclement weather during the winter months, an extension of time for completion of the Contract to 7 August 1973 was granted and on this date the completion certificate was signed.

The demolition work, on the whole, went very smoothly. Alarms were sounded occasionally by DLA when oxy-acetylene cutters started off small fires which might develop into forest fires. Necessary precautions were taken by having fire fighting equipment to hand at all times and restricting burning operations to selected open areas where close control could be exercised. All recovered materials had to be transported by road, but the Military Authorities co-operated splendidly in allowing vehicles to use certain roads in the Camp networks where, of course, security precautions prevailed due to possible IRA activities. At the final site meeting the Contractor was congratulated on the satisfactory way the work was executed. Mr D MacMillan and Mr L Thompson of the firm, who attended monthly site meetings, were very helpful and co-operative and very satisfactory relationships developed between all concerned. Much credit must go to our Supervising Foreman—George Randall—who must have walked hundreds of miles keeping a close eye on the work and ensuring that all aspects of it were carried out in accordance with the terms of the contract. (Photo 4.)

It can be said, I think, that the wish, expressed by the SO at the initial site meeting, that the railway should be laid to rest in a manner befitting its singular importance to the Corps over three generations, was fulfilled. All was cleared and the ground levelled and made good, as far as was possible. (Photo 5.) Though scars remain, none should be such as will not be healed by nature in the course of time. Should the Part II service for the provision of an AFV track proceed, then part of the old railway formation will be fulfilling a new need—to train AFV drivers.

As with the contract period, Mr Randall's date for retirement was extended so that he could complete his last assignment with the railway he had served over a period of forty-four years.

Before the railway demolition was completed, another contract was let for the demolition of the whole of Kimberley Lines. This was the last of the old Hutted Boer War camps—constructed of timber and corrugated iron in 1903. To house the Army on return from the war, four camps were built—known as "A", "B", "C" and "D" camps. "C" and "D" were subsequently named Mafeking and Kimberley respectively. Because of the marshy nature of the land at Longmoor and its affect on the health of the troops, it was decided to move "A" and "B" camps to Bordon, where, later, they were named Guadaloupe and Martinque Barracks.

CRE Bordon and Longmoor was given the removal task. He decided to move the huts bodily as they stood and 53 (Railway) Company RE constructed two 18-in light railway Decaville tracks, running exactly parallel to each other and 22 ft apart, between Longmoor and Bordon. Each of the sixty-eight huts was jacked up to allow seven pairs of trolleys to fit beneath, and the hut, now on wheels, was drawn to the light railway and placed across the bogies on the two tracks. They were then hauled by horses to Bordon. The whole operation took about two years. The record for the course—moving one hut the 5 miles to Bordon, excluding preparation at either end—was one day. The operation was completed in 1905.

Whilst movement of the huts was going on, 53 Company constructed an 18-in gauge railway to Weavers Down. Thus was pioneered the railway which, when

Photo 5. Weavers Down Station after demolition.

standard gauge was laid and with the alterations and additions made over the years, became famous as the private railway of the Royal Engineers.

Apart from the author, who retired from the Corps in 1960 and is due to retire from DOE in March 1973 after forty-four years continuous Military and Civil Service, most of the DOE staff concerned with the demolition of the LMR were either ex-Sappers or civilians who had served with the old RE Works Services and were absorbed into succeeding organizations:-

Mr L A Harrod	Ex AMWD and Depot Superintendent Bordon until 31 December 1971.
Major (retd) A R Bicknell	Thirty-nine years service (including boys) with RE and Depot Superintendent, Bordon from 1 January 1972.
Mr H G Durrant	War Service (1940–6) with RE, reaching the rank of Sergeant. Asst DS Bordon with special responsibility for supervising the contract.
Mr A Pengilly	Joined RE Works Services as a civilian with DCRE Tidworth in 1938. Except for War Service (with RTR) has been with Works (QS) since. Nominated QS for contract.
Mr G Randall	Engaged as a platelayer at Longmoor in 1928. Except for War Service (with RA) has served the LMR since and was foreman platelayer for several years before retiring in October 1972.

Acknowledgement: The author is indebted to Lieut-Colonel (Retd) L Cromwell OBE for some of the historical detail so well recorded in his booklet: "Some Notes on the Military History of Longmoor and Bordon". He was Garrison Adjutant from 1956–70.

Correspondence

Captain M D P Young BSc(Eng)
40 Army Support Regiment RE
British Forces Post Office 34

LIGHTNING PROTECTION OF LINE–CABLE JUNCTIONS

Sir,—Major S Osborne raised the question of the protection of the underground cables connected to overhead line systems against the effects of lightning in his letter in the June edition of the *Journal*.

The effect of joining a cable to a line results in a voltage doubling at the junction under surge conditions, to the detriment of the cable and equipment connected to it. Wood pole lines, due to their high intrinsic insulation level, present particularly severe problems to cables and terminal equipment.

Current practice is to instal lightning arrestors at the cable termination; the arrestors being connected to the same earth as the cable sheath. The performance of the modern lightning arrestors is such that virtually all surges are dissipated safely; however, where the danger from lightning is particularly severe overrunning earthwires are installed, for about 1 km out from the termination, for lines of unearthed constructions.

The main advantage of lightning arrestors is that once they have dissipated the surge system is cleared of faults. Other methods of protection leave a fault on the system which has to be cleared by circuit breaker action and also possibly requires replacement of damaged components. An added advantage of the lightning arrestor is it's cheapness, £30 for 11 kV operation.—Yours sincerely, M D P Young.

Lieut-Colonel D R Whitaker MA FI Nuc E
G Division
The Royal Military College of Science
Shrivenham
Swindon
Wilts SN6 8LA

EVOLUTION—SOME REFLECTIONS ON CORPS HISTORY

Sir,—I enjoyed General Foulke's resumé of the Corps very much. It was particularly nice to be reminded of our almost exclusive control of the development of new weapons systems before the last war. Regrettably this seems to be a side of soldiering in which we have now lost interest—at least it is if my recent Corps List is to be believed. Of the seventy-one officers of Colonel and above in the Corps only three (or less than 5 per cent) have qualified for Weapons staff appointments, so clearly we can have little technical influence in this field at the moment. This figure has to be compared to the 11 per cent of similar Royal Signals officers so qualified and 21 per cent of Gunners. The latter are about twice our size and so there must be eight times as many Senior Gunners in weapons field as there are Sappers, which is sad to say the least. It is not absolutely clear to me how we have reached this state of affairs, but it seems obvious that officers must over the years have been encouraged in some way to opt for ordinary, rather than technical, staff jobs.—Yours sincerely, D R Whitaker.

Book Reviews

FOUNDATION INSTRUMENTATION

THOMAS H HANNA BSc PhD CEng MICE AMASCE
(Trans Tech Publications US $30.00)

The author has identified a need for a text devoted to foundation instrumentation. He assumes that data obtained by laboratory testing of "typical" samples and interpreted according to the classical theories of soil mechanics do not always predict accurately the actual behaviour of foundations under load. He argues that this shortcoming can be overcome only by the greater use of field instrumentation and his book is devoted to the principles of operation, installation and use of instruments and data processing systems now available.

After an introduction to the subject of soil mechanics and a list of some of the methods

currently used by ground engineers for the solution of foundation problems the author discusses the measurement of forces encountered in foundations, listing instruments used to measure them, and reviews the theory of piezometers, explaining the use of the instruments, and the interpretation of the data obtained. Having explained the analysis of earth pressures (total and effective), and their measurement, ground movement methods of measuring soil deformation, both at the surface and within the soil mass, are explained. The author gives examples of foundation instrumentation and the results they yielded after analysis. In the last chapter of the book the author concentrates on the instrumentation of laboratory scale foundations for this is the research area with its own unique problems.

The book is well presented on good quality paper with clear print and numerous well labelled diagrams and illustrations. The subject of each chapter is reviewed at the start and followed by detailed comment. The chapters follow a logical sequence so the information is presented in an unbroken flow. The book is unusual in that it describes proprietary products, and has a series of advertisements at the end. I consider the need for such a book is demonstrated, and that this valuable book meets that need.

JFJ

A HANDBOOK OF ACCURATE SURVEYING METHODS

S P Collins BSc Tech AMCT CEng FICE
(Published by Sir Isaac Pitman & Sons Ltd, Kingsway, London WC. Price £1·30)

The author has spent twenty years on the construction of major dams, tunnels, bridges, harbours and similar projects in which a main feature is precise survey control.

This handbook is therefore essentially practical, it describes the uses of the instruments which are likely to be available and emphasises the different levels of accuracy that can be consistently maintained with these instruments. The worked-through examples, written in layman's terms, are based on practical as opposed to theoretical schemes; the errors and difficulties likely to be met on site are identified and the methods of correcting them are explained. The layout of the computations are a little "dated" and do not conform to RSME teaching but this is not really important.

The book, in SI Units throughout, will be most useful to those who have become a little "rusty" and feel the need for a renewal of confidence before tackling a practical survey task.

MJE

ARCHITECTURE OF AGGRESSION

Keith Mallory and Arvid Ottar
(Published by Architectural Press Ltd. Price £6·50)

This very interesting book brings together some topics of military construction and architecture, in North West Europe, in the period 1900–45. It relates these topics to the weapons, military techniques and the pressures of military and political events which affected them. The authors state that one of the interesting things about military architecture is its responsiveness and adaptability to events! About half of the book is given to some 300 illustrations, some of which are copies of old photographs and drawings and are therefore lacking in quality.

The first section of the book covers the period 1900–18. At this time forts were in vogue. The Belgian forts built in the 1880s were of concrete construction, the mix used was a weak one, and they did not withstand the German weapons of 1914, they fell to the German Army in eleven days. The French forts constructed on the Franco-German border were constructed of reinforced concrete, much of it in the form of a sandwich with shock absorbing sand as the centre layer. As a result of tests they had made the French used a roof thickness of 2·6 m of concrete covered with 5·5 m of earth. The Germans at this time were constructing small reinforced concrete bunkers and strongpoints. Their use of reinforced concrete was probably the first time that this material had been used on such a vast scale. By 1918 defence structures had to give protection from air attack. The British made use of concrete sandwich construction having an outer burster slab, then an air gap to cushion the blast and reduce its effect on the inner and main protective shell. Corrugated iron was favoured for the formwork. To protect their submarines from air attack the Germans constructed the Bruges submarine pen. Its neo-classic style featured strongly in many of the pens built by Hitler twenty years later. Hutting developed rapidly during the First World War, the book devotes a chapter to this subject. The "Nissen" hut became the most popular

form of hut and by early 1917 there were 20,000 of them in use. Demountable hangars for airships and aircraft were also necessary and are well illustrated.

The second section covers the period 1918–40. It starts with information on the French Maginot Line. The forts were sited so that they could cover the neighbouring forts and were designed to take direct hits from their neighbours without damage. The minimum roof cover was 3·5 m of reinforced concrete covered with earth. Underground bunkers (with electricity, water from deep wells and septic tanks to contain the sewage), were constructed to accommodate the men. The Germans outflanked these fortifications by advancing through the Ardennes in 1940, and they fell within a month without being tested!

The autobahns constructed in Germany in the 1930s are considered by the authors to have a layout based more on military strategy than on civilian needs. Their construction is strong enough to take the axle loads of modern vehicles, so the design criteria used was probably based on the tank. At this time the Germans also constructed their "West Wall" on the Franco–German border, some 22,000 pill-box type structures were constructed by 500,000 men, using over 6 million tons of concrete. The structures were sited to give defence in depth.

The third section of the book covers the period 1940–45, and starts with details of the coastal defences of Britain. There are cross-sections and photographs of the Thames Estuary Forts designed by G A Maunsell. These forts were constructed of reinforced concrete on shore, they were then floated into position, sea-cocks were opened and they were allowed to settle on the sea-bed. Forts positioned in Liverpool Bay had to have a different base to cope with shifting sands. The next chapter is illustrated by many photographs of the variety of structures constructed by the Germans on the French coast to form the Atlantic Wall.

The housing of the invasion forces in Britain resulted in a vast hutting programme. Timber and steel were in short supply so precast concrete structures were developed and are illustrated. The Stancon System hut developed in 1940 made use of pre-stressing techniques. The authors consider that precast systems became generally accepted as a form of construction as a result of these developments. The Mulberry Harbour Project is well covered, but is considered to have been of more psychological than practical value. This statement is based on the fact that the Americans discharged twice the tonnage which passed through the Mulberries, over the open Omaha beach. Two chapters are given to the construction of bomb-proof structures to house civilians in Britain and Germany. The section finishes with construction details of the German bomb-proof submarine pens, factories and V-sites. The submarine pens were not damaged until Barnes Wallis' invention, the "Tallboy" bomb, was used.

The final section of the book considers some trends since 1945. Traditional military construction continues, China fearing a Russian attack has constructed "a world of underground tunnels and shelters". Israel has constructed heavy concrete installations on the Bar-Lev line. Impressive radar installations such as that at Fylingdales have been constructed to provide "early warning", setting up an "electronic defence wall". Illustrations are included of structures required by rocket technology.

The book concludes by quoting "that the strong relationship between military technology and civil architecture continues. Money can always be found for weapons, it is somehow never available for the application of scientific resources to housing or recreation, to the environment, for experimental cities rather than rocket installations we do not intend to use. . . ."

RJO

Technical Notes

CIVIL ENGINEERING AND PUBLIC WORKS REVIEW—JULY 1973

Grouts and Grouting. The July 1973 edition contains a special feature on grouts and grouting developments in civil engineering. The first article, as a tripartite effort by the commercial company Chemical Building Products Ltd, covers a survey of the different materials now used in this field and details several current practices with these materials. The second article details the companies concerned and the plant/equipment used. The articles show the wide range of material from cement through PFA to epoxy and polyester resins now used in a wide range of applications from post-tensioned ducting to anchorages and fixings.

Repairs and Extensions to Concrete Structures using Resin Anchored Bars. The method of rock bolting using the mechanical expansion shell bolt is well known. The resultant high

local stress area in the rock around the point of anchorage giving possible slippage under load or vibration is also well known as a major disadvantage of this type of anchoring. The article, by R L W Biviridge of Nobel's Explosives Co Ltd, outlines the development of polyester resin anchored bolt systems. Research and development in the last decade has produced the encapsulated polyester resin bolt system which requires no site measuring or mixing. The advantages of this system, particularly in concrete fixing problems are clearly given and many applications are detailed in the article. The advantages over site mixed and poured resins are obvious, although at present the costs for encapsulated systems are higher, the author indicates a wider use for concrete work in future years. JTS

CIVIL ENGINEERING AND PUBLIC WORKS REVIEW—AUGUST 1973

Floors and Flooring. The August edition carries a comprehensive special feature on floors in structural engineering. A series of four articles cover concrete, composite, timber and synthetic resin flooring applications and further articles deal with finishes, maintenance and repair. The feature is completed by a list of the various products and materials available for special flooring applications.

Fresh Concrete—Important Properties and Their Measurement. The workability of fresh concrete is perhaps the most misunderstood property in concrete practice as shear reinforcement is in concrete design. Certainly an equal volume of literature is published annually in each case! A 3-day seminar held in Leeds earlier this year attempted to rationalize the definition of workability and allied properties. A summary of the topics covered in the seminar is given in an article in this edition. In addition to trying to define workability and its measurement the problems of transporting, segregation and retempering were discussed. Perhaps the most interesting conclusion is that engineers should be talking about the "rheology" of the concrete rather than the "workability". For those concerned the full proceedings of the seminar in three volumes of 1,200 pages can be obtained from the Department of Civil Engineering, University of Leeds.

JTS

* * * * *