ISSN 0035-8878

# THE ROYAL ENGINEERS JOURNAL



Volume 100 DECEMBER 1986 No 4

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ISSN 0035-8878

# THE ROYAL ENGINEERS JOURNAL

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*Printed by Staples Printers Rochester Limited, Love Lane, Rochester, Kent*

Volume 100 DECEMBER 1986 No. 4

## Contents



*Authors alone are responsible for the statements made and the opinions expressed in their papers* 4,250

# Editorial

## YOUR *JOURNAL* PREFERENCES

*Thanks*

First we must thank you for an excellent response to the *Journal* questionnaire. Well over four hundred replies were received giving your Publications Committee plenty to think about over the next few months. They have not considered the matter in detail yet, therefore this editorial will not indicate what changes might be planned. Any opinions that slip out are those of the editor and not the committee.

*The Target*

Many of you pointed out the central problem: for whom is the *Journal* published? For analysing the results, we divided you into three groups; captains and below, majors and above and retired. This is not a precise division we realise, since older captains might not wish to be lumped together with brash youngsters; likewise young retired might not wish to be branded as fogies. But first, an overall view.

*The Overall View*

There is a strong tide of opinion against any shift in the direction of a lightweight publication. The *Journal* must remain (some say become) a serious professional publication we can all admire and show to our friends. (Incidentally, 25% of you pass on your copy, we hope not all to the dustman.)

Nearly all of you seem to believe, as we do, that the content is more important than the presentation. You would like to see more articles on military engineering, new equipment and new ideas—97% said yes to the latter. You would like more Corps News about people and Units (61%) but you would prefer to see it in the *Supplement* (76%).

*Journal Articles*

The tick test results on *Journal* articles are shown in the diagram (*Fig 1*). History and "I was there" show strongly, Corps Affairs offering a strong challenge and Combat Engineering coming up on the rails. Subtle variations appear in the different age-groups, however. Amongst the yearlings, Combat Engineering has edged ahead (displaying a thirst for knowledge, perhaps). Amongst the three-year olds Combat Engineering has slipped to being unplaced with Corps Affairs striding into a lead (reflecting the clubbery of the middle-aged!). Amongst the stayers, it is no surprise to see History and "I was there" firmly up front. Poor old Technical and Project Reports are some way down the field in all groups but might have been unduly handicapped by a split vote. Survey, Postal and Logistic Engineering must all have started at long odds. Nevertheless they can not of course, be ignored.

*Presentation*

On presentation, less than half (43%) opted for no change in size but a clear message came through that the majority were against a floppy publication that will not stand in a bookshelf. More than half (63%) wanted a better cover. Within the suggestion of better presentation, however, there lurked a booby trap which not everybody spotted. Improved presentation means increased cost and this means a saving which could only be achieved by a reduction in the frequency of issue. However, there you were reluctant to see change. On the whole the *Supplement* monthly and *Journal* quarterly was found to be the preferred frequency although some 40% would accept less.

*Views and Ideas*

Quite apart from the statistics, you have produced a rich offering of views and ideas. Passing over such sallies as "spelling and grammer [*sic*] should be improved" and "Anyone who is not prepared to sign should not have his view taken into account", we much appreciated the many suggestions and points of view often reinforcing our own. A common theme was the need for the *Journal* to explore ideas for the future; another, the offer of cash awards for articles. We particularly liked the ones that

advocated greater editorial stringency and independence. The position of *Sapper* in relation to the Institution publications was much discussed. This is a matter which we continue to keep under review but from the Institution's point of view it is unattractive as it offers negligible scope for saving and few advantages.

There will now be a pause while the Publications Committee digests all this information. In the meantime, your views continue to be welcome but, more especially, so do your articles, particularly those on themes for which the demand exists.

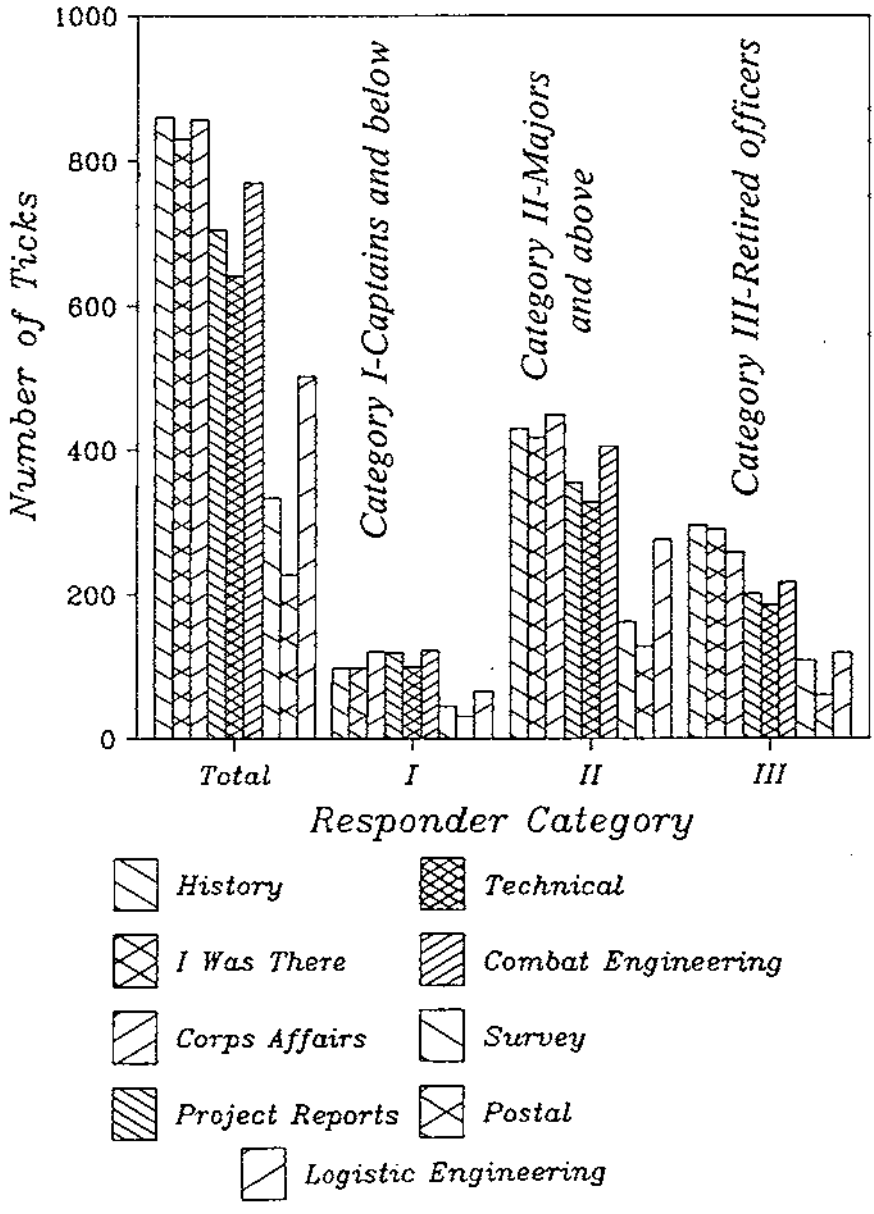


Figure 1. Analysis of Article Preferences.

# Earthquake Relief in Mexico City

MAJOR D M WEBB MBE RE AND CAPTAIN P D COOK B Sc RE

*Major Derek Webb has served with 4 and 33 Field Squadrons, in the RHQ of 2 Armoured Division Engineer Regiment and 21 Engineer Regiment, as an SO3 in HQRE 1(BR) Corps and held instructor appointments at Chepstow and RSME. In July 1985 whilst commanding 32 Field Squadron and based in Belize he was sent to Mexico City following the earthquakes of 19 and 20 September.*

*Captain Duncan Cook graduated from Birmingham University with an Honours Degree in Civil Engineering. In 1985 he joined 32 Field Squadron and deployed on exercises in Cyprus, UK and on a Harrier deployment in BAOR before moving to Belize in July to become the Troop Commander Airport Camp. On 22 September he flew to Mexico City in command of the enlarged troop which undertook the disaster relief work at the Telmex exchange building.*

32 FIELD SQUADRON last provided earthquake disaster relief aid to Solofra in Italy in May 1981 so perhaps fate has a 32 card in her hand as we were tasked to Mexico City four years later for similar work. This article is in two parts, the first describing the Operation, the second, the earthquake and its effects on structures.

## PART 1

### OPERATION VASCO

32 FIELD SQUADRON deployed to Belize in July last year and were thus well placed to assist when our government offered aid to the Mexican authorities following the earthquakes that struck Mexico City on Thurday 19 and Friday 20 September 1985. The epicentres were calculated to have been in the Pacific some 420 km and 385 km from Mexico City. The shock waves from these were powerful, 8.1 and 7.5 on the Richter Scale. Fortunately little damage was done as they passed through the hard rocks until they reached the soft lake deposits on which the older parts of Mexico City centre is built. An area some 3 km by 5 km was affected. This amounted to 10% of the city, which by some criteria is the largest city in the world with a population of 18 million. In round figures some 500 buildings were destroyed and perhaps 1000 damaged. The television coverage of these tragic events was virtually all that was available to the Foreign and Commonwealth Office (FCO) and MOD for the combined



Major DM Webb MBE RE and Captain PD Cook B Sc RE
Earthquake Relief In Mexico City (2)

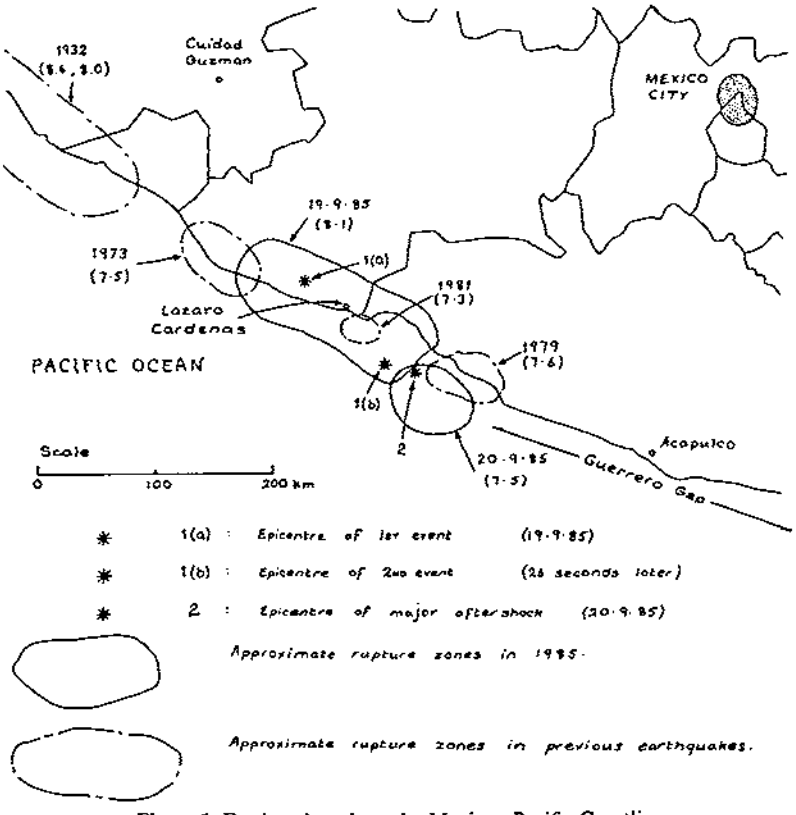


Figure 1. Earthquakes along the Mexican Pacific Coastline.

Army RAF operation, which became Operation *VASCO*. Orders were passed to Headquarters British Forces Belize to dispatch two Puma helicopters and Royal Engineers to Mexico City. These were received at approximately mid-day (local time) on Saturday in Belize. Brigadier D B W Webb Carter OBE MC nominated Wing Commander P W Day AFC RAF as the detachment commander and tasked OC 32 Field Squadron to run the relief work on the ground. Communications were provided by a Royal Signals section. Regrettably there were no tasks for the Pumas so they returned to Belize after a week, similarly the Signals element left once the Foreign and Commonwealth Office had established a new secure link.

The Sapper organisation became a troop headquarters and three well equipped sections based on 3 Troop as 1 Troop was almost beyond reach in the jungle and 2 Troop had to remain at Rideau to support Battle Group South. The troop strength was built up to 30 with a good mix of tradesmen so that it would be balanced and capable of undertaking a wide range of tasks. Each section was equipped with a hi-cycle set, chainsaw, Tirfor jack, Stihl saw, artisan toolboxes and most of its usual combat engineering items. The heavier kit prepared for the first Hercules flight was a motorcycle, ½ ton landrover with its ¾ ton trailer carrying a standard water purification unit. The mighty midget arc welding kit was included among the heavier items. In addition we assembled and packed all the stores needed to live and operate independently in the field. Our numbers increased to include a medical orderly, cook and three Belizian Defence Force Officers as interpreters. Planning continued in the Force Headquarters for both the Sapper and Puma deployment. Fortunately a Hercules was fairly close to Belize and could be retasked to Operation *VASCO*. The

movement plan became a dawn departure on Sunday morning for the helicopters and mid-morning take off for the Hercules carrying the troop and equipment.

The Pumas flew north avoiding Guatemala then west, refuelling three times before climbing to over 10,000 feet near Puebla to clear the mountains, then down to land at Mexico City airport, itself some 7500 feet above sea level. We arrived to be greeted by the world's press and the British Ambassador. A Mexican government official asked us to tackle the collapsed telephone exchange building in the City centre as we were the first military engineers available for such work.

We left the airport in Mexican Army trucks and were obliged to call on the General of Police who was co-ordinating the rescue efforts in Mexico City centre itself, as well as at the Mexican Army Headquarters. We had had the impression that the city was virtually destroyed but we were escorted through a comparatively normal weekend rush hour for much of our journey. All this activity fell silent as we approached the Old City centre. We had the road to ourselves apart from the occasional rescue vehicle rushing through. The damage to the city became more obvious, a few buildings in each street had collapsed, some showed minor damage whilst others looked alright until you realised that they were leaning by some 5 degrees or so. A good number of streets were blocked but after driving for an hour we arrived at Caye Victoria, our task site for the next three weeks.

We met the Telmex senior manager and began to discuss the task. The troop commander Lieutenant Duncan Cook then carried out a reconnaissance of the damaged building, returning to the improvised conference room to plan the task. This was made more difficult as the plans of the newer buildings in the complex had been destroyed in a fire some years ago. In the subsequent discussions we established the aim which was to direct the combined efforts of Telmex, ourselves and ICA, the major contractor on site. The aim was to preserve that part of the building which still contained working communications equipment. This was achieved in two phases, Phase 1 to shore the remaining structure, Phase 2 to clear the collapsed upper floors. At this stage it was known that there were ten dead bodies in the rubble. The union, for quite proper humanitarian reasons, wished the priority to be the recovery of the bodies. To do this was a dangerous undertaking which would have risked the lives of those recovering the bodies and perhaps jeopardised the entire task. Telmex union brought immense pressure to bear on the management to change their plans but fortunately the aim was not overlooked, eventually we recovered the bodies without coming into conflict with the union.

Whilst the planning and reconnaissance were taking place Staff Sergeant Watret tackled the administration. All stores, equipment, cooking gear, rations and water were moved into an undamaged part of the exchange complex. The kitchen was set up on a roof six storeys up and accommodation found on the third floor. Carrying the kit up the stairs at 7000 feet above sea level introduced the sappers to the rarefied and badly polluted air. A stores area was set up on the ground floor, much to the troops' relief. With the reconnaissance and offload happening concurrently we were able to start work on the damaged part of the complex within two hours of arrival on site.

The condition of the six storey building was that the top four storeys had collapsed and the rubble from these floors was resting on the ceiling of the first floor. The building had been shaken east-west and then north-south causing the upper floors to fall in a south-easterly direction resulting in a two to three metre overhang. The ceiling of the first floor had been punctured in places and rubble had fallen through onto the exchange equipment below. The bottom two storeys had remained upright and were supporting the 2600 tons of rubble and wrecked exchange equipment from the upper four storeys. Virtually all the columns and beams in the lower two floors and basement were damaged to some extent, so we could not afford to waste time before shoring the building. We started work on Sunday evening (22 September 1985) with a shift system of sixteen hours on, eight hours off, thus two sections were at work around the clock. The initial task was to shore up the entrance before we could move inside.

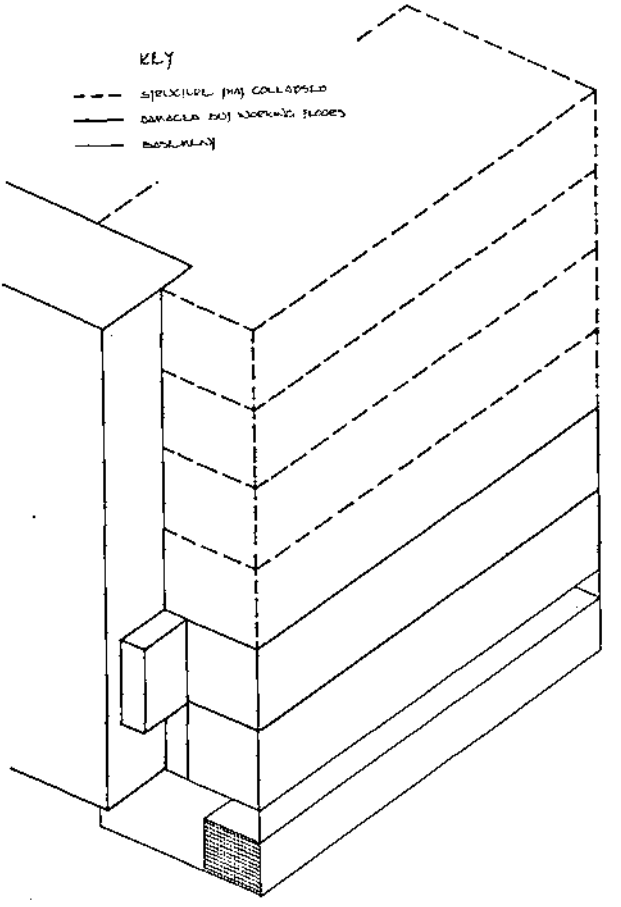


**Figure 2.** Sketch of building prior to September 1985 earthquake.

There were initial communication difficulties between ourselves and the Mexicans. We were assured by people who actually worked in the building that there was no basement. We asked if there were any dangerous liquids or substances stored and told no, but several men suffered acid burns from leaking battery banks. Safety was a major concern as at this stage there were still tremors occuring, up to 5.2 on the Richter Scale. Every man carried a water bottle in case he got trapped and each section had a first aid kit. Escape routes were planned and NCOs kept track of where each man was, whether he was working or resting.

The Mexican workforce concentrated on the basement whilst we worked on the ground floor. Here we used timber shoring making use of readily available telegraph poles. The method we adopted was fairly standard using timber spreaders top and bottom with wedges driven firmly to prevent movement. Placing the poles was hard work as the gap between the exchanges was less than a metre. Each pole weighed about 280 kg and was some 5m long so that it could reach the beam or slab of the floor above. Large numbers of spreaders were needed so a production line was set up to prefabricate them.

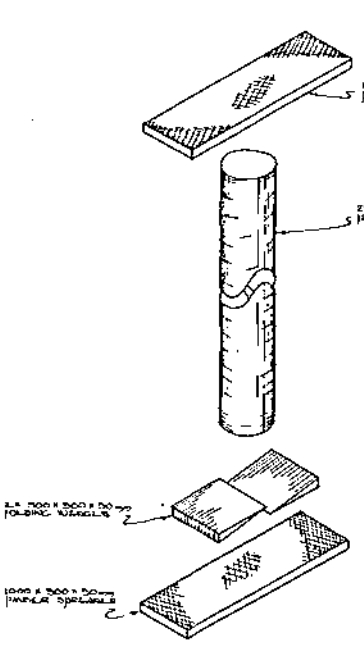

Figure 3. Timber shoring.

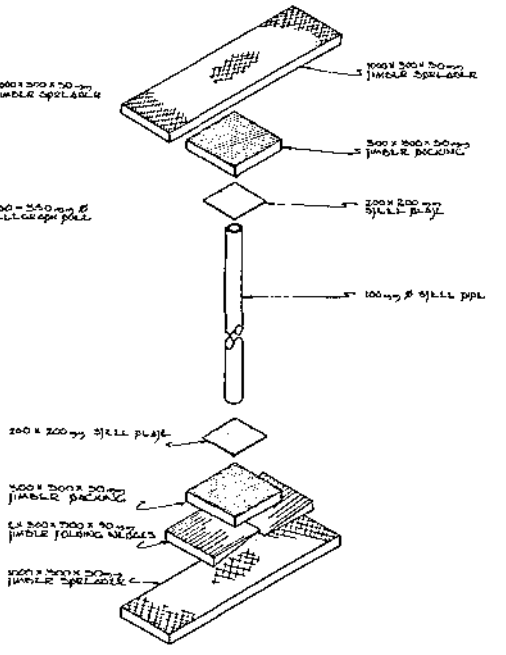

Figure 4. Steel pipe shoring.

The assistance given to us by the Mexicans was considerable both for the task itself and for our administration. They responded quickly to requests for more tools and materials. Our initial requirement was for safety equipment, breathing masks, helmets, gloves, jackets, etc, items which were not readily available in Belize. Later we asked for compressors, two large cranes, one for each side of the building, and a mechanical shovel.

After perfecting our shoring technique with over 100 poles placed on the ground floor we moved onto the even more restricted first floor. Gaining access to this floor for 5m poles proved more difficult so an access ramp was built. External cladding was removed and replaced by tarpaulins to provide access for poles as well as providing additional escape routes. Steel pipes were used instead of telegraph poles as they were lighter and of smaller cross-section, about 100mm in diameter. Timber spreaders were still used top and bottom but it was necessary to use steel plates to prevent the pipe "punching" through the wood. A second timber spreader was used at the bottom so that the wedges could be driven in without splitting.

We learnt of the numerous aftershocks which were occurring from the local television and this prompted us to check on movement in our building. We found that some of the wedges had worked loose on the northern side, we then surveyed it every six hours. From these checks we found the building was falling further to the south reaching a maximum speed of 6mm in 6 hours. At the next planning meeting we debated the best course of action. If we had stuck to our initial plan and braced all the shoring the building would have withstood the aftershocks better, but if this had taken too long it might simply have fallen over. The 2600 tons of rubble, much of it on the southern edge was clearly assisting this rotational movement so we decided to omit the bracing and attack the rubble.

**Photo 1.** Removal of the roof by cutting out slabs followed by beams.

The start of Phase 2 coincided with the arrival of the fourth section from Belize. This reduced the shifts from sixteen to twelve hours but still kept the same number of men on site. The works plan for Phase 2 was simply to remove the debris layer by layer. The first task at each stage was to remove the slabs and beams by cutting them into manageable sections and using the crane to lift them out. This left us with a mass of crushed and twisted exchange equipenent which was removed by using Stihl saws, Tirfors, bolt croppers and gas cutting equipment. Once one floor had been cleared the whole process was repeated. This simple plan was made more complicated by the overhang to the south of the building. The only way to cut through these sections was to abseil over the edge and cut through the reinforcing bars using an oxy-acetylene torch. A further difficulty was the south-west corner in which most of the cables were still in use. To preserve communications, work here had to be slow and careful. Although we started to remove debris by throwing it from the roof, this was causing the building to move as well as damaging the lower levels. Everything had to be lowered by skips which were in short supply. There were no purpose made skips

Earthquake Relief In Mexico City (1)

available so we used refuse skips obtained from the sanitation department. It was at this stage that we had to deal with the bodies still in the building. Four bodies were removed from our section of the building, eleven days after the earthquake happened. Once exposed and cut free by us the Mexican Red Cross moved in to take them away. The aspect we found most disconcerting was that the mothers of some of the victims were brought along to watch their removal. Once the four collapsed storeys had been cleared it was necessary to patch up the holes above the exchange equipment with tarpaulins. This stage was reached after 17 days and Phase 2 of our task was complete. The operation ended with a farewell ceremony in the presence of the British Ambassador before boarding the Hercules for the flight back to Belize where on the following day the troop met Her Majesty the Queen.

In all, this was a thoroughly worthwhile operation from which we learnt a good deal but in terms of the Corps experience there were no new lessons. With the benefit of hindsight we realised that some points should have been tackled differently and thus deserve mention here. A small headquarters was required for this operation to deal with matters above those of immediate concern to the troop. On reflection a command vehicle crew would have been an extremely good team with which to step into the unknown. Providing public information (PI) increased the workload and distracted us from the main tasks in hand. A PI officer supported by a good cameraman with both still and video cameras in his kit bag are almost essential if the demands for media coverage are to be met. Mail is extremely important, ours was despatched regularly from Belize but proved impossible to find at Mexico City Airport until the last week. A courier service would perhaps have been expensive but worthwhile until routine deliveries could be established. As to logistics, we had excellent support from the G1/4 staff and 78 (Belize) Ordnance Company but in this type of operation we found it is possible to have too much kit pushed forward. This can be embarassing as unwanted items distract effort from the main task which in turn could attract adverse publicity. If communications are workable then the good ideas from the mounting base can be discussed in conjunction with the units bids. The best course of action we would suggest is that the detachment commander should retain control of what is sent forward.

Planning a relief operation is difficult as only rarely will there be adequate information available to work on. It would seem that the work which follows a disaster is split into four phases:

*Phase 1* Life Saving.

*Phase 2* Emergency assistance provided as:
*Services* eg Medical, Engineers, Helicopters.
*Supplies* eg Food, Accommodation, Medical Supplies perhaps delivered by Hercules aircraft.

*Phase 3* Rehabilitation.

*Phase 4* Reconstruction.

Clearly identifying the phase during which help is to be provided will go a long way to ensuring our assistance is effective and does not encumber or negate local efforts. Coupled closely with this is the major question of whether or not there is time to carry out a reconnaissance before deploying a relief contingent. A reconnaissance will provide the best information but almost certainly delay the operation. If help is to arrive during Phases 1 or 2 then it is better to go in with a best guess solution rather than wait 24 or 48 hours to prepare the perfect organisation but arrive too late. In our experience the initial flights should be used to fully equip the team on the ground. Once the team is fully established relief stores can follow and be properly handled without imposing a further load on the locals committed to the operation.

## PART 2 MEXICO CITY
### EARTHQUAKES–GEOLOGY–STRUCTURES

*Foreword*

Following the disaster various news programmes compared the movement of the soils below Mexico City with a bowl of jelly which had been given a good shake. This is a fair description in some ways of what happened but we were fortunate to meet the UK Earthquake Engineering Field Investigation Team in Mexico City who gave us a much better understanding of the events that had occurred. We are indebted to them for the explanation that follows, the team members we met on this occasion were E Booth and J Pappin of Ove Arup & Partners and R S Steedman of Cambridge University. Indeed most of this part is drawn from Edmund Booth's paper *"The Lessons from Mexico–A Structural Engineers View"*.

*Introduction*

Until the end of the XVIII century the Valley of Mexico was a closed basin, with a number of lakes inside. Lake Texcoco, now drained, laid down the deposits on which the older part of Mexico City is built. The major engineering projects which have drained the basin are the Nochis Tongo cut completed in 1789, the two Tequisquiac tunnels and canal opened in early 1900 and more recently the Emison Central in 1969. The basin is surrounded by volcanic mountains rising to over 5000m and it is the ash from these which has produced a layer of highly compressible clays up to 50m thick interbedded with layers of silt on the lake bed. The clays are "mainly formed of amorphous minerals, which cannot be catalogued with any crystalline mineralogical group, and are thus allophane clays" (Girault 1964).

*Foundations in Clays*

The clays significantly affect the design of structures to be built on them, even in the absence of earthquakes. They have a water content of up to 500% and the removal of this water has meant a general settlement of the clay layers by some 8m since 1900, but now reduced to 20 to 50mm per year as the authorities have ceased to draw water from under the city. Buildings of five storeys are too heavy to be supported entirely by the clays and are therefore piled to the silt layers. As these do not settle at the same rate as the clays the buildings supported by them can emerge above street level.

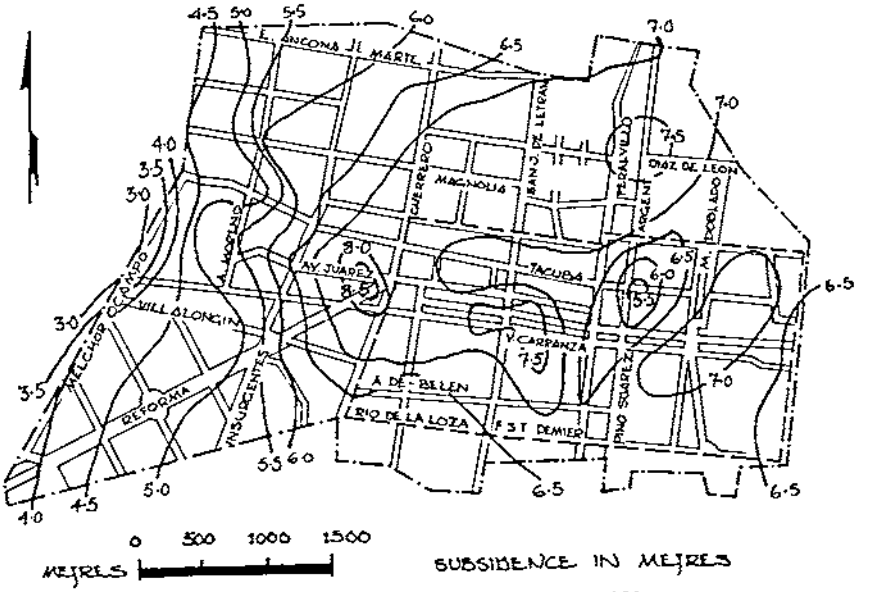


Figure 5. Curves of equal subsidence 1891–1970.

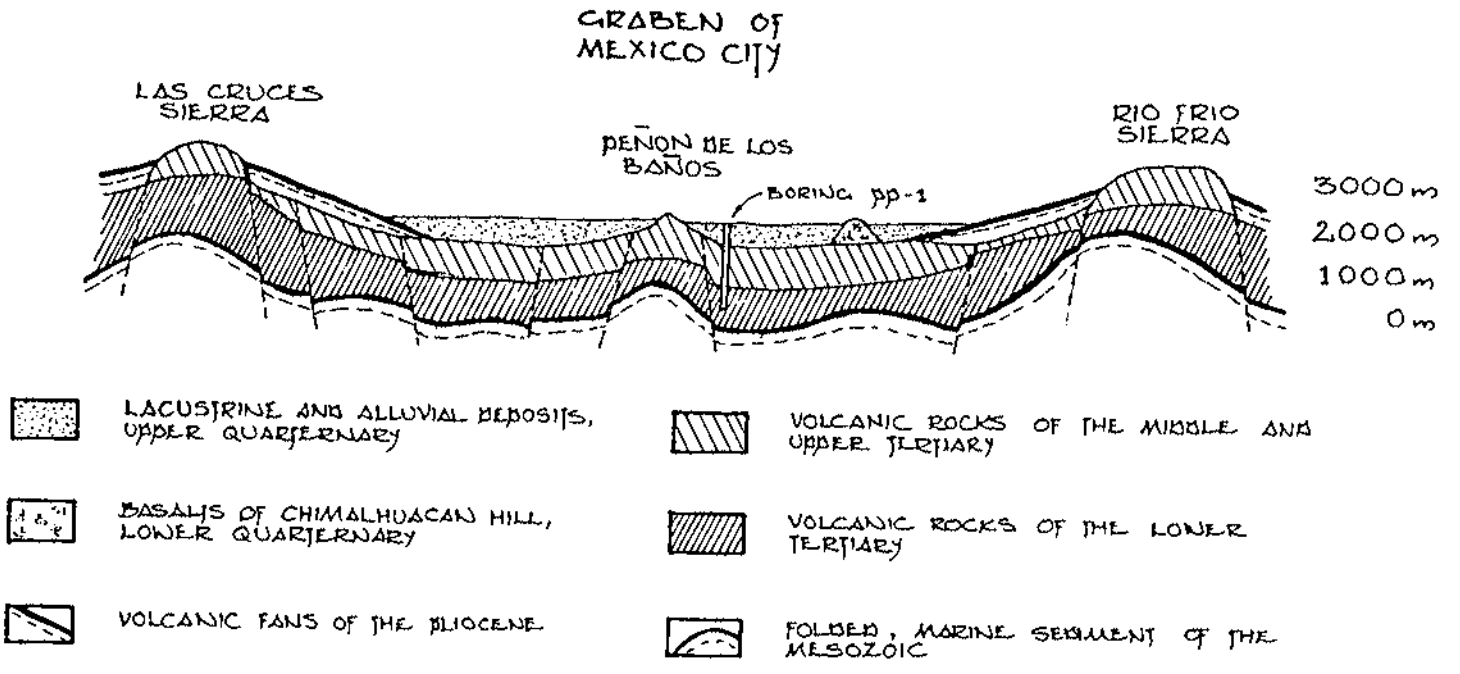


**Figure 6.** Main geological formations of the valley of Mexico.
(R J Marsal, *The Lacustrine Clays of the Valley of Mexico*. UNAM, Faculty of Engineering, Mexico City 1959.)

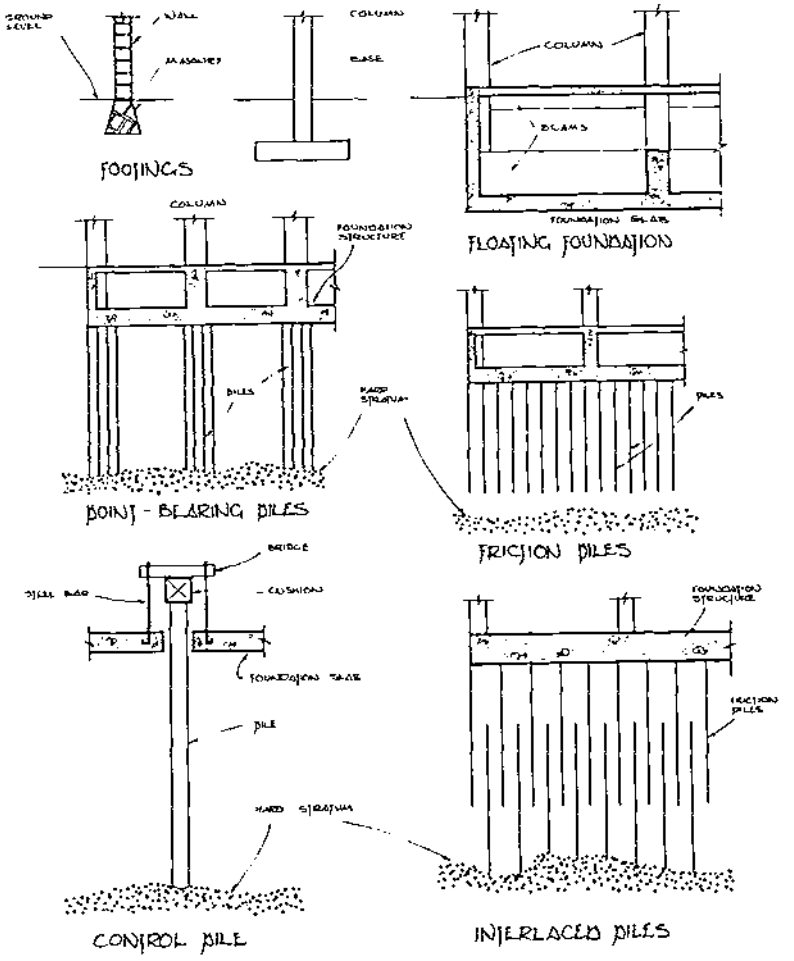


Figure 7. Some types of foundation used in Mexico City (schematic). (R J Marsal, *The Lacustrine Clays of the Valley of Mexico.* UNAM, Faculty of Engineering, Mexico City 1959.)

A common solution adopted by Mexican engineers has been to spread the foundation loads between the clays, via a partially compensated basement, and the underlying hard strata, via piles. Settlement of the clays causes load to be shed from the basement to the piles, which are designed to penetrate further into the hard strata, until the excess load is once more taken up by the clays. The building therefore settles with the surrounding ground thus avoiding problems with access, services, etc. The problem with this solution is that, to allow gradual settlement, the piles are actually designed to fail partially under gravity loading. The spare capacity in the piles available to resist earthquake overturning moments is therefore limited, and the basement may have to withstand the additional forces arising during an earthquake. Many foundation failures occurred in the 1985 earthquake, in the sense that settlements of up to one metre and more were recorded, and many buildings rotated significantly. Indeed the buildings with foundation failure generally suffered less structural damage than average, possibly because the energy dissipated in the foundations provided some

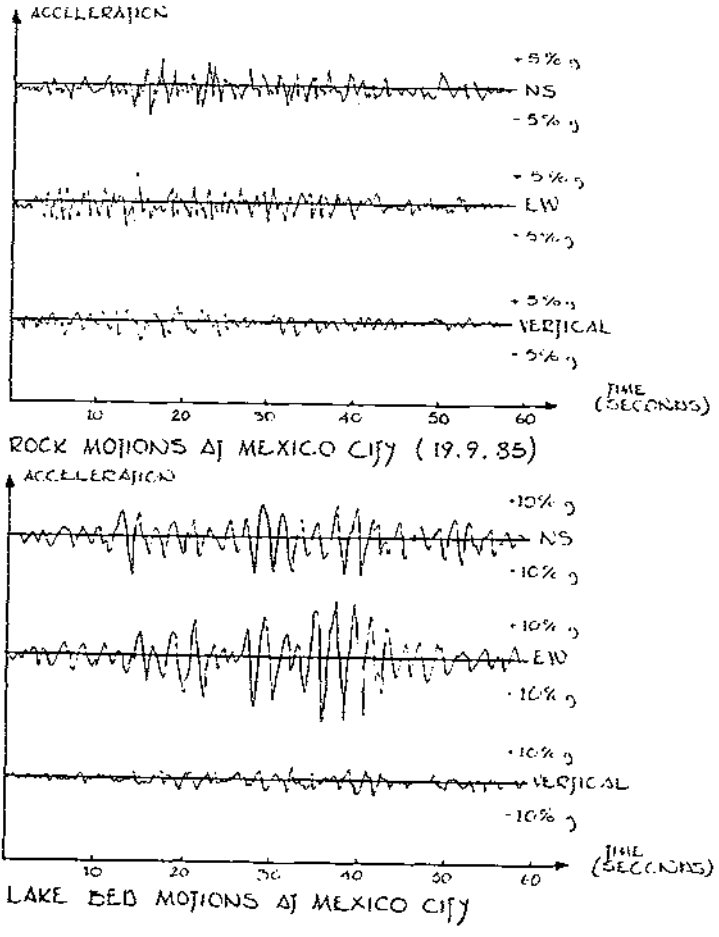


**Figure 8.** Rock motions at Mexico City (19 September 1985) and lake bed motions at Mexico City.
*(Spectra of the Horizontal Components Recorded by the Digital Strong Motion Instruments of Mexico DF Earthquake. UNAM INFORME IPS-10D.)*

isolation for the superstructure. However, the clay deposits caused an enormous amplification of the earthquake motions, as described in the following paragraphs, and hence their presence played an important part in the extent of damage.

*Amplification of Seismic Motions by the Clay Deposit*

Earthquake motions some 400km from the epicentre are not particularly damaging. This was true for the areas of Mexico City away from the lake bed zone where strong motion instruments recorded a peak horizontal ground acceleration of 4%g on rock. There was very little damage in these areas but on the clay deposits the peak acceleration was over 20%g and all the significant damage was concentrated in this area. *Figure 8* shows that the horizontal motions were amplified and concentrated into a nearly sinusoidal response of frequency around 0.5Hz. The long duration of nearly a minute is also significant. This type of amplification was anticipated but not at this magnitude. Mexico City's code of 1977 provides for forces which are 150% greater on the lake zone, the amplification in 1985 was 400% greater on the clays

than on rock. It should be noted that the 1977 Code compares well with current US and International practice.

*Damage to Building Structures in Mexico City*

The low frequency of the lake bed zone motions would lead to the expectation that medium to high rise buildings would be most affected by the earthquake, while low rise buildings being stiffer and having a much higher frequency, would be less affected. This was borne out in practice; damage of any sort was found in only 5% of buildings under five storeys on the lake bed, whereas up to 80% of 10 to 12-storey buildings had at least non-structural or superficial damage, and in the city centre, as many as 71 out of 456 buildings over five storeys high—15.6% were reported to be seriously damaged. One dynamic characteristic of the buildings, namely natural period, was therefore crucial in determining response. The peak damage ratio occurred at a building height of around twelve storeys. Simple rules of thumb, whereby building frequency F is related to number of storeys N by

$$F = 10/N$$

would suggest that around twenty storeys would be necessary to match the earthquake frequency of 0.5Hz. However, the rule of thumb applies to buildings on a rigid foundation. A simple calculation has confirmed that the flexibility of the lake bed zone foundation soils is sufficient to lower the frequency of a typical twelve storey building from around 0.8Hz to 0.5Hz. Torsional effects in buildings without plan symmetry are well known to amplify earthquake response, and preliminary indications are that the Mexico experience was no exception. Around 40% of the damaged buildings were found on corner sites which might be expected to have more open facades fronting on to the two streets than the corresponding facades at the rear. Hence the high damage on corner sites may be a result of torsional effects arising from this asymmetrical arrangement. However, many failures in Mexico City occurred because the structures lacked ductility. In particular, collapse modes involving hinges in columns, not beams, were frequently observed. Such collapse modes in moment frame buildings are well known to be much less ductile than modes involving beam hinge mechanisms. Another common feature in the failure of reinforced concrete frame buildings appeared to be inadequate confining steel, particularly at column/beam junctions. Practically every major earthquake re-emphasises the important influence of reinforcement detailing on ductility. Many of the buildings that collapsed were well built modern structures, designed to a modern code. The scale of the damage reflects the fact that the earthquake was exceptionally severe; for example, the motions can be shown on a number of counts to be more damaging than El Centro 1940 (a Californian event, often taken as a proving earthquake in design). The number of collapses can perhaps be partly attributed to the failure of the code to foresee such a damaging event, but probably also to the failure of engineers to ensure that their structures could in practice achieve the level of ductility they assumed in design. In the next section of his paper Edmund Booth considers the adequacy of force levels in the Mexico City Code and concludes with three points:

(1) The force levels in the Mexico code for high levels of ductility were probably not substantially out of line with the demands made by the lake bed motions.
(2) For low levels of ductility, the code force levels were significantly low, for structures having natural frequencies around 0.5Hz.
(3) As is well known, systems capable of achieving high levels of ductility contain reserves of strength greater than a simple reduction of elastic response by the ductility factor would indicate. The absence of a prohibition of structures with low ductility for medium to high rise buildings in the lake bed zone seems a significant omission from the Mexico City code (1977), which should be rectified.

Emergency regulations have been introduced since the earthquake, which substantially increase the seismic design forces.

*Failure of Non-structural Elements*

The use of rigid infill panels in reinforced concrete frames is a very common form

of construction in Mexico City. Some degree of failure in such panels appeared practically universal in medium rise reinforced concrete frame buildings on the lake bed zone. The significance of such failures goes beyond the danger from falling masonry, and the cost of repair. The rigid but brittle nature of the infill causes a substantial but unpredictable alteration to structural behaviour. Failure of the panels at a given level could cause an effective "soft storey" to form, with the attendant risks of an enormous increase in ductility demand in the columns at the same level, possibly leading to collapse. It is reasonably certain that "softening" of buildings (ie lengthening of their period) following brittle failure of their infill panels caused many buildings to shake themselves into resonance with the fundamental period of the lake bed motions. These dangers are well recognised in Mexico and elsewhere. The problem is that blockwork is a simple technology, which provides good acoustic and thermal insulation. Detailing to provide separation of panels from the structural frame leads to complications in ensuring out of plan stability for the panels. Lightweight, flexible cladding—the more usual solution in California—may not always be technically appropriate in Mexico. Finding an appropriate solution seems an important task.

*Conclusions*

1. The superficial clay deposits at Mexico City caused a number of very significant modifications to earthquake response. The most important was the conversion of the relatively harmless motions in the surrounding bedrock into an extremely damaging excitation. The influence of the soft ground in causing a reduction in the natural frequency of buildings was also important, since in many cases it caused the buildings to come closer in resonance with the ground motions than if the buildings had been founded on firm ground.

Although the Mexico City clays are in many respects most unusual, basins of trapped, soft, alluvial material are commonly found, and have been connected with concentrations of damage in other earthquakes. The lessons from Mexico will therefore have a widespread relevance.

2. The dynamic characteristics of individual structures, particularly their natural period and torsional response, were important factors in determining the degree of damage that they suffered. An equally important factor was ductility, or the ability to deform past yield without collapse, for which the influence of collapse mode and, in concrete structures, reinforcement detailing are crucial. A high degree of ductility has been shown to be much more effective in guarding against structural collapse than high static lateral strength. A very important lesson from Mexico is that greater care than is common at present may have to be taken to assess post yield behaviour, in order to ensure good ductility.

3. Failure of non structural elements, not always under the control of the structural engineer, was widespread in Mexico City and in particular, failure of brittle infill panels in frame structures appears to have had serious consequences for structural stability. Good liaison is therefore required between the various disciplines in building design. The interface between the responsibilities of geotechnical and structural engineers is another area where good liaison is required; lack of such liaison appears to have led to at least one major foundation failure in Mexico City.

4. Transport and electricity lifelines fared quite well in the earthquake in comparison to many previous events—for example, San Fernando, California, 1971. However, telecommunications and water supplies were badly affected, and the collapse of a number of buildings housing emergency facilities, including fire headquarters and hospitals, hampered relief efforts. The importance of providing additional protection, and some degree of duplication in such facilities is apparent.

*Post Script*

The Telmex structure which we worked on was as a six storey building which failed at the junction of the third and fourth levels. It collapsed almost vertically suggesting that there was insufficient ductility in the frame and that the columns probably failed

**Photo 2.** The collapsed exchange building.

at this level as their cross section reduced progressively at each higher level. The great weight carried on each floor can only have increased the earthquake motions. There was only 5cm between this building and a school on one side and a block of flats on the other, both were fairly solid and may have contributed to the third level failure as the Telmex building crashed into them whilst moving on its control piles.

In December the temporary repairs on the remaining lower floors and basement were virtually complete. Steel cages had been tightened around the cracked columns and steel beams placed under damaged beams. The building will remain in use for some two years whilst a new network of five exchanges, linked by fibre optics and this time constructed away from the lake bed are built around the city. It is expected that Mexico City will be able to retain virtually its full telephone capacity even if three of these new exchanges become damaged in a future earthquake to which the area remains prone.

Earthquake Relief In Mexico City (2)

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*ACKNOWLEDGEMENTS*

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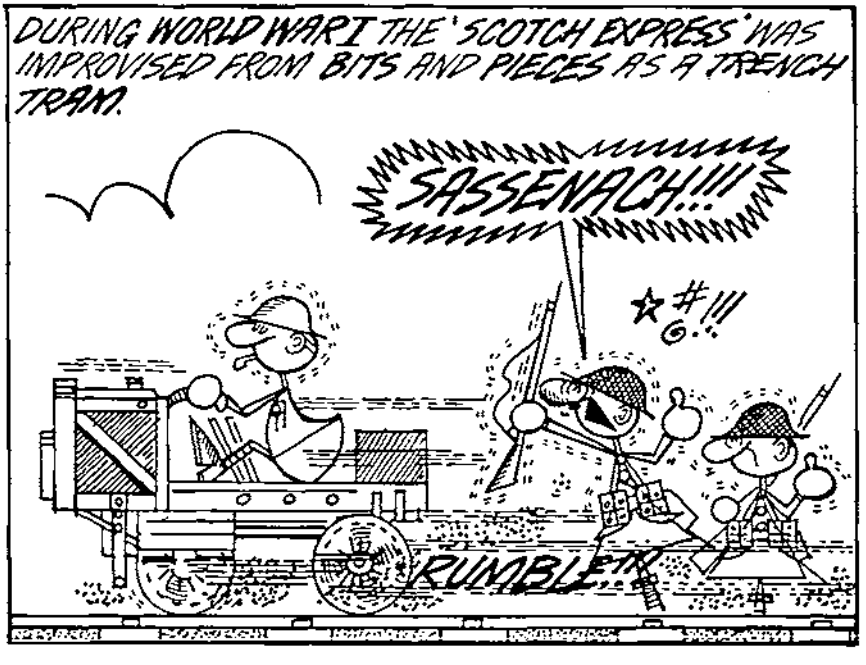

# Are we playing at being a Technical Corps?

MAJOR M S CAMPBELL B Sc MICE RE

*Stuart Campbell built jetties for an oil terminal while on his Long Civil Engineering Course. As OC of 53 Field Squadron (Construction), he built a road over granite and through swamp at CFB Gagetown; built a 600 metre rifle range at Sandhurst for the PSA, and filled in lots of holes at RAF Wildenrath. He was a Section Leader in the United States Air Force Rapid Runway Repair research programme, and was then briefly OC of the Engineer Base Workshop at Long Marston. He is now the ADR and Harrier staff officer in Engineer Branch HQ BAOR.*

HAVE you noticed the radical changes in the professionally qualified engineer (PQE) career structure since 1983, when over 30% of the officers in the Corps with electrical and mechanical engineering qualifications left? If not, it is hardly surprising: there have not been any. Lieut Colonel Richard Brooks has produced his report to the Deputy Engineer-in-Chief on the PQE career. There has been some consultation, but the whole subject seems to have sunk into the "too difficult" category. Perhaps the reason is that the Corps is asking the wrong question. The problem is not how to keep a few PQEs quiet, but rather how technical the Corps wants, or needs, to be. Having answered that question, it will be easier to decide whether we even need PQE officers.

The primary role of the Army is to fight a war in Europe, and that war is expected to be of very short duration. The Army is therefore equipped, and has developed procedures, to carry out a limited number of tasks quickly and to a well rehearsed plan. For the Royal Engineers, most of the engineering decisions have of necessity been taken by the equipment designers, and within the unit the skills needed are those of organisation and the ability to transport men and equipment to the right place in preparation for the "Carry on, Staff" executive order. Unlike armour and artillery that have no scope to improvise when the ammunition runs out, the challenging part of a military engineer's job begins after the last equipment bridge in the supply chain has been placed over a gap.

Government policy for many years has increased the "teeth" and reduced the "tail" of the Army. In the Royal Engineers this has had the effect of denigrating the importance of the rear area skills of resource husbandry and construction engineering. Yet it is these same skills that are needed in a 1(BR) Corps field squadron to improvise an engineering solution to a problem with less than ideal equipment and materials.

There are many shades of engineering that the Corps might be called upon to perform but, with the exception of the highly specialised combat engineering of 1(BR) Corps, most come under the heading of "general engineering" if one understands that to mean building, operating and repairing those facilities that are essential in war, using construction engineering skills and materials.

If pressed, the Royal Engineers can usually find one or more individuals who have the knowledge or experience to deal with a particular problem. But this is not the



Major M S Campbell B Sc MICE

same as saying that the Corps has a capability in that field. A capability only exists if the local commander can get a practical response from his Sapper adviser within a tactically acceptable time. Capability requires knowledge, skills, equipment and materials. Of these, knowledge is the most difficult to improvise. The field squadron, which is the basic "brick" with which to build up any required capability, gets its knowledge from previous training, technical publications or expert advice.

The squadron does not need to be able to do state of the art engineering. The battlefield construction site is not conducive to efficient working and good quality control. Engineering must be simple, but adequate for the problem of the moment: it takes experience to know what is "near enough". A military engineer who can only work to peacetime standards will always deliver too little, too late in war.

Ignoring the PQEs and technicians for the moment, how technically capable is the Corps?

For an engineering organisation, we do recruit a large proportion of graduates with non-engineering degrees. Any officer without physics and mathematics at "A" Level is unlikely ever to develop a better understanding of engineering principles than that acquired by a Class 1 Combat Engineer. Even with an engineering degree, there is little opportunity within a normal career pattern to enhance one's theoretical degree course knowledge with practical experience. This experience is the essential basis of an ability to improvise.

By the age of thirty, most officers are locked into a UK or a BAOR stream of regimental employment. If a UK squadron commander becomes a commanding officer, it is generally of a UK regiment. Similarly the BAOR squadron commander aspires to being a BAOR commanding officer. The result is that the engineering experience of being responsible for a *WATERLEAP* exercise or a Belize deployment does not find its way into a BOAR regiment.

It is surprising how infrequently a Royal Engineers officer has to consult a Military Engineering Volume (ME Vol) or other technical book when carrying out his duties. This is not because he is so knowledgeable but because his job is mostly organisational, and the normal engineering demands on the unit are well within the capabilities of a corporal or sergeant. In consequence, the ME vols are increasingly written at Combat Engineer 1 level and, if one must of necessity use a piece of equipment in some non-standard manner, the pamphlets do not contain the allowable stresses, second moments of area or pipe friction coefficients that are needed when doing simple design calculations.

The picture so far is that, if knowledge is a vital element in having an engineering capability at squadron level, the expertise of the regimental officers and the publications available to them leave some room for improvement. What of the expert advice that might be available?

To be of value as the Corps' engineering experts, PQE officers should be able to design and construct, and technicians to operate and maintain engineering works. All should be able to supervise and ensure the quality of work done, and be capable of planning and organising (according to their rank and technical or professional status) an engineering task. Clerk of Works and Garrison Engineer employment generally enhances the individual's technical knowledge and supervisory skills, though not in the full range of subjects covered on the clerk of works course. In comparison, the PQE officer loses a lot of his technical skill between the ages of thirty and forty. Squadron command and a staff job "for employability" take up four years; then comes officer commanding of a specialist team. This is mostly an organisational and report writing job because the technical content of many of the jobs given to the Military Works Force does not require the technical skills of a chartered engineer.

The PQE officer's employment therefore enhances his organisational, but not his technical skill; and the Corps appears not to regard his organisational skill as highly as that of his regimental counterpart. In Northern Ireland there have been only two PQE CREs. In the Falklands, the Corps sent a CRE (Works), presumably to run the Military Works Area, as well as a commanding officer to command the squadrons.

The Royal Engineers organisation changed several times, but throughout the post-conflict reconstruction, the sapper in charge has always been a regimental officer. In both these theatres, construction engineering has been a high priority and PQE officers could have been expected to be better qualified than their regimental counterparts to organise and command the work. The PQE system conspicuously failed to produce officers with the right skills and qualities when the need arose.

If a capability depends on expert advice, there have to be enough experts around to give the advice. At the present time in BAOR, the RAOC is designing and building fuel installations. This is supposed to be a Royal Engineers responsibility but since the Corps has only two officers in its single regular STRE (Bulk Petroleum), there are occasions when demand exceeds their ability to be in more than two places at once. In comparison to our two new UK based fuels experts every two years, the RAOC annually trains eight officers on its long Petroleum Course. There is an Ordnance Company in Germany whose job is fuel, and the Army sees the RAOC, and not the Royal Engineers, as the corps with the fuels capability in BAOR.

Inevitably, a squadron's engineering capability in an unaccustomed role will in peacetime depend on the Corps' ability to find sufficient experts to help it. If an acceptable standard is only achieved by conforming to some peacetime regulation, an improvisation is not good enough. In war, however, the ability to improvise may produce a satisfactory result without having to await the expert; but to achieve this will require officers to have more practical engineering experience than the majority have now. How might this be done?

1. Accept more engineering and fewer arts degree candidates for commissions.
2. Recruit graduates and stop in-service degrees. The number of employable subalterns is then increased by about 21 per year (figure extracted from November 1985 *RE List*).
3. After one tour as a Troop Commander, post some officers to Military Works Force as designers/seconds-in-command in STREs, and others on one year attachments to civil engineering firms.
4. Later, some officers return to squadrons as second tour troop commanders, while others instruct in bridging, civil, electrical and mechanical engineering, or roads and airfields departments at the RSME.

With this as the normal career pattern, both UK and BAOR squadrons will eventually have squadron commanders with better engineering experience than now, and at least one second tour troop commander with post-degree construction engineering experience.

What of the PQE officers? The fact that we have them is an acknowledgement of the lack of engineering expertise of the regimental officer. It also has the effect of further lowering the standard of expertise at squadron level, because nearly all technical engineering design and planning is now done by technicians and PQEs. There will always be some problems which require a better than average understanding of engineering, and there will be some officers who have a preference for technical rather than staff employment. It will be less divisive for the Corps, however, if those individuals are "normal" RE officers, whose work experience eventually qualifies them for chartered engineer status.

In conclusion, there is a lack of engineering expertise within the Corps which greatly limits a squadron's capability to do anything but use combat engineering equipment. The major cause of this is a postings policy and career pattern designed to allow the Corps' most able officers to do those Army jobs which are the necessary stepping stones to high rank. Inevitably there is little time for engineering. However, it is not only the most able who follow this pattern. Far too many officers, whose rank potential is no more than colonel, are being employed in a progression of jobs which do not enhance their individual engineering skills; and this cannot be in the best interests of the Army. The engineering capability of the Corps will best be improved by a general raising of the engineering expertise of the majority of its officers. The PQE system is an obstruction to this occurring.

# Belize. A Haven for Exploration

LIEUTENANT A J L HOLT B Sc

*Lieutenant Holt graduated from Manchester University with a degree in Civil Engineering. He attended 82 YO Course in 1984 and was posted to 8 Field Squadron RE where he served as a troop commander. He left the army in September 1986 on completion of his Short Service Commission and from September to December 1986 was a staff member on Operation* RALEIGH *in New Zealand.*

To the soldier in the British Forces of today, service in the Caribbean state of Belize offers a brand of military life which is almost unique amongst our various defensive tasks around the world. The close-knit tri-service force and the geography of the area combine to make the life quite different from that in Europe. Belize is a poor country with an ethnically mixed population of 147,000 and very few natural resources. The tropical climate is uncomfortable for most of the year, with a rainy season that lasts from July to December and there are periodic hurricanes. The force is stationed as a deterrent to the territorial claims of Guatemala, and is mainly based beside the international airport near to Belize City. Although it has a certain amount of character, the city is something of a shanty town and apart from the bars, there is not much to interest the visitor there.

In spite of its apparent drawbacks, one of the great features of Belize for the serviceman is the extensive range of activities offered during off-duty hours. Having exploited as many of these as possible during my six month tour I shall attempt to summarise some of them.

Belize is about the size of Wales with the Caribbean running down its eastern side. Up to thirty miles off the entire coast lies part of the second largest barrier reef in the world. Around this oceanic feature are shallow coastal waters, and a string of islands or cays where the coral breaks the sea's surface. The cays are covered with anything from mangrove swamps to actual town and tourist resorts, but they always feature enough sand, sun and palm trees to make an attractive venue for weekend trips in chartered boats. Some are beautifully unspoilt, and indeed most of the country is largely unknown to tourists. Lurking beneath the surface of the waters is some of the world's finest tropical reef diving, and much of it untouched. The RAF sub aqua club runs monthly expeditions to various parts of the reef. One notable venue is the Blue Hole where in the centre of the shallow waters of Lighthouse Reef a cylindrical 50m diameter hole plunges earthward to a depth of 150m. In the silent gloom the hole increases in diameter at 50m where a series of huge stalactites hang from the walls.

Many soldiers are given the opportunity to do a week's adventure training during the tour. A centre is run on one cay where tuition in sailing, canoeing, windsurfing and diving is provided.

The seas naturally provide the perfect place for deep sea fishing. Some married personnel on two-year tours have taken advantage of this opportunity and have



Lieut A J L Holt
Belize. A Haven For Exploration

**Photo 1.** Diving the inland Blue Hole

purchased their own boats. Many of the catch are barracuda, which once in difficulty get bitten in half by their own kind before they are even taken out of the water!

On the mainland interest centres on natural and archaeological features. The coastal belt is largely swamp but inland the rolling cultivated hills of the north give way to the jungle clad mountains of the south. The jungles are penetrable only on small tracks, and indeed nowhere in the country are roads particularly good. There is only one main road which runs the length of the country and much of it remains unmetalled.

Belize is situated in the centre of the old Mayan civilisations. As well as a liberal covering of smaller Mayan edifices there are three very large sites. Xanantunich in the west features a very large pyramid which overlooks far into Guatemala. Altun-ha near Belize City is a complex of pyramid structures surrounded by jungle. Perhaps the most impressive is Lamanai which is still only partially excavated. Four hours drive from Belize City, the extensive complex rests beside a huge inland lagoon and most of it is still under the shade of the jungle canopy. Restoration of these sites to their original grandeur is paralysed by a lack of available finance.

Natural wonders are equally extensive, and mostly derive from the hollow limestone of the interior. The inland Blue Hole is a popular site, where an underground river surfaces briefly in a turquoise pool surrounded by jungle. On one occasion we dived in the river which surfaces after 50m in an underground tunnel. We followed the water right back into the mountain without finding the source. The mountains are full of huge caves and underground tunnels, and a film crew recently made a trip into a massive cave 100m wide with a roof so high that it could barely be seen in the torch beams. They had to be taken in by helicopter due to access problems, and were mainly interested in studying a particular blind land crab. Some caves are still full of undisturbed Mayan relics. One weekend we explored a cave called Mountain Cow and climbed and scrambled for three hours into the bowels of the rock. It was quite a privilege to witness so much in its virgin state, and some of the limestone formations were stunning. Fortunately we marked our route in, since the cave looked entirely different on our return and we would otherwise have become hopelessly lost.

In the south a feature called the Natural Arch is a huge rock span which bridges a gorge. It takes three hours to get near it, followed by a walk through the jungle. A

**Photo 2.** The Natural Arch

similar feature at Augustine is the Rio Frio cave where the river passes through the mountain in a large cavern which was also once settled by Maya. The northern part of the Maya Mountains is called Mountain Pine Ridge and features very attractive pine woods. The force rents a hut there on a permanent basis for anyone who cares to book it. Not far away are the 1000ft falls where the river plunges over the edge of the gorge into the hidden valley. Soldiers serving in Belize and keen to explore such places are fortunate to benefit from free use of military vehicles and fuel. Equally any trip outside the camp gets a gratuitous issue of a barbeque from the cookhouse or mess. As Sappers we were particularly lucky in having a stock of Rigid Raiders and assault boats which were the envy of many.

A final advantage of serving a tour in Belize is its close vicinity to other countries of interest. All personnel on six month tours are allowed a fortnight's leave and a small travel allowance. Many go to Florida where there are sufficient attractions for a month, and others go to Cancun in Mexico. Cancun would appear to be the new Acapulco, and is situated on the warm white sands of the Caribbean. It is a relatively new resort, and ten years ago was just a small fishing village. Cancun is also in range for a long weekend and is used by many as the best chance for meeting white females. Other servicemen choose to spend their leave in Costa Rica or on the islands in the Caribbean.

I spent one week of my leave travelling around the Yucatan Peninsula in Mexico, and the second week in Honduras. Both were fascinating, very cheap places to visit and probably provided for me an unrepeatable opportunity. I was also able to practise the Spanish I had learnt at the class organised at Airport Camp.

In addition to considerable Sapper experience all these opportunities for exploration and adventure made my Belize tour particularly worthwhile. It is an unfortunate fact that for many of the unmotivated soldiers stationed in the country Belize proves to be such an unbearable place that they want to leave as soon as it is possible. With a little motivation they could have the time of their lives.

Belize. A Haven For Exploration (2)

# A Worm's Eye View

R J P COWAN, ESQ, OBE, ERD

*The author was educated at Glasgow Academy and gained a B Sc in Civil Engineering at Glasgow University. He was commissioned in 1933 and posted to 103 (Glasgow) Company RE. He joined the REOCA in 1936. He served in the War in France (BEF), North Africa, Italy, Normandy, Belgium and Germany. After the War he became a partner in a Glasgow firm of consulting Civil Engineers. He became Governor of Paisley College of Technology, Deacon of the Incorporation of Cordiners in Glasgow, Chairman of the Glasgow and West of Scotland Civil Engineers, Chairman of the Hamilton Bequest, Chairman of Malin Court, a Trustee of the Turnberry Trust and President of the Glasgow Branch REA.*

BRIGADIER A E M WALTER CBE has already told the overall story of Mulberry Harbour in *A Harbour Goes to War (RE Journal Mar 86)*. This is the story of the part played in its construction by two specially formed RE companies.

The harbour consisted of huge concrete caissons forming the breakwater, enclosing an area of about 1300 acres, two miles long and a mile out to sea, within which steel "spud" pierheads were connected to the shore by three piers, each three-quarters of a mile long.

The breakwater caissons were cellular reinforced concrete boxes upturned, the larger caissons being 70 yards in length, 20 yards wide, and 60 feet deep, and weighing 6000 tons.

The "spud" pierheads could be described as steel suitcases with a "spud", or column, 90 feet long, at each corner; these spuds were lowered to the sea bed by winches, and the pierheads then lifted in the water, *ie* off flotation: 6 inches "up" put a load of about 50 tons down each spud.

The piers were pontoon bridges with steel girders, 80 feet span, very flexible along and across the bridge, designed to support 40 ton Cromwell and Sherman tanks, and were carried on reinforced concrete pontoons. There were also a few steel pontoons.

All this equipment had to be towed over 100 miles across the Channel to Arromanches in Normandy.

In February 1944 Brigadier A E M Walter, a Regular Army officer, took command of the Mulberry project. We found him to be a relaxed, calm, kindly, but utterly determined and resolute man. He had collected about him a team of experienced officers, who inspired the greatest confidence in us all; Colonel A E Howarth, Colonel Stuart K Gilbert and Lieutenant Colonel A R Mais (now Lord Mais) who was in charge of the construction of the piers and pierheads—a tough, driving, determined officer with an enviable reputation and a keen sense of humour. His second-in-command was Major R J Court.

Two Companies, the 969th and 970th, aptly named Port Floating Equipment Companies, were given the task of building the piers and the pierheads. It was decided that they should operate as one Unit so that construction could be carried on, day and night, without cease. I became OC of the Combined Companies for the invasion and my friend Major Tim Tonks, a very sound and clever Civil Engineer, was responsible



R J P Cowan ESQ OBE ERD
A Worm's eye view

**Photo 1.** The Mulberry Team. Back row l. to r. Lieuts D Barton, G Budworth, D Jones, P Pollard, A J Hirst and W W Rigbye. Front row l. to r. Capt G Tarling, Maj R J P Cowan, Lieut Colonel A R Mais (now Lord Mais), Capt A R K Simpson, and Capt E W Witcomb. (Not present Capts J Luck, A J Harris, and WO J Heming (U.S. Army)).

for the "back up" in the UK and came over later. He had been involved in the development of Mulberry.

The company officers, all highly skilled and individual characters from diverse pre-war walks of life, were Captain E W Witcomb, in charge of pierheads, Captain John Luck, in charge of tugs and tows, Captain Simpson in charge of bridge construction, Captain George Tarling, the only Regular soldier, in charge of administration, and Captain A J Harris (now Professor Sir Alan Harris) the diving officer. He inspected the spud feet and caissons on the sea bed for scour etc, and dealt with anything nasty dropped in the harbour by enemy aircraft. He used a Siebe-Gorman canvas and rubber suit with helmet, a two-man hand operated air pump, air hose and telephone cable connecting to the diving boat.

The Junior Officers were all straight from OCTU. Keen fit young men, full of energy, ready for anything—Lieutenants A J Hirst, P C Pollard, D W Barton, W W Rigbye, Donald Jones and G T Budworth.

Brigadier Walter had managed to borrow a section of motor towing launches from the 334 Harbour Craft Company of the United States Army. Under the command of Warrant Officer John Heming, a laconic and skilled yachtsman from Lake Michigan, these highly manoeuvrable craft complemented the heavier British steam tugs. Luck and Heming and their crews were quickly expert at handling the awkward tows. They became great friends.

Formation of the Mulberry Companies went ahead in the spring of 1944. By naming names we managed to obtain a nucleus of experienced WOs and NCOs. Colonel Mais brought with him his old friend and companion, the very experienced and tough CSM George Braysford (he had survived the Dieppe raid). Others included CQMS Charles Gray (from Aberdeen, who had served in France and Africa), Sergeant Blake, McMeakin (from Glasgow), Sergeant H W Priest (who had been with me in Africa and Italy) and Corporal Warburton, all first class soldiers.

A Worm's eye view (1)

But, as for the rank and file, we were told by "those-on-high" in the War Office that orders had been passed to every RE Unit in the United Kingdom to send, immediately, their finest, bravest and most highly skilled Sappers to join this crack invasion force; we would have the best, because "Mulberry" must not fail. Alas, what actually happened was that every RE Unit in the UK seized this golden opportunity to unload on us their most formidable and desperate criminals—hard men who arrived at the Company HQ clutching crime sheets covering every offence in the Army Act—insolence, insubordination, theft, assault, robbery with violence, arson, desertion, *etc.*

Training, carried out at Garlieston on the Solway Firth (where the tidal range was about 22 feet—the same as in Normandy) and the Isle of Wight, was restricted because the equipment was still being constructed and delivered and there was little to spare for practice. We were never able to hold anything like a full scale exercise. In fact the first time some of the men saw the equipment was in Normandy. In their moments of leisure, our Sappers robbed, assaulted the local ladies, beat up the local men, deserted in droves and set Glasserton House, Wigton (our billet) on fire and burnt it to the ground. George Tarling had about twenty court martials "on the go" when we embarked for Normandy.

## The Equipment

The main girders of the pontoon bridge were lozenge shaped to ensure the best disposition of chord material to withstand bending stresses and longitudinal forces along the piers. To allow for free angular movement along the line of the bridge one span relative to another, the bridge bearings were of spherical construction; the bearings of adjacent spans sat one inside the other. This allowed a difference in level between adjacent pontoons of 16 feet. The bridge could "snake" along its length; it was a most extraordinary sight during storm conditions.

To allow torsional displacement along the 80 foot length of each bridge span, *ie* when adjacent pontoons were dipping in opposite directions, the steel bridge decking was supported on pinned cross girders (*ie* pinned connections to the main girders). In order to hold the planes of the main girders parallel there was a 3 feet deep centre girder bolted to the main girders. This centre girder did not have a bottom flange and so could accommodate over 5° of twist without overstrain.

For towing across the Channel six spans of the bridge were coupled together to form a 480 feet long "tow". The "free" end span was supported on a cylindrical steel erection tank, 8 feet in diameter and 36 feet long. About 50% of these "tows" were lost en route to Normandy. Each had a crew of seven sappers for the crossing who sheltered on the steel deck under tarpaulins and lived on self-heating food. Many were drowned with their tows.

Coupling up the tows to form the pier was carried out by bringing the tow into line with the section of bridge already established. When in position the erection tank was flooded so that the free bridge end of the tow sank into the bearings of the established bridge end. This operation required very skilful and delicate handling by the tug crews and the bridge erection teams. In the bad weather during erection, with Force 5 winds and waves over four feet high, the exact moment had to be snatched to slot the free end into guides and thence to the bearings. A miscalculation by Luck and Heming and their tug crews, or a freak wave, could crush, main, and kill the bridge teams, and smash the bridge connections. Luck and Heming and their men were superb at this tricky and difficult work.

Most of the pontoons (about 95%) were constructed of reinforced concrete. They were 43 feet long, 16 feet wide and 11 feet deep; each weighed 47 tons. There were six watertight compartments, each with an access manhole. The vibrated reinforced concrete was supposed to be 1¼ inches thick but in many places it was much less. We hated and loathed these concrete pontoons, they were so fragile and easily damaged. During the storm they were constantly holed by floating debris. If damaged (this nearly always happened to the end compartment), we had about half an hour to

**Photo 2.** Coupling up the bridge "tows"—D+2. Lieut Colonel Mais (right), author (foreground left), Sgt Swayden (centre) and Captain John Luck (with megaphone) on bridge "tow".

**Photo 3.** Preparing to locate a pierhead in position.

A Worm's eye view 2 & 3

change the holed pontoons, because if one were allowed to sink it would quickly pull down the entire bridge.

Mooring of the pontoons was carried out by using very long 3½ inch SWR cables set taut at 6 tons tension (low water) and 12 tons (high water) tension.

Specially designed and very effective "kite" anchors (shaped rather like a plough), were used to hold the cables.

Damaged pontoons were replaced by slipping partially flooded erection tanks under the bridge close to the damaged and sinking pontoon. Water was then blown out of the erection tanks by compressed air so that they rose to support the bridge, when the pontoon was pulled out and a new one "slotted" in. In daylight, in good weather, this was not an easy operation; in the dark, during the storm, it was a nightmare which recurred again and again.

The "spud" pontoon pierheads had been developed from a dredger design. Built of steel plate, they were 200 feet long, 60 feet wide and 10 feet deep. Each weighed 1100 tons. They were designed to operate in fifty feet of water (maximum depth), and five foot waves. The tidal range of Arromanches was 22–25 feet so that vessels of 20 feet draught and 200–300 feet long could berth alongside. The steel "spuds" were 90 feet long and 4 foot square columns.

Only two of the huge breakwater caissons were lost while being towed across to Arromanches. One struck a mine, another was torpedoed. They sank in 30 seconds, taking with them many good fellows I had served with in Africa and Italy.

Two piers were set aside for landing ammunition and stores. The third was a special pier for landing tanks. It was formed by setting two spud pierheads at right angles to each other and connected by a telescopic span. One pierhead was set in the normal position to the pontoon bridge; the other at right angles to it. Attached to the first pierhead, one on either side of the second pierhead, were two cellular steel "buffer" pontoons, wedge shaped false beaches, on to which the 2500 ton LSTs sailed at about 3 knots.

The pontoon bridges had been designed by Major A H Beckett. "Joe" Beckett was determined that his brain child, his baby, would not be ill-used during erection in Normandy. He persuaded Brigadier Walter to let him join us. He was a first class chap, always in the thick of things.

The equipment was excellent and well designed. In our opinion, however, there had not been enough time to assess and develop it for conditions on the battlefield. But Joe Beckett could hardly have envisaged erection of the equipment in a dense smoke screen, in bad weather by half-trained men, and the storm which caught the harbour half-completed.

## Invasion

It is difficult to describe the electric atmosphere of the pre-invasion days, the mixture of exhilaration, fear, excitement and tension; and a sort of dim realisation that we were about to take part in history. None of us would have changed places with anyone in the world.

Early on "D" Day, 6 June 1944, Colonel Mais, with Major Bobby Court; CSM George Braysford and a small Advance Party, waded ashore through the surf at Le Hamel, found their way along the narrow Normandy lanes, through scattered units of a very hostile German Army, to the little seaside village of Arromanches, where the port was to be built. There he met Brigadier Walter, who arrived in some style with his batman in a DUKW which he had, somehow, "acquired" during the darkness off-shore from our American Allies. Both men were lucky to have escaped death that morning.

The main body of the Company caught up with them during the early hours of the following day. It was hot; confused fighting was going on all around the village, German tanks had been seen nosing out of the woods less than half-a-mile away, and there was that never-to-be-forgotten feeling in the air of crackling tension that you get when sudden, violent death is about.

Wally Walter and Raymond Mais had just started to instruct us in our first tasks when, round the corner on to the sea front, came an old Frenchman with his wife and daughter. It was obvious that they were frightened to death, the women were weeping, and only pride was keeping the old man going. They stopped short, affrighted, when they saw us, wondering for the instant were we friend or foe. Brigadier Walter and Raymond Mais put down their map cases. "Wally" Walter walked over to the ladies, while Raymond Mais (close to me) gave the old man a crashing salute. I heard him, in absolutely appalling French (an indictment, if ever I heard one, of the English Public School System), congratulate the old fellow on bringing his ladies to safety through the enemy lines, and express the hope thay they would accept the hospitality of the British Royal Engineers. Meanwhile, Wally Walter was "chatting up" and charming the two ladies, had found chairs for them, had them laughing and talking and attending to their appearance. The old Frenchman, his pride and his dignity restored, then joined them, when they were given hot tea and food and shelter by CSM Braysford.

This act of kindness, of chivalry, by these two men, did not pass unnoticed by the sappers. During the build-up to the invasion they had worked us very hard indeed, and won our respect. They now had our respect and our affection. Officers, in the British Army, who had won these, could achieve anything, and this was to prove the decisive factor in the days ahead.

That evening, at dusk, we bivouaced in an orchard just outside the village. It was noisier than ever, a battle had developed on the hillside some 200 yards away to the west, with machine guns, mortars, tracers, flares, *etc* and we didn't know who was winning. The perimeter of the orchard was manned and we settled down, uneasily, for the night.

Suddenly, so it seemed, a hush fell over the battlefield. Turning, by the light of flares, I was astonished to see Colonel Mais slipping into the most mode-ish pale blue silk pyjamas—they had a sort of floral motif embroidered on the front—of primroses and forget-me-nots—obviously the work of some loved one. To this day I do not know if the gallant Colonel habitually wore pale blue silk pyjamas on the battlefield, but I very much hope that he thanked the lady—and I like to think that it was the charming Lady Mais—whose loving stitches turned our thoughts to gentler and happier things, so that we settled down for the night, in that dark Normandy wood, forgetting for the moment, our surroundings. I should add that the Colonel's somewhat unusual night attire for the battlefield did wonders for morale and steadied the raw and nervous troops.

## Construction

Next morning, D+2 (8 June), the bridge tows started to arrive and construction began. It went on thereafter day and night with a sort of dreadful, relentless urgency, mostly in difficult, often in appalling, conditions.

By day, the sight at Arromanches was most impressive—apart from the huge breakwater caissons, the ungainly spud pierheads and long piers continued to grow in the harbour. Beyond the breakwater, destroyers and battleships steamed up and down the coast firing salvoes inland. Sixteen inch shells from the *Rodney* and USN Battleship *Utah* continually whistled overhead like flying coal scuttles, as they shelled strategic targets a few miles inland.

At night work was hampered, made chaotic, by a dense smoke screen, within which pierheads and tugs and tows missed each other by inches; and a vast number of anti-aircraft guns, sited on the high ground above the growing port, thundered away at raiding aircraft. Shells and tracers went up, shrapnel and flares and bombs came down. We seemed to be working in a sort of mad nightmare.

One morning, following a very heavy raid, Captain Harris, sixty feet below the surface in a cloud of fine sand and working blind by "feel", reported that he was investigating a large and strangely shaped object. To this day Alan blushes when

reminded that the unidentified explosive device turned out to be an upside-down "elsan" chemical WC.

However, by the early hours of 14 June (D+8) (*ie* after six days of construction) the first pier had been completed and vitally needed ammunition and stores were coming ashore. By D+10, 2000 tons per day of stores and ammunition were being unloaded from the piers.

## The Storm

On 18 June (after ten days of construction) the harbour was all but completed, except for the section at the eastern end of the breakwater, and the special tank landing pier (half completed). On that day Colonel Mais called an urgent conference, when he told us that the weather was about to deteriorate, he did not know how badly, but no chances would be taken.

All moorings were to be checked and duplicated. The "spud" pierheads were to be "spudded" up as far as Ted Witcomb dared. The tugs were to be provisioned and fuelled up for maximum endurance. All craft to the windward (by this time the wind had backed round into the north-east) must up-anchor and move lest they drag anchor and bear down on the piers and pierheads. Any failure to carry out these orders to the letter would result in my head on a bayonet at the pier-end. I found this threat—and I could see that he meant it—most interesting. Fellow Scots will recall that in AD 1305, the Scottish patriot, Sir William Wallace of Elderslie, was betrayed and captured by the English. He was taken to Smithfield in London, executed, and his head stuck on a pike and exhibited at the Tower of London. Which shows that over the centuries, the English have not changed one bit.

Raymond Mais was right—on the evening of 18 June, the weather rapidly worsened and by the early hours of 19 June a storm had begun. The ensuing storm has been described (Chapter XII, "The Story of the Mulberries") as "the worst summer storm in memory, second only to that which wrecked the Spanish Armada in 1588". It lasted for four days, four days and nights, which no-one who served at Arromanches will ever in his life forget. Tired out before it started, the men were far beyond exhaustion point when it finished, with only reserves of will-power and courage keeping them going; and an utter determination not to let Wally Walter and Raymond Mais down.

Writing at the time Captain Tarling described the scene during the storm—"The wind howled and screamed like a banshee; waves eight feet high crashed against the shuddering pierheads and washed over the pontoon bridges, so that the men had to cling to the steelwork or be washed away to drown. In the grey daylight and in the dark, out of the gloom would appear drifting, crewless vessels, steel pontoons, debris, *etc* driven by wind and tide, and bearing down on the piers—but pursued always by Luck and Heming and their tug crews. In the darkness and heaving seas, men had to jump from the tugs and from the bridges on to these abandoned craft, to attach a line so that they could be towed away before they smashed the fragile pontoons. There were many extraordinary feats of courage and daring by Luck and Heming—and by Colonel Mais—during these times.

"In daylight and in darkness the nightmare task of removing damaged and sinking pontoons, by the bridge crews went on and on. Sergeants Allen, Williams, Swayden and Priest particularly distinguished themselves during these times. The "back-up" by CQMS Gray, who saw to it that they never at any time lacked the tools and equipment for the repairs, and ensured that there was always food and hot tea (laced with rum), was vital. Lance Corporal George Malcolm from my office staff, acting as runner, carrying messages along the piers and holding on to the steelwork as waves broke over him, always got through.

"The pierheads, winched up far beyond the makers' wildest dreams, were awash, shuddering. The noise of the wind, of the overload warning klaxons, the screech of the spuds grinding on the rocky sea bed, the banging and crashing of the spud legs in the guides, was beyond description; the pierheads were no place for the faint-hearted.

**Photo 4.** Coupling up the bridge in bad weather. Note erection tank. Sergeant Blake in foreground.

**Photo 6.** On the pierhead. Preparing seating for the bridge end.

A Worm's eye view (4 & 6)

**Photo 5.** (top) "Slotting" the "free" bridge end into the established bridge.

**Photo 7.** (bottom) Inshore end of pier completed.

A Worm's eye view (5 & 7)

And although three pierheads were lost, Ted Witcomb remained cool and steadfast, and with his men held on throughout. Never, in my wildest dreams, would I have believed that these rejects from other companies could produce such determination and endurance as they did during these appalling days and nights at Arromanches. They just would not give in, and in the end they "held the port", but only just."

Today George Tarling's words may sound overly dramatic, but it was a long, long, grim battle which never seemed to end, to the very limit of our endurance.

On the bridges, in the darkness, throughout the storm, Wally Walter and Raymond Mais always seemed to be standing beside us, watching and encouraging. These two gallant and brave men somehow willed us not to give in; we had a great regard and affection and respect for them and would have been ashamed to fail them.

## After the Storm

On 23 June the storm abated, the weather improved, and we were able to assess the extent of the damage and destruction. The scene after the storm is described in "The History of the 21st Army Group":— "... The Allied beaches were an appalling and disheartening sight, corpses of the drowned, smashed equipment, stores strewn everywhere; hundreds, almost thousands of craft and small ships, some up to 1000 tons deadweight, were lying at high water mark in a shambles which had to be seen to be believed—craft were actually piled on top of each other, two and three deep. But ... throughout the storm the Sappers somehow managed to off-load desperately needed stores and ammunition and even on the worst day managed to land 800 tons of ammunition over the piers."

The storm had been beaten, but the two stores piers, although in full use, needed urgent repairs. The third pier, the tank landing pier, was, however, a twisted hopeless wreck. The pontoon bridge had turned right over, cork-screwed, with landing craft and small ships wedged underneath the smashed pontoons. Bill Rigbye and Donald Jones were in charge of the repairs and reconstruction. Alan Harris carried out several dangerous underwater reconnaissances among the twisted and moving steelwork. With his reports Rigbye was able to salvage much of the bridgework but few of the pontoons survived the storm. Work started at once, by day and night, so that the discharge over the piers rose steadily. Three days after the storm, 11,000 tons of ammunition was discharged over the two stores piers. But partly due to salvage problems, partly to lack of spare pontoons and damaged bridge spans, it took fourteen days to re-build and complete the tank landing pier.

## Final

Mulberry Harbour was probably one of the most interesting and outstanding feats of Military Engineering of all time. The Companies of men who built it, and held it together during the storm, have long ago marched off into history. As a last farewell and tribute to them, I quote Brigadier Walter:— "It was the morale of the men that built Mulberry, and saved it during the storm of 19 June, and not merely technical skill."

Colonel Howarth commented:— "The equipment was first class, but the storm produced conditions fully twice as bad as the worst for which it had been designed. In the last analysis, however, success or failure depended on the courage and determination of the Sappers."

My own "worm's eye" view was that Mulberry was constructed, and succeeded, because of four remarkable and gallant men—Brigadier "Wally" Walter, Colonel "Daddy" Howarth, Colonel Stuart Gilbert, and Colonel Mais. These men, by sheer force of character, inspired a half-trained company of men—many the very dregs of the Corps—to build the harbour, and then willed them to hold it together, against all the odds, through the great storm of 19–23 June. For, in the end, it all comes back to leadership.

# Are we in Control for the 90s?

CAPTAIN (GE(M)) H J MITCHELL

*Captain Mitchell joined the army as a boy entrant being posted to the Junior Leaders Regiment in 1962. He qualified as a Clerk of Works in 1972 and was commissioned in September 1984. After a posting to the Falkland Islands he is now serving in the E & M Wing at RSME.*

## Background

The responsibilities of the Royal Engineers for control engineering has been the subject of much recent discussion. Although control engineering was initially identified as a subject in its own right to be investigated as a result of the Jolley Study on artisan employment its effect on the Professional and Technician Engineer employments has now been drawn into the discussion. A number of specific comments on artisan training have already been received and, where appropriate, included in new job specifications as part of the follow-up to the Jolley Study. However, a variety of opinions prevail as to the training requirement for the professional and technician engineer levels; these are not yet clearly defined and cannot be so until the full range of RE responsibilities is known. This is not to say that units or individuals are unaware of their own responsibilities in a given role but rather that these responsibilities have not been formally consolidated Corps-wide.

A study to determine the control enginering responsibilities of the Corps and how best they might be met through the training given at the RSME has recently been completed. The study included a reconnaissance to BAOR, where there is a wide range of the works services that typify RE responsibilities world-wide.

The aim of this article is to present the major findings of the study and discuss how they will affect future training in control enginering.

## Responsibilities

Control engineering, of one form or another, is applied across an extremely wide field of engineering works services. As a result of the study a list of the more important services that are a Corps responsibility has been compiled and includes airfield systems, fuel and water supply installations, electrical generation and distribution systems and building services installations. These responsibilities may have to be met in different scenarios:

*War.* In war all installations/equipments that are the responsibility of Property Services Agency (PSA) in peacetime become the responsibility of the Royal Engineers. Tasks under this heading may include the use of expedient methods, and normal peacetime standards and practices may not be applicable.

*Peace.* A number of RE officers and soldiers are employed with outside agencies (mainly PSA) with responsibilities for works services to normal peacetime standards.

*"Out of Area".* Out of Area works are defined as those taking place in areas where there is no existing works organisation—either in peace or war and normally without the prior opportunity for reconnaissance.

The wide variety of works service responsibilities, in differing scenarios, is further complicated by the variety of equipments that may be employed for a particular type of service. This is to be expected world-wide but even in BAOR, with a few exceptions,



Captain H J Mitchell
Are We In Control of the 90's

**Photo 1.** WO2 G Letties (who took part in the recce to BAOR) instructing students on an Electrician RE course studying control engineering at the RSME Chatham.

each installation is unique: for example there is no standard boilerhouse or air-conditioning system. This situation is already acknowledged in that most technical instruction in the Corps is directed towards principles rather than equipments. It follows that formal training in control engineering must also adopt this approach; with such a variety of services, equipments and scenarios there is little choice. What therefore are the implications of a policy of teaching principles only?

If a student is only taught the principles of a subject he cannot be expected to have an immediate intimate knowledge of the specific installations for which he is made responsible. Time is required to "get to know the patch". Sapper efforts in war would concentrate on essential installations including airfields, static operations and communications centres, hospitals and bulk fuel supply. At present, dossiers containing detailed information on essential installations are maintained by specialist RE units. The continuation of this dossier policy would be essential. Dossiers provide a detailed up-to-date record of each installation which is so essential in reducing the familiarisation time required for a particular installation. The process of compiling dossier notes also familiarises anyone working on a particular installation. This increase in personal knowledge (or experience) will also reduce familiarisation time for similar installations.

In peacetime, anyone involved with outside agencies can afford to take longer with the familiarisation process. He would belong to an organisation that has a pool of expertise for the area and invariably will have civilian colleagues, employees and contractors who are familiar with the installation for which they are jointly responsible.

For Out of Area tasks at present, action is simply dependent on the experience of the individual who happens to be sent to the area. The aim in future must be to give everyone sufficient formal training to meet a minimum acceptable level of competence.

Overall it has to be accepted that the individual training organisation (ITO) cannot prepare a person to be immediately familiar with all of the works services for which

Royal Engineers are responsible. The use of dossiers and "on the job" training is essential to building and maintaining a pool of expertise within the Corps.

## Training Objectives

Having stated that there is a very wide range of control systems for which the Royal Engineers are responsible, the same basic principles can be applied to them all. All systems comprise a combination of basic components; the media used for control systems (electronic, pneumatic etc) form a relatively short list and it is possible to demonstrate typical control applications for various works services which generally would not differ greatly from those found in practice.

At professional and technician level the Professionally Qualified Engineer (Electrical and Mechanical), Garrison Engineer and the Clerk of Works (Electrical) and (Mechanical) should logically be responsible for control engineering. At artisan level, the Electrician RE and the Fitter group of employments are the most likely candidates. Formal training on control engineering, for those services for which the Corps is likely to be responsible, should aim to achieve the following broad objectives:

*At professional level,* training should provide a thorough understanding of the general principles of control engineering together with a knowledge of typical control applications and the capabilities of Technician Engineer and artisan employments.

*At technician engineer level,* training should provide a thorough understanding of the basic principles of control engineering together with a knowledge of typical control applications for which their employment within the Corps is responsible and the capabilities of their artisan tradesmen.

*At artisan level,* training should provide an understanding of the typical control applications for works services for which their employment within the Corps is responsible and should teach the capability to install, adjust and carry out repairs to such systems.

The achievement of these objectives would enable professional and technician engineer employments to compile detailed dossiers given time to investigate a specific installation, understand dossiers and supporting reports, direct artisan employments and determine the best course of action on unfamiliar control systems. In respect of the latter it is worth noting that few control systems are indispensible; if necessary, systems can be switched from "automatic" to "manual" or dispensed with altogether. This may cause less efficient operation or attract more manpower but the basic service can generally be maintained.

Artisan tradesmen would be able to undertake work on services and their control systems as a complete entity and carry out fault location, adjustments and repairs as appropriate.

## Detailed Requirements

The study has identified in detail the material required to meet the broad objectives given above. A comparison of the control engineering material currently being taught against that now considered necessary shows that a great deal is already covered during course phases dedicated to control engineering. Additionally, controls are being covered in course phases not specifically dedicated to the subject, for example clerk of works (mechanical) students cover heating and air conditioning controls while studying these topics and fitters studying power hydraulics are engaged in a form of control engineering without being aware that this is so. Overall it has been discovered that the situation requires fine tuning rather than major surgery.

It is estimated that the additional material that is required for professional and technician engineer levels could be covered without increasing overall course lengths. It is difficult to predict accurately the effects on artisan courses as most of these have still to have detailed syllabi produced as part of the follow-up to the Jolley Study. However, the indications are that course lengths will not need to be increased.

The study has identified some equipments/techniques that are standard and proposals to include these in future training are currently being considered.

## Conclusions

The range and number of types of control systems for which the Royal Engineers are responsible are extremely large and, with a few exceptions, this prevents the teaching of specific equipments. Formal training must therefore adopt the policy applied to teaching most other technical subjects—the application of principles.

It will be essential to continue to maintain the dossier policy for installations in order to reduce time for familiarisation and increase individual experience at all levels. Formal training should therefore provide sufficient foundation material, in the form of principles, to enable individuals to build upon it.

Existing formal training on control engineering is not too far off the mark; some existing material requires amendment and some new material is required but the net increases in training time are relatively small and can probably be absorbed within existing course lengths.

## The Future

At time of writing the recommendations of the study with respect to course syllabi and scheduling of the material within the respective courses have been circulated and generally agreed. Work is now well in hand to implement these recommendations to enable the Corps to continue to meet its works services and associated controls responsibilities into the future.

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# The Bailey Story – a Tribute to Sir Donald Bailey Part 1

COLONEL J H JOINER B Sc(Eng), C Eng, MICE, FI Struct E

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## Introduction

The fortieth anniversary commemorations marking the end of World War II and the recent sad death of Sir Donald Bailey bring to mind the background story to the bridge that bore his name, and prompt this short article on its early development and its subsequent evolution. The Bailey Bridge was most certainly one of the major inventions of the War, ranking alongside, for example, the jet engine and RADAR. Without doubt the bridge did much to shorten the course of the war, a view expressed by Montgomery who wrote, in 1947, "Bailey Bridging made an immense contribution towards final victory in World War II. As far as my own operations were concerned, with the Eighth Army in Italy and with the 21 Army Group in N W Europe, I could never have maintained the speed and tempo of forward movement without large supplies of Bailey Bridging."

Military Bridges have always been required by armies, in order to maintain the mobility of the armed forces. During both the advance and the retreat existing bridges are an obvious target for an enemy, since their destruction can seriously reduce the mobility of an army and allow valuable time for an enemy to deploy his own forces. It follows that it is essential for an army to have at its disposal equipment to enable it very rapidly to replace demolished bridges, and responsibility for the development of such equipment for the Royal Engineers was given to the Experimental Bridging Company RE, at Christchurch, in 1919. In 1925 the military unit was disbanded and replaced by the Experimental Bridging Establishment, or EBE, with both military and civilian staff. It was soon after this, in 1928, that Donald Bailey came upon the scene. Bailey was born in 1901, in Yorkshire, and was educated at Leys School, Cambridge, and then at the University of Sheffield where he obtained a Bachelor of Engineering degree in 1923. He took up employment with Rowntrees of York, and after subsequent spells with the LMS Railway and the City Engineers Department at Sheffield, during which he was involved with civil bridge design, he came south to Christchurch, in 1928, to join EBE as a civilian designer. In those days, and indeed right up until the considerable World War II expansion, EBE worked on a shoestring, with a very small staff and few resources. In this they were not alone; the early and mid thirties were for the whole Army a lean period, the campaign for dis-armament resulting in all things military being out of favour, with very little developement work in hand.



Colonel J H Joiner
The Bailey Story A Tribute To Sir Donald Bailey part (1)

**Photo 1.** Sir Donald Bailey in his 81st year. A 1982 portrait by Gareth Bell.

By 1936 Germany had re-occupied the Rhineland, war clouds began to gather and the tide turned. It was realised that we had a small out-of-date army with practically no modern equipment. For the Sappers in particular, the introduction of new and heavier tanks meant the re-design of our bridging equipment to carry the greater loads. By the outbreak of the War we had up-dated our bridging equipment as far as possible and despite some shortcomings the Sappers were well served, at least in quality if not in quantity. The equipment then in use was the Small Box Girder Bridge and the Mark V Pontoon Bridge for loads up to 24 tons, and the Large Box Girder and the Hamilton Unit Construction Bridges, both fairly slow to build, for loads up to 30 tons. A certain amount of this equipment was sent to France but little was used and all was destroyed or captured prior to Dunkirk.

It soon became clear that still heavier tanks would be needed for the eventual counter-offensive against Germany and thus in 1940 the Churchill Tank was being developed at a weight anticipated to be between 40 and 45 tons. Although the two Box Girder Bridges could be stretched to take the heavier loads, in both cases this involved use of the slowly constructed four girder versions of the bridges, and also meant a considerable reduction in span capability. An alternative solution was therefore needed and it was proposed that this should be provided by a Mark III version of the Inglis Rectangular Bridge. This was a redesigned version of the Mark I and Mark II Inglis Bridges, which were built from tubular members built up into Warren girders. All three versions of the bridge were designed by Professor C E Inglis of Cambridge University, a Sapper major in World War I and later to become Sir

# The Bailey Story A Tribute To Sir Donald Bailey part 1 (1)

**Photo 2.** Light tanks crossing a Mark III Inglis bridge; note the knee bracing and the use of the extra truss members at mid-span.

Charles Inglis. In 1940 a first-off production test loading of the new bridge was carried out at the EBE and unfortunately the top chord of the bridge buckled under the test load. Subsequent modifications to the bridge complicated the design and it was considered that mass production of the bridge would have been difficult. Although the bridge was brought into service, it soon became relegated to rear area use.

## The Birth of the Bailey Bridge

The way was thus open for an alternative design to meet the requirement for a new 40 ton capacity bridge. It was late in 1940 that Major S A Stewart RE (now Brigadier S A Stewart CBE (retd)), Superintendent of EBE, and Donald Bailey were returning from Cambridge, having been to see a trial on Inglis Bridge modifications. They discussed the complication produced by these modifications, and it was at this stage that Bailey produced the legendary envelope from his pocket, using it to sketch out his ideas for a new bridge made from panels. He had had the basic idea at the back of his mind for some years and it had been briefly discussed at EBE, but no detailed work on the idea had been undertaken. Further investigation was authorised immediately and work started next morning, the actual design work being carried out by Donald Bailey, who was now Chief Designer at EBE with a very much larger staff, and Captain H A T Jarrett-Kerr RE (now Brigadier H A T Jarrett-Kerr CBE (retd)), who did much of the detailed design work. Over the years EBE had built up a considerable experience of the shortcomings that could arise with equipments and with this in mind guidelines were drawn up for the new design. These included the following:

Maximum flexibility to be aimed at, enabling the bridge to be used, if possible, as a pontoon bridge as well as a fixed bridge, and with a deck and girder system that could be strengthened at will, preferably in-situ, to cope with a wide range of spans and bridge loads.

All parts to be made from readily available materials, avoiding the use of

aluminium alloys, for which aircraft production had priority, and making full use of welding.

Parts to be capable of manufacture by almost any engineering firm, and with reasonable tolerances to make manufacture straightforward.

All parts to fit into a standard GS 3-ton lorry, and with no part exceeding a six man load.

Early calculations showed that a panel of suitable size to fit into a 3-ton lorry and capable of being carried by six men, could be made up into a 120 foot bridge with a load capacity of about 45 tons. Formal approval was therefore given for work to start on the design proper. The concept was for a "through" type bridge, the girders being made up of the panels and supporting the roadway between them. Various forms of construction for the panels were considered, using for example M, N and K bracing; the final version used two 4 inch by 2 inch rolled steel channels for both top and bottom chords, welded either side of 3 inch by 1½ inch rolled steel joist vertical web members and diamond bracing members, in the now familiar pattern. Two additional vertical members, forming diagonals to the diamond bracing, were eliminated at an early stage, once testing proved that the stiffness of the welded joints was adequate.

At this stage EBE staff were working flat out on the project and for some time the drawing office staff were putting in a ninety hour week. As a result preliminary design work was completed within two months and the first bridge was manufactured and ready for trial three months later, that is by May 1941. The manufacture of the pilot model was outside the capacity of the EBE workshops, and Braithwaites were selected to make the 120 foot double truss double story bridge needed for the testing; minor items of the equipment were designed one by one and made in EBE workshops.

Because of the indeterminate nature of the structure, it was decided to subject the pilot model of the bridge to an extensive test programme. Early in the war the Structural Engineering Committee, set up by the Scientific Advisory Council, had recommended a static load test involving application of a test load 50% in excess of the maximum design live load, including impact, applied at maximum eccentricity; the test load was to be applied eleven times, with no increase in permanent set between the tenth and eleventh application. Such a test necessitated application of a load in excess of 90 tons, applied over a deck length of 10 to 12 feet, a far greater load than had ever been applied before at EBE. This test load was eventually achieved by positioning a 1917 Mark V tank at mid-span, and then using an early No1 Tank Bridge as a ramp to drive two smaller tanks up on to a platform built on top of the Mark V tank. The heavy tank was then filled with pig iron and some tons of steel beams were added to the load where ever possible. Jacks and safety packing had previously been placed at mid-span, and the load was then applied to the bridge by jacking down at the centre of the bridge, the load remaining in position during eleven applications. In addition a number of tests to destruction were carried out, failure under bending always occurring by local lateral buckling of the top chord of a panel, whilst shear failure always occurred by buckling of the end upper diagonals in the end panels of the bridge. As a result of these tests and after some weeks of adjustment of test loads and spans, a provisional table of safe loads was drawn up for use by the Sappers. At a later stage wind load tests were carried out at the National Physical Laboratory, using 1/13 scale models of the bridge.

The bridge passed the test programme with very few modifications, and in two months was formally accepted for production. In anticipation of this, a number of firms had already been forewarned and orders for materials had been placed. Thus within five months of production being put in hand, the first bridges were with the troops. During the early stages of production vehicle loading trials, launching trials and troop trials were held, so that construction drills could be finalised for the issue of a provisional user handbook.

**Photo 3.** A Double/Single bridge under test load in early 1941. Donald Bailey is in the foreground, in his familiar sports jacket and cloth cap.

## Into Production

At this stage a brief description of the bridge as it went to production would be useful. The two main girders were formed from the basic panels, arranged in either one, two or three trusses either side of the bridge and additionally arranged in either one, two or three storeys. Each panel was approximately 10 foot by 5 foot in size and weighed about 570 pounds, a convenient six man load. Male and female jaws were fitted at the four corners so that panels could be assembled into trusses using steel panel pins. Extra storeys could be added using chord bolts to bolt on the additional line or lines of panels. A timber chess decking was supported on light steel stringers, in turn carried by 18 foot long steel transoms. Either two or four transoms could be used in each bay of bridge, depending upon the load to be carried; the transoms were fixed to the bottom chords of the panels to produce a through bridge with a roadway width of 10 foot 9 inches between the ribands. The combination of varying numbers of trusses, storeys and transoms gave great flexibility of construction, ranging from the 90 foot Single/Single Class 9 bridge up to the 240 foot Triple/Triple Class 9 or the 150 foot Triple/Triple Class 70 bridges. (*Note* In this context "Single/Single" means that each bridge girder is single truss and also single storey, and so on, whilst "Class 9", for example, implies a live load capacity of approximately 9 tons). The bridge was normally constructed at right angles to the river, on rollers, and was then cantilevered forward across the obstacle, as building preceeded, until the skeleton launching nose landed on the far bank rollers. As construction proceeded the bridge was boomed out further whilst the nose was dismantled, until the bridge was in its final position for jacking down on to base plates.

A high strength structural steel developed from the BSS 968 weldable quality steel was used for the chord and web members of the panels and for the transoms. The BSS 968 specification was modified to improve weldability by adjusting the carbon content, which had the effect of raising the yield point from 21 to 23 tons per square inch. Once initial problems of welding jig design had been overcome, the welding of

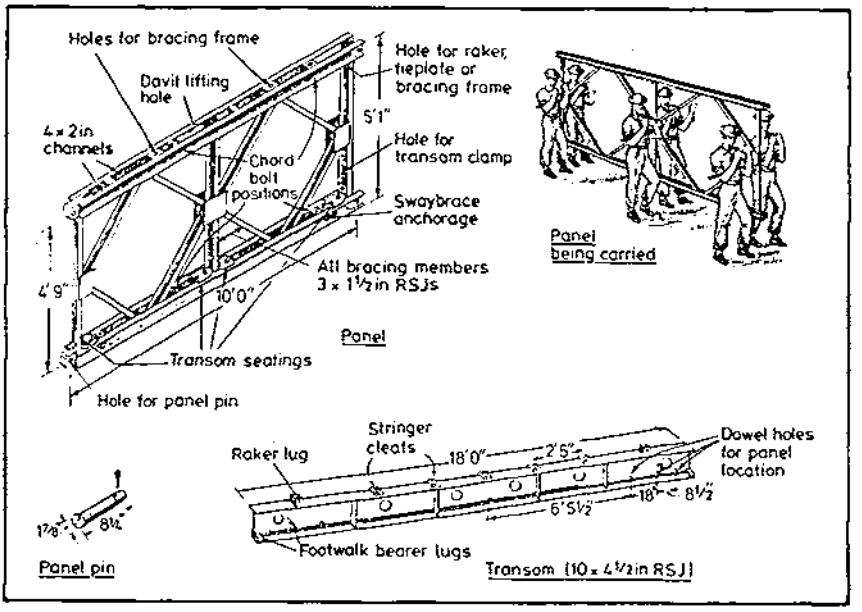


Figure 1. Details of the Bailey panel and transom.

the high tensile steel did not present any great difficulties, those troubles that did arise being mainly due to the difficulty of controlling the alloy content of the steel, since there is little margin between weldability and the point where welding can not be guaranteed, once the upper limits of carbon and manganese content are approached. A manganese-molybdenum alloy steel was used for the panel pins, with a yield of about 65 tons per square inch, whilst all other components such as stringers and sway-brace, and gussets, jaw blocks and small components of the panels, were formed from normal BSS 15 mild steel.

One interesting problem arose from the need to distinguish easily, in a foolproof manner, the high tensile steel sections destined for Bailey from normal rolled sections. The solution was to paint a green line down the centre of the Bailey sections. However this was followed by an outbreak of weld cracking, and it was only after very careful investigation that this was traced to sulphur absorption from the paint used; the trouble was completely cured by the specification of a sulphur free oil-bound distemper.

The jigging and gauging of components during manufacture was of particular importance, in view of the necessity for all similar parts of the bridge manufactured to be absolutely interchangeable; this was no mean feat considering the vast production runs, the great number of small firms engaged in production, and the extensive use of black-rolled sections which could vary considerably in dimension and trueness. Jigs used were of two types; the welding jigs held together all loose components in their correct position prior to and during welding; and the drilling jigs held complete components prior to drilling to ensure the absolute correct relationship between holes and other features. The procedure adopted for manufacture of the panels was first to weld up the chords complete with jaw blocks, and then to weld in the verticals and diagonals between the two cords using a second jig. A period of 48 hours was allowed to relapse before the main pin holes were drilled, using a drilling jig, to ensure cessation of shrinkage and adjustment of residual stresses resulting from the welding.

With so many firms involved in the manufacture, and with no choice, in war-time, other than to make use of inexperienced labour, it was initially decided to proof load

all panels, to ensure that they were up to the required standard. This was done by setting up panel testing centres, at which all panels were in turn built up into a continuous girder, which was slowly moved forward, tested panels being uncoupled at the front as new panels were added at the back. Test loads applied were 55% above working load in shear and 17% above in bending. Each centre was capable of testing up to 500 panels a week, working flat out at 16 hours a day. However, once production had peaked at over 25,000 panels a month, the task of testing became such that only a 10% sample could be dealt with, pending design and installation of more compact testing machines which enabled 100% testing to be resumed. It is interesting to note that with over 70% of the UK panel production being tested, and with total production running into hundreds of thousands of panels, only 140 panels had to be rejected for welding defects, with a further 131 rejected because the steel was below specification.

Without any doubt the story behind the early development and manufacture of Bailey is one of great success. To summarise the initial programme, design work started in December 1940, the pilot model was ready for test in May 1941, production started in July 1941, and the first bridges were with the troops by December 1941. Braithwaite and Co were the first firm to undertake full scale mass production of the panels, but eventually some 650 British firms became involved in the manufacture of Bailey, firms of all types from the conventional engineering firm to the confectioner and football pool proprietor brought in to help with the war effort. In the last three years of the war over 490,000 tons of Bailey Bridges were manufactured, representing over 200 miles of fixed bridge and 40 miles of floating bridge, for use in all theatres of war; manufacture included almost 700,000 Bailey panels, almost enough to build a single bridge girder from Christchurch to Leningrad!

The Americans manufactured about 20 miles of the bridge for their own use, which they preferred to call "The Panel Bridge—Bailey Type". Their design was slightly modified to take account of differences between British and American standard rolled sections, resulting in a slightly heavier panel. Initially the incorrect gauging of some American components meant that not only would some American parts not couple with British parts, but in some cases American parts would not join with each other. Early teething troubles were overcome however, and eventually all panels and endposts were completely interchangeable, incompatibility remaining only in the case of some minor components.

*This article was first printed in* Metal Construction *Vol 18 No 9 in September 1986*

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# Asahi Beer In a Small World

LIEUT COLONEL G E P MULHERN, OBE

BEFORE World War II, the Dai Nippon Company Limited, of Tokyo, Japan, produced a lager, specially brewed for export, called Asahi Beer. For all I know, it may still do so.

The international and Japanese settlements in Shanghai in the thirties provided the main market for this bottled beer which was slightly cheaper and, to my taste, inferior to its only competitor, a beer called "UB"—the initials of the local United Breweries. Both brews could be fairly classed as slightly refined "onion water". Undoubtedly in a hot climate, however, millions of gallons were consumed.

When I left Shanghai in 1936 after nearly four years with the RE Detachment at Area Headquarters, I thought I'd seen and heard the last of Asahi Beer or "Ash-Eye" as it was known by the troops—but not so!

IT was on 4 November 1942 when Eighth Army broke through at Alamein where, since the 23 October, the battle had raged.

The Deputy Chief Engineer, under whom I was serving as Staff Captain, was located with Rear Eighth Army HQ, a few miles back from Alamein and, on the 5 November, orders came for us to move forward on the 7 November.

About that time, a phone call from the Engineer-in-Chief at GHQ Cairo advised that, in anticipation of extensive damage to our water pipeline west of Alamein, by the retreating enemy, a stated mileage of 11 inch piping was en-route by rail and 72 CRE (Pipeline) was to be informed accordingly.

So off I hared to the desert camp where I had recently visited the CRE only to find that the unit had already moved off. As good Sappers they had left the area tidy—all rubbish buried etc, but, lo and behold, probably considered "unburyable" in the time, were several wooden crates (empty of course) labelled "ASAHI BEER" and marked with a conglomerate of Japanese characters.

How in Rommel's name did the beer get there? But, over the 7000 miles from the Far East, I didn't doubt that it had travelled well and was guzzled with gusto!

Incidentally, CRE (Pipeline) (Lieut Colonel Abercrombie (Crombie) Armitage) duly received the message and the piping.

FOLLOWING the successful conclusion of the North African campaign, the assault upon Sicily took place on 10 July 1943. At this time I was attached to 72 CRE (now Lieut Colonel S R Shaw) in *TRIPBASE* (ie Tripoli), one of the main ports from which the invasion was launched and some forty years later, Colonel Gadaffi's capital. Of the hotels on the palm tree lined esplanade, the Grand, was centrally sited and put to excellent use as an officers' transit hotel. There, any officer could obtain a daily tuppence worth of gin on presentation of a unit chit—or perhaps an extra tot from the odd officer who might be disinterested. One drank this comforter from odd receptacles ranging from shrimp paste jars to sawn-off sauce bottles. They did nothing to impair the taste!

Just a few days after the invasion of Sicily Lieut Colonel Shaw and I called at the Grand for our twopennorth and looking around the lounge we spotted an unlikely looking pair of very elderly men seated in a corner. One was bald and so tubby and his trousers so ill-fitting that some three fly buttons had to remain unfastened. The other was skeletal skinny with a goatee beard. Both wore American GI type shirts and slacks (or in the fat man's case, tights).

Shaw was so intrigued that he approached and asked if we might join them. A strong southern American acent gave us the "OK".

It transpired that each man was a Captain of a "Liberty" merchant ship (Mr Kaiser produced one a day for Mr Roosevelt) which formed part of the supply convoy in support of Monty's invasion force. Both Captains had lost their ships by dive bombing at Augusta but were fortunate enough to be rescued, roughly kitted out and sent to Tripoli en-route for the States and, hopefully, new ships.

I remember one of the sunken ships was the *Thomas Pickering* and one of the men was Captain Svensen. The other names escape me. Lieut Colonel Shaw forthwith invited them to our mess—a lovely villa just a quarter of a mile away.

Captain Svenson sat next to me at our bully beef dinner and engaged us with tales of how he'd met this other Captain twenty years ago in New Orleans and had not seen him until they had encountered each other in the water at Augusta. He also said that late in 1941 he had just unloaded a cargo in Shanghai when the imminent occupation by the Japanese decreed that he should "beat it" and quickly. Not wishing to leave empty handed, as it were, he thought he'd try and find a worth while cargo and of course he found one. You've guessed it—Asahi Beer. And to which port did he bring this beer—why, "Sooezz" as he pronounced it.

The subsequent distribution obviously included the odd desert unit, as evidenced by the empty crates in rear of Alamein. One mystery duly solved!

# Professional Jet-Setter Royal Engineers

CAPTAIN M R H BURROWS B Sc RE

*Captain Burrows was educated at Downside and then went on to Exeter University with Army sponsorship to read chemical engineering. He was commissioned from Sandhurst in 1981 and took up an appointment as troop commander in 25 Field Squadron RE in Iserlohn. In 1983 he spent four months in the Falkland Islands with the Squadron and then was posted to 1 Training Regiment where he spent much of his time shooting at Bisley! He took up his appointment with 512 STRE in January 1985.*

"PROBABLY the best job in the British Army"... Commander of Dhekelia Garrison Cyprus.

"It's jobs like yours that make us realise how interesting the Forces can be at times"... British Representative in Diego Garcia, British Indian Ocean Territories.

"... and you just put it on your MOD American Express Account"... Manager of the Equatorial Hotel in Singapore.

"... but do you ever have to wear a uniform?"... Commander British Forces Ascension Island.

"Hey jee, are you British, honey? Could you just let me hear that again? Your accent; it's kinda cute"... Air stewardess in Atlanta, Georgia.

*Prologue*

512 Specialist Team Royal Engineers is a small unit which works closely with the US Defense Mapping Agency in Washington DC. I was OC No 3 Doppler Section which is responsible for operating three static satellite tracking stations on Ascension Island, Cyprus and Diego Garcia. Tracking navigation and scientific satellites is our main business but needless to say, throughout the year a number of other tasks occur; just to keep us on our toes.

*Posting In—Washington DC*

The first two weeks of this posting were spent "cruising around Downtown DC" picking up US ID Cards, learning about tracking satellites, meeting "stax of folk", understanding data communication systems, meeting even more folk, comprehending American football and of course mastering the art of operating seven litres of engine "under the hood" on the wrong side of the road without a shift stick (ie automatic). After a fortnight's introductory course the cultural adjustment had been made and I was given my first assignment. As it happened, the GEOSAT Satellite was about to be launched and a new tracking station had to be set up on Terceira Island in the Azores.

*Azores*

I am sure that the Azores is a good place to be in the Summer but as the Honorary Consul remarked, "In February we get most of our rain . . . ".

Terceira itself is one of the less developed islands in the Azorean archipelago. Earthquakes have occurred, tap water was brackish, high winds (up to 120 knots)



Captain M R H Burrows
Professional Jet Setter RE

**Photo 1.** SSgt Al Barnes RE guying the antenna on the Azores.

seemed to be normal and electricity appeared to be an optional extra. The town of Praia da Vittoria had a couple of restaurants which served beef on Thursdays, but the speciality was the chicken claw soup. To add to all this, the Portuguese escudo was depreciating at a rate of one a day against the US dollar which of course made accounting all the more fun. The good things, however, included excellent but cheap booze, a golf course and an attractive Portuguese tutor. After five weeks, however, my job was done. SSgt Al Barnes (now WOII) had arrived and GEOSAT was quite happily bleeping in its correct orbit.

*Cyprus*

Lisbon, London and Brize Norton were visited during the next week. Captain Rob Henderson was met at 2am at Brize Norton en route to Cyprus to begin a job handover programme of the static stations. Cyprus these days is unfortunately a little unsettled. The Lebanese seemed to be flocking in from Beirut by the shipful, riots have occurred in Limassol, the PLO shot Israelis and recently an attempt was made on the British High Commissioner's life. Nonetheless, the brandy sours were still good and there seemed to be no limits to windsurfing, diving, water skiing and topless Swedish tourists. 62 (Cyprus) Squadron RE are based in the same garrison and on a number of occasions welcomed us into their fold. But all good things must come to an end and after three weeks it was time to move on to pastures new—next stop Ascension Island.

*Ascension Island*

Most folk that have been "down South" are aware that Ascension Island is nothing more than a lump of extrusive volcanic rock with a green bit at the top (called, not surprisingly, Green Mountain). When one has to live there the Island becomes more interesting, particularly around the shores where both diving and fishing* are superb. Major Hilary Nash from the Junior Leaders Regiment was involved in a diving expedition and there was even a rumour that gold had been found in one of the

* *Footnote:* For those piscatorially minded, the 512 STRE record now stands at 166lb a yellow fin tuna/tunny which took 3 hours to play on a 100lb breaking strain rod, drew out 500m of it, broke the rod and dragged our boat for 2 miles.

Professional Jet Setter RE (1)

**Photo 2.** The team on Cyprus: Michelle Rogan USA, the author, and Sgt George Petrie RAF.

**Photo 3.** The author at Geoceiver tracking station, Ascension Island. Green Mountain, shrouded in mist, in the background.

Professional Jet Setter RE (2 & 3)

**Photo 4.** The lagoon surrounded by the thin land form of Diego Garcia provides a natural harbour for the US Navy's Indian Ocean Battle Group.

countless wrecks. All I have to show for many hours under water is a marvellous collection of copper rivets.

Not having seen the boss now for at least three months, I felt the urge to return to Washington DC—via Antigua and Florida.

*Sigonella, Sicily*

A new set of orders were issued and after five days in DC I was on an aircraft bound for US Naval Air Facility Sigonella in Sicily. Here the US Navy presumes that all in-bound captains are navy captains. I normally did not go out of my way to put them right and consequently had to suffer their VIP treatment, but that beats standing in queues any day! Diego Garcia was next port of call.

*Diego Garcia*

With a length of 20 miles Diego Garcia is one of the larger atolls in the Indian Ocean. The island itself forms a lagoon which is used as a harbour for the US Navy's Indian Ocean Battle Group. It is also ideal for sailing, windsurfing and fishing. Water skiing is not permitted owing to the shark hazard. There is no indigenous population but suffice to say there are nearly 3000 Americans, 2500 Filipinoes and Mauritans and 39 British Naval Party 1002. The British own and administer the island, the Americans finance the developments and the Filipinoes seem to run the place. Food and water are a little limited unless of course you become addicted to sharks and coconuts. Diego Garcia graffiti reports, "Take a bite for mankind, eat a shark".

Two and a half weeks on this tropical island seemed to go quickly. Difficulties had developed in Cyprus and the quickest way to get there happened to be via Singapore.

The next six months or so were spent island hopping between Ascension, Cyprus and Diego Garcia with other odd tasks in places like Nairobi and Bath Spa. It soon became possible to anticipate where problems might occur and arrange to be in the right place at the right time. On average, two weeks were spent in each location and a great deal of time was passed sitting, standing, sleeping and reading on aircraft of all different shapes and sizes.

Christmas and New Year were spent in the Southern hemisphere on Diego Garcia. A number of goodies such as mince pies and Christmas pudding had recently been purchased in Hong Kong, so Naval Party 1002 was able to host a proper British Christmas party on the beach. Windsurfing on Christmas day was essential to complete the festivities, so a number of us took to the water and terrorised a few unsuspecting turtles. Just to make us feel totally at home the weather became somewhat inclement. A cyclone had developed a few hundred miles away and we experienced eleven days

of torrential rain (which ruined the suntan). In the New Year, however, there were strong rumours about a posting and even that a successor had been nominated. So it was back to Washington DC on one of the infamous Arrow Air DC8s.

*Posting Out—Washington/Cyprus*

Captain Eric Putter arrived in Washington to take on this task of professional jet-setting. Accounts, reports, outstanding work programmes and girlfriends were all handed over (and signed for). UK in February is generally unpleasant, so the "stores handover" *had* to take place in Cyprus and it seemed like a good place to take some leave.

Skiing in Cyprus is generally adequate for amateurs at this time of year and it is possible to attend *SNOW QUEEN* style courses. Israel, Egypt and Jordan are close enough for weekend visits (PLO permitting). The Troodos mountains were alive with mistle thrushes which had recently migrated from the Carpathian Hills and the new born lambs were being castrated. Consequently every other meal seemed to contain "little birds" and sweetbreads.

*. . . And Finally*

Altogether I had a fun year seeing strange parts of the world and meeting even stranger people. The total distance travelled was 120,000 miles, equivalent to five times around the world, and the number of countries visited came to fourteen. "Eat your heart out Dr Kissenger!"—if you will forgive the transatlantic expression. Liaising with Americans, Portuguese, Kenyans and the RAF proved to have been a valuable experience and has certainly restored my faith in our own system.

JDSC, PQS2 and the other necessary evils of life were starting to rear their ugly heads. It was time to finish my hard earned leave in Jerusalem and go home.

# Memoirs

## GENERAL SIR FRANK SIMPSON GBE KCB DSO

*Born 21 March 1899, died 28 July 1986 aged 87*

FRANK ERNEST WALLACE SIMPSON, the son of Major R W Simpson, was educated at Bedford School and the Shop, from which he was commissioned into the Corps in May 1916. The inspecting officer at his commissioning parade was Lord Kitchener, just two weeks before the latter's death at sea in *HMS Hampshire*. He served with a field company in France and Belgium in 1918 and was mentioned in despatches.

In 1919 he went to India to join the Royal Bombay Sappers and Miners. He was just in time to go on active service again in the third Afghan War of 1919. As a member of 24 Field Company, 3rd Sappers and Miners, he took part in 4 Indian Division's successful assault on Spin Baldak. He then spent two years as Adjutant at Kirkee.

He returned home to Chatham in 1930 from where he went to the Staff College. CLR remembers: "We found him—aged 31 a veteran of two wars—very friendly and remarkably approachable. There was no barrier of age or rank. He was sincerely interested in individuals and their problems and took great pains to advise us about India".



General Sir Frank Simpson GBE KCB DSO

After Staff College Frank Simpson completed a Garrison Engineer's tour in London District, a staff tour in the War Office and was then appointed Brigade Major to the Portsmouth Infantry Brigade and Garrison, commanded by Montgomery. CLR: "From the moment that that glittering eye fell upon him, his career was transformed. A creative bond was established between the two men which, despite many stresses, was to survive sound and steadfast until the end of the Field Marshal's life". After a further tour in the War Office he was appointed Assistant Military Secretary to Lord Gort and during the withdrawal of the BEF at the height of the crisis in the Dunkirk operation was made responsible for planning the defence of Arras as a GSO1. He was awarded the DSO for his contribution to that campaign.

After Dunkirk he again joined Montgomery, this time as BGS V, and later, XII Corps; but, in April 1942 he returned to the War Office as Deputy Director Military Operations. So began his great contribution as a staff officer to the winning of the war. He was appointed Director of Military Operations in 1943, as a Major General; was awarded the CB in 1944, and became Assistant Chief of the Imperial General Staff in February 1945. When Montgomery became CIGS in 1946 Frank Simpson was appointed his Vice-Chief in the rank of Lieutenant General. Thus the mutual trust which had built up during their association in the Portsmouth Brigade, and had continued during Mongomery's campaigns in both Africa, Sicily and North West Europe (demonstrated by the considerable correspondence which Montgomery had maintained with Simpson during those years), was now to be continued in establishing the post-war Army.

In March 1948 he was appointed GOC-in-C Western Command and promoted General in 1950. His last tour in the Army was as Commandant of the Imperial Defence College but before he retired in April 1945 he spent three months lecturing, on behalf of the Foreign Office, in the United States on the British defence effort.

In 1947 he was made a Knight Grand Cross of the Order of Orange-Nassau (with Swords). In 1951 he was awarded the KCB and appointed ADC General to King George VI and remained an ADC General to our present Queen until 1954. In 1953 he received the GBE. In January 1954 he became a Colonel Commandant of the Corps and he was Chief Royal Engineer from March 1961 to June 1967. He was Colonel Commmandant of the Royal Pioneer Corps from May 1950 to November 1960. In 1934 Frank Simpson had married Dulcie Cooke, niece of a former Commandant of the Royal Bombay Sappers. After his retirement from the Army, they made their home in Essex where, in 1955 he became a Justice of the Peace for the Beacontree Division and, in 1956, was appointed a Deputy for the County.

In 1961 Sir Frank Simpson was appointed Governor of the Royal Hospital Chelsea. The Royal Hospital book *A Village in Chelsea* bears witness to the success of his eight years there where not only were four major building projects undertaken, the fruits of his determination and skill at dealing with bureaucracy; but also where he left an enduring memory as a communicator establishing a personal relationship with the pensioners and placing them firmly in the public eye. The rebuilt Simpson Wing remains a permanent memorial to his work and a symbol of a great and charitable man.

*CLR, EICJ, JHN, THFF*

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# LIEUT GENERAL SIR CLARENCE BIRD, KCIE, CB, DSO, FRSA

*Born 5 February 1885, died 30 July 1986 aged 101*

CLARENCE AUGUST BIRD was commissioned into the Corps from Cheltenham College in 1904. After a short spell in Works Services, he joined the 1st Prince of Wales Own (later Bengal) Sappers and Miners at Roorkee in 1909 and saw service there, at Rawalpindi and in Chitral in command of a section of 4 Company. His impressive photographs of Chitral are now in the Corps library. His nickname *Chiriya*, Hindustani for bird, was given him early in his career by the Pathans of 4 Company to distinguish him from his company commander Captain (later Colonel) A J G Bird who later preceded him as Commandant at Roorkee. He mobilized with 1 Company for the Abor campaign but the operation was postponed and when it went ahead in August 1911 he was otherwise engaged. He was on extended furlough in the UK when World War One began but rejoined 4 Company in Egypt on its way to France as part of the Indian Expeditionary Force, arriving in October 1914. An account of the fierce fighting near Givenchy in December 1914 in *The Indian Corps in France* says "There as usual, where danger was, the Sapper was found in the person of Lieutenant Bird RE with a few of his men". He remained in France until July 1917 apart from a spell of seven months recovering from wounds received at the second battle of Neuve Chapelle in March 1915. He was three times mentioned in despatches and won the DSO; his final appointment in France was as staff officer (brigade major) to the Chief Engineer, after which he returned to Roorkee where he was appointed Corps Adjutant until he went to the Staff College at Quetta in 1921. His time as Corps Adjutant was particularly influential on the newly joined subalterns. A recurring theme in recollections is his helpfulness, the welcome he gave by meeting new arrivals personally whatever the time of day or night and, a characteristic retained throughout his long life "the courteous manners of a bygone age, a trait deeply rooted and not a facade".

A staff tour as DAAG followed, at Army Headquarters, India; and a tour at the SME, as brevet lieut colonel, until he returned to Roorkee as Commandant of the Bengal Sappers in 1930.

Towards the end of 1932 the three Corps of Sappers and Miners in India were reorganised and had to absorb the recently disbanded Corps of Pioneers. This produced very serious problems due the racial caste society. The Pioneer Mazhbi Sikhs and Meo Mohammedans were not readily acceptable as fellow Sappers to the relatively high caste Jat Sikhs and Punjabi Mohammedans of the Bengal and the Bombay Sappers and Miners. When "Chiriya" Bird arrived in Roorkee as Commandant he had to steer the reorganisation through its difficult course. Not only did he manage to avoid any serious troubles, but he helped to persuade Army Headquarters to issue a new order in May 1933 allocating all Jat Sikhs to the Bengal and all Mazhbis to the Bombay Sappers. The Meos were satisfactorily absorbed and all went well.

In November 1933, Clarence Bird returned to England first as AQMG (colonel) and, in 1935, Chief Engineer Aldershot Command.

At the beginning of World War Two he returned to India as Engineer-in-Chief in the rank of Major General. IHLG writes, "Between 1939 and 1942 he laid the

Lieut General Sir Clarence BIRD

foundation of the vast expansion of the Indian Engineers from 10,000 volunteers in 1939 to 242,000 volunteers in 1945. Then as MGO in India for two years at the height of the war he must have had a vast job trying to obtain equipment for all the new units, not only from overseas but also by the encouragement of indigenous industry". He was awarded the CB in 1940, promoted Lieut General in December 1941 and became MGO India in April 1942, an appointment which he held until his retirement in July 1944. He received the KCIE in 1943.

After his retirement from the Army, Sir Clarence Bird stayed on in India to work in the Department of Food in the Government of India, as Regional Commissioner North West Region, from 1944 to 1945 and as Special Commissioner until 1947. He then became Divisional Food Officer under the Ministry of Food in the UK, in the North Midland Division. In 1948 he went to Africa as Chairman of the Rhodesian Railways. While in Rhodesia he formed the Bulawayo branch of the REA. He retired to live near Cape Town in 1953 and during this time was much involved with St Dunstans, South Africa. He returned finally to England in 1961.

Music had been a life-long interest for General Bird, as performer, concert goer and listener. He was an outstanding violinist and, throughout his service, played with various groupings of instrumentalists as opportunities offered. During his periods at Chatham he took a great interest in the Corps Band and, while at Aldershot, was responsible for the music of two of the tattooes.

In 1919 he married Dorothea Marian Nichols, who was made an MBE and awarded the Kaisar-i-Hind medal and who died in 1982 at Polesden Lacey near Dorking where they had settled on return from Africa. They had two sons, one of whom was killed on active service in India in 1943. The other survives them.

General Bird was born two weeks after Gordon died in Khartoum. He was, by many years, the longest living Sapper, the doyen of the Corps. The vigour he maintained to the end of his life became legendary. MCAH: "He always shook one's hand with a markedly vigorous handshake and his mind was as clear as a bell. When he bade one farewell he always accompanied one back to the car, up a considerable flight of steps, in spite of rain, snow or sleet". And CLR remarks how his interest in world affairs and his sage comments on them were maintained to the last days of his life in which his mental capacity was retained almost unaffected. On his hundredth birthday he was visited at home by a delegation from Regimental Headquarters RE who reported with admiration on the sharpness of his faculties. It was at this time that he recounted from his memory and then wrote down the story of the silver centrepiece, *Winged Victory*, which appears in Volume X of Corps History.

*SMHB, IHLG, EENS, PCB, MBA, EFEA, CLR, MCAH, MCP-P*

## CAPTAIN J C BAGGETT

*Born 17 June 1912 died 13 September 1986, aged 74 years*

Captain Joe Baggett died on 13 September 1986 after a short illness. He was Secretary of the Corps Committee for some twenty-one years from 1951 to 1978. HEMLG writes

"He was dedicated to the Corps and one of the most helpful officers I ever knew".

This sums up the life of a most loyal Corps servant and is an epitaph he would have been proud of.

## COLONEL P A ADAMS

*Born 14 May 1915, died 8 May 1986, aged 70*

PATRICK ARTHUR ADAMS, who died recently after a short illness, was born at Crosshaven, County Cork, and educated at Clifton.

He was commissioned from the Shop in January 1935, joining 33 YO Batch. After the usual training at Chatham he went up to Cambridge, where he developed a life-long interest in oarsmanship and rowed for his college, Emmanuel, both years.

On completing YO training he was posted to the Madras Sappers and Miners, joining a field company on the North West Frontier in the operations against the Fakir of Ipi. Here he gained knowledge of the Pathans which was to stand him in good stead when he commanded an Engineer Battalion during the closing stages of the war; his genuine respect and affection for the "Thambis" was reciprocated by their whole-hearted loyalty.

He came home in 1946, having served in Waziristan, Farikdot, Sialkot and Burma, but was soon abroad again, with the Military Mission to the Iraqi Army. This was followed by eighteen months as OCRE Nigeria and three and half years with the Sudan Defence Force. He was almost thirty-eight by the time he returned to the UK, having served some fifteen years overseas with only short spells of home leave. This may be one reason why he never married.

In March 1953 he took command of 10 Trades Training Regiment at Kitchener Barracks, Chatham, and soon impressed his personality upon the disparate parts of this large unit, a difficult task as its members spent most of the time training under HQ SME control. His enthusiasm knew no bounds; he expected high standards and set an excellent example. An activity which earned him particular notoriety was using his plant trainees to dig up the sloping barracks square, level it and grass it over as a hockey pitch; its first use was however as the arena at which the Corps was given the Freedom of Chatham.

During this time he managed the RE Rowing Club's coxless four which won the Wyfold Championship at Henley and later went on to represent Great Britain in the European Championships, reaching the semi-finals. Pat Adams was President of the RE Rowing Club for five years from 1953, and in 1958 took part in running the Empire Games rowing and became team manager for the British crews to the European Championships. He was Race Controller at the World Rowing Championships in 1975 and later took a prominent part in establishing the International Rowing course at Nottingham.

On handing over 10 Regiment he remained in the Chatham area as CRE Kent, responsible for RE Works Services. His last appointment was Chief Engineer, Home Counties District, at Shorncliffe. He retired from the Corps in 1960, just before his 45th birthday.

After a short time with the Chamberlain Group he became first UK Director General of Young Enterprise, a youth training scheme aimed at developing business acumen, and built up the national organisation; one of the first centres was at Chatham. After ten years he left to join St John Ambulance as Chief Officer, Cadets and Brigade Training, and served as such until retiring in 1980. He was particularly popular amongst the cadets; his annual Brigade conferences were considered tremen-

Colonel P A Adams

companion, looked up to by officers and men alike". He will be greatly missed by all of us, and to his widow, Peggy, and his three children, John, Susie and David, we extend our heartfelt sympathy.

*JStJB, ROHC, OLF, JIP, AHWS*

## CAPTAIN T J P ROBERTS RE

*Born 15 May 1960, died 16 July 1986, aged 26*

It may not have surprised those who knew Tim Roberts well to hear that he tragically lost his life in the Cordillera Blanca of Peru whilst climbing a hard route and leading from the front. That was the style of somebody who often took long falls before he finally climbed a route and who will above all be remembered for being tough and irrepressible.

He joined the Army in 1978 already an accomplished climber and in two years of training at RMA Sandhurst and RSME he made a reputation as a cheerful, robust man who put his all into everything he did. Since this included his social life he had many good close friends.

Climbing was a very strong force in his life and from his first tour at 1 Training Regiment he led a patrol on Exercise MONTE BIANCO as well as taking a full part in REMEC meets and activities.

He also, with a typical casualness that belied his true ability, fitted in a "few games of Corps rugby". His next tour was to 42 Field Squadron in Hameln from where he spent two seasons in the Rockies as an instructor at BATUS. It was here that some of his students discovered that he was not a man to be trifled with. The RV for transport was 1400 at Banff and at 1400 sharp Captain Roberts and party left for Jasper 200 miles away minus two tardy soldiers. In his words "They were not late again".

He was also a great expeditioner. At the last minute he stepped into the breach when someone dropped out of an AMA expedition to Dharmsura. He reached the summit of that mountain in the lead pair as many will have seen on the front cover of *Sapper* magazine. Then, as he had on previous occasions when there was an accident, he stepped into the breach and played a leading role in rescuing the injured man. It was not unusual for him to take a big fall on a climb before succeeding when most of us would have given up.

I will always remember a lesson he gave in leadership. He was leading a group of twenty officer cadets in the Cairngorms when a blizzard, then darkness came in and the Sinclair hut could not be found. Wavering voices started to pipe up, "Camp here, I can't go on. He's got exposure", etc and finally from one small group hoping to foment rebellion "Tim we are camping here". "Fine", he said, "I am off to the hut" he said casually. They followed.

Probably about a thousand soldiers learnt to climb under his direct or indirect tuition. Perhaps if they learnt to live with the vigour he did then he has left more than fond memories and good friends behind him.

*SJS*

Captain TJ P Roberts

# COLONEL J R ALFORD MA

*Born 10 July 1933 died 13 August 1986 aged 53*

JONATHAN ROBERT ALFORD was commissioned into the Corps in 1953. He had been educated at Rugby and Sandhurst and after a brief spell of unit experience took an in-service degree at Jesus College, Cambridge. He gained a second class honours in Part 1 of the Mechanical Services Tripos in two years and went on to read Part 2 in his third year, winning one of the two university prizes as a result. Even in those days "Jack", as he was known to his friends, showed signs of those talents which were to place him ahead of his contemporaries; the apparent ease with which he could recall facts on professional miltary matters, his ability to argue their significance with articulate conviction, his evident self sufficiency which set him apart from the average without the stuffiness that can accompany such intellects.

His military career was predictably successful in the fast stream of command and staff. The foundations were laid as a young officer on Christmas Island where his ability to get his hands dirty was demonstrated. The actual tests which he witnessed must have remained influential with him in his later life as an analyst of strategic matters. Later, his military talents took him through tours as MA to the CGS, command of 25 Engineer Regiment in Germany and as a member of the directing staff at Camberley, until a severe heart condition leading to a major operation necessitated his early retirement. He loved the Army and was greatly respected by all who knew him. His success and early promotion were proof of his ability to reach the top had he stayed.

He then began the second career which led to him becoming a nationally recognised figure on television and radio, as Deputy Director of the International Institute for Strategic Studies, in 1978. His work there embraced many functions and topics. As principal military expert and spokesman of the Institute he oversaw with vigour the production of *The Military Balance*, their detailed report on the military strengths of all states with significant armed forces. He also edited the *Adelphi Papers* series of monographs and the book series *Studies in International Security*, and directed the Institute's publications programme. The clarity of his expositions, and the logic of his advocacy of arms control and political negotiation, excited much admiration, but he was more than a good communicator, his verbal skills being backed by an accurate and disciplined marshalling of facts. Two articles in the *RE Journal* in 1974, on Sappers in the infantry role in Northern Ireland, bear witness to his skill as an author.

He followed his recreational interests with the same intensity as his work. He was widely read, deeply interested in music and the arts, was an accomplished artist himself and a collector of watercolours. A keen hockey player in his youth, his particular love was sailing. He became an REYC skipper at an early age and in recent years bought his own 30ft yacht.

Thus he was a marvellous companion on many levels; physical, mental and emotional. Great loss as he will be in his professional and public role; it is as a talented, stimulating and considerate companion that he will be so sadly missed by his friends, colleagues and family.

*AJIP, CJR, RO'N, WGHB, GWAN, NMW*

Colonel J R Alford

# SIR HAROLD HARDING, Kt, D Sc, B Sc, F Eng, FICE, DIC, FCGI

*Born 6 January 1900, died 27 March 1986, aged 86*

SIR HAROLD HARDING, one of the Institution's most eminent honorary members, an engineer of distinction and great achievement with a long association with the Army, died in March this year.

Harold John Boyer Harding was educated at Christ's Hospital and the City and Guilds College South Kensington where he gained a BSc(Eng) in 1922. His degree course studies had been interrupted by a year of full-time military service in 1918. Initially he wanted to join the Corps but was foiled by a medical board who defeated his ruse of learning the eye-test card by heart, by turning the card round. He was extremely short-sighted. However, he trained as an officer cadet throughout the anxious days of 1918 finally being commissioned into the Royal Fusiliers just before being demobilised. He then spent a further two years in the TA in the London Rifle Brigade.

He joined John Mowlem and Company in 1922 and remained with them until 1956. He was involved in some twenty-five projects over this period and the list of these bears witness to his expertise particularly in below-ground work in difficult unstable soils, pioneering many new techniques. This experience was drawn upon by the Corps when, in World War Two, he acted as adviser to bomb disposal units on shoring up excavations.

In 1956 Harold Harding started in private practice as a consulting engineer and became involved in many projects including being joint consultant to the Channel Tunnel Study Group from 1958 to 1970 and a member of the Aberfan disaster tribunal. He became a council member of the Institution of Civil Engineers in 1949 and was elected president in 1963. He was a governor of Westminster Technical College, Northampton Engineering College and of Imperial College, London University. He was created a knight in 1968 and made an honorary DSc by the City University in 1970.

A man of immense energy and a sparkling sense of humour, Sir Harold Harding continued to take a wide interest in engineering affairs when many others might have felt it time to retire. After his time as President of the Civils, he was founder Chairman of the British Tunnelling Society. He was a member of the Engineer and Railway Staff Corps for many years and became a honorary member of the Institution in 1968.

*REJ*

* * * * *

Sir Harold Harding

# Correspondence

Maj General T H F Foulkes, CB, OBE, MA, FICE
32 Fitzroy Road, Fleet
Aldershot, Hants GU13 8JW

### RE Journal

Sir,—About the time I was commissioned in 1928, I asked my father, who was then CE Aldershot command what he thought of the *Journal*, and he said "It makes me feel tired".

Soon after, however, he advised me to cut out selected articles and keep them for ready reference. This I did and roughly bound them and in fact made very good use of some of them during the war.

Practical experience is a precious and usually scarce commodity, especially when the last war is so far behind us and it is often valuable to employ other peoples' experience to put flesh and blood on the bare bones of our excellent text books.

When that ancient polymath, the late Sir Harold Hartley became an Hon Member of the Institution he was not slow to give me as President his frank criticisms of certain details he noticed in the *Journal*, reminding me thereby that we need, through the *Journal*, to retain the respect of our most learned and influential friends in the technical world, whose standards never slip.

The *Journal* is our shop window, by which our goods are bound to be judged. It can be serious, useful and often amusing, but never slack or "pop".

As for the Memoirs, I agree with John Lacey that they should be seen as a source of pride in the traditions and achievements of the Corps and of inspiration for the future.—Yours sincerely, Tom Foulkes.

Lieut Colonel R H Smitherman,
BSc(Eng), MSc, CEng, MICE, MIE(Aust)
65 Chattenden Lane
Chattenden, Rochester
Kent ME3 8LQ

### A Question of Style

Sir,—In the preface to the part of the Journal Questionnaire which deals with technical content you state, "The man-in-the-street does not read long and very technical articles." This statement begs three questions:

(1) Who is "the man-in-the-street"?
(2) How long is "long"?
(3) What is "very technical"?

Surely the *RE Journal* is written for the members of the Institution of Royal Engineers—a learned society of military engineers. If this is so it implies that the *Journal* should contain a mix of articles, of an intellectual standard appropriate to a learned society, on all aspects of military engineering. The man-in-the-street reads *Sapper* magazine not the *Journal*.

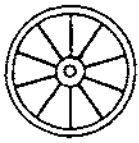
The length of an article can be compared to that of a run which depends on: running time, the number of obstacles encountered and on the going. So the length of an article depends on reading time, the difficulty of the subject matter and whether the reader feels comfortable with the style (and grammar) of the written word. An easy style disguises length and makes light of difficulty.

I wonder whether "very technical" in the questionnaire actually means "crammed with mathematics"? All engineering is firmly rooted in mathematics. The engineer, whatever his discipline, uses the language of mathematics to analyse and explain the real world challenges he faces. The military engineer may have much of this work done for him and enshrined in pamphlets and manuals, but it is no bad thing for him to be reminded from time to time that the graphs and tables that he uses are not produced by clutching figures from the ether. An equation is, after all, nothing more than a sentence with subject the left hand side, with verb "equals" and with a right hand side which contains a number of indirect objects. An equation is by definition concise which is more than can be said of much writing.

No! It is not mathematics that makes some articles virtually indigestible it is the learned academic style that some authors adopt. It is the back to front word order they use, combined with a liberal spattering of jargon words, which is the antithesis of an easily understandable style. If only these authors would follow the rules of the *Economist Style Sheet* which urges writers to:

(1) Use short Anglo-Saxon words rather than long jargon words whenever there is a choice.
(2) Limit the number of ideas introduced in a single sentence.
(3) Arrange the word order in each sentence so that the most important idea is covered first.
(4) Avoid disconnected linking words (like "this" or "that") at the beginning of a sentence as it is often difficult to be sure what they refer to.

I submit that if the style is right the members of the Institution will not notice that an article is long nor that it is very technical. Yours sincerely,—R H Smitherman.



Major M C McCabe, RE
5 Field Squadron
British Forces Post Office 24

THE WHEEL

Sir,—5 Field Squadron carries as a badge a spoked wheel. The official story of its origins, as documented by the librarian of the RE Corps Library, traces it back to the mid 1930s when 5 Field Company apparently took part in a mechanized trial—being issued with bicycles, the wheel is thus a bicycle wheel.

We are reconsidering the design of our Squadron badge and we would like to know whether anyone can vouch for this story. We have a plan to replace the bicycle wheel with some representation of the arms or crest of J R M Chard VC, feeling that a bicycle wheel is not quite representative of the past of such a distinguished Field Company and Field Squadron (the modern 5 Field Squadron has no link with the 5 Field Squadron formed in World War 2 and is descended from the old 5 Field Company). There is an alternative theory that the wheel is a wagon wheel dating back to the Company's time in South Africa before the Zulu War of 1879, if that were so we would happily perpetuate this longer tradition.

Could I ask your readers to help us by sending us their recollections of the origins of our wheel. I would be most grateful to hear from them, especially if anyone has any documents linking the wheel to the Company before the mid 1930s. This would be very persuasive evidence against the bicycle theory—we would of course return them, taking good care not to damage them.

I very much hope that former members of 5 Field Company and 5 Field Squadron will not take offence at our feelings about "the bicycle wheel", no discourtesy to them intended. Yours sincerely,—Michael McCabe.

Lieut Colonel P J Russell-Jones, RE
Military Assistant to MGO, Room 2187
Procurement Executive
Ministry of Defence, Main Building
Whitehall, London SW1A 2HB

### Congratulations on Success

Sir,—We pride ourselves in the Corps on being a "family". And quite rightly too. But there is one area where I suggest we could improve our family ties, namely by making more of an effort to congratulate our "brothers" on their successes.

On talking to friends it is clear that we are not as good as we might be at writing, for example, when captains get selected for PQE training or for Staff College, or majors get promoted, or more senior officers climb the tree even higher, or, indeed, when people retire from the Corps.

And, dare I suggest, our senior officers are no better at writing than most!—Yours faithfully, P J Russell-Jones

Lieut Colonel P S Wadsworth,
MICE, FI Mech E, FI Plant E
Sheraton House
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Oxted, Surrey RH8 9JB

### Officer Shortages

Sir,—With regard to the notice on page 58 of the *Supplement* relating to officer shortages, I note the shortage includes Lieutenant Colonel. It follows that senior Major vacancies also exist.

I wonder if the Corps has considered the possibility of retaining retired officers on a consultancy hourly paid basis? For example retired officers with commitment and detailed knowledge and experience of MOD committees, development projects, Corps selection procedures for trade training, might be prepared to assist in this way. The harassed serving officer would therefore have a working shadow to assist him. It seems wrong that hard earned experience should be so readily lost and at an apparently increasingly early age. I believe some benefit would accrue if this suggestion were followed as retired officers RARO are still bound by the Official Secrets Acts and any personal limitations imposed by deed of sensitive knowledge gained on special assignment.—Yours faithfully, P S Wadsworth.

*Extract from a letter from Brigadier Sir Mark Henniker:*

"In the mid-nineteen twenties, when 14 YO Batch was at the SME Chatham, the Chief Instructor in Fieldworks was Brevet Lt Colonel, C A Bird DSO RE; and about 20 years later the present writer was his successor in the same post at Ripon. When it came to packing for the move back to Chatham I found amongst oceans of papers to be sorted a file containing the Confidential Reports written by C A Bird on the YOs of 14 Batch, including my own. Curiosity prompted me to look at it. I was immediately struck by the almost uncanny insight he displayed in judging characters. I therefore wrote to General Bird—as he then was—asking him how he did it. He told me that whenever he was writing a YO's report, he would cast his mind back to his own YO days and try to see which of his contemporaries most nearly resembled the man he was currently reporting upon; and he chose his words accordingly. He advised me to try the same technique. It proved admirable advice and I take the liberty of repeating it here."

# Book Reviews

## DISASTROUS TWILIGHT
## A PERSONAL RECORD OF THE PARTITION OF INDIA

MAJOR GENERAL SHAHID HAMID
Private Secretary to Field Marshal Sir Claude Auchinleck 1946–47

*(Published by Leo Cooper/Secker and Warburg Ltd—Price £17.50)*

IT was a surprising decision to appoint an Indian officer as private secretary to Auchinleck in March 1946. Whether he was a Hindu, Sikh or Muslim he would inevitably be accused of partiality towards his own community, thus undermining Auchinleck's authority. However Shahid Hamid was at once captivated by his Chief's charm and honesty of purpose and became his devoted assistant and friend. The day to day diary which he kept for eighteen months, together with copies of Auchinleck's private correspondence and secret memoranda provides a valuable insight into the problems confronting the CinC and his efforts to resolve them. The factual accounts of events are accurate but the author's comments and opinions are clearly weighted in favour of Pakistan.

Besides Auchinleck there were a number of other "great men" in Delhi at this time both British and Indian. They were all out of touch with the man in the street, had different views and had their own axes to grind. It was a tragedy that the three men who best understood the situation and were completely impartial had to be sacked—Wavell, Auchinleck and Conrad Corfield, Political Adviser to the Viceroy.

The trials of ex-members of the Japanese-controlled Indian National Army proved a difficult nettle to grasp. Few of them had joined the Japanese in the hope of obtaining freedom for India by the defeat of the British. They were just cowards who turned traitor as the easy way out. Loyal members of the victorious Indian Army were horrified at the idea that these men should be made into national heroes and escape punishment for their treachery. Moving their trials from the forward areas to Delhi was a big mistake, which gave the Congress politicians a powerful handle with which to stir up feeling against the British and particulalrly against the CinC. However it must be realised that there was no such thing as genuine public opinion in India. The overwhelming majority of the population could not read and had no access to the radio, so they had little idea of what was going on. There was no question of self-determination. It did not matter to the mass of the people whether the rulers in Delhi were Moguls, British or Congress provided that law and order were maintained and they had enough to eat. Your reviewer is still getting letters in 1986 from pensioners who say "Why did the British have to go in 1947? Look at the trouble we are in today. This would never have happened under British rule."

One thing that comes out clearly is the irresponsibility and ineptitude of the British government in London. One cannot help wondering what would have happened if Churchill had won the general election in March 1946. We were committed to giving India her freedom but need not have scuttled away leaving rivers of blood.

The reliability of the Punjab Boundary Force is discussed without accurate knowledge of the situation. The Force contained several famous regiments of mixed class composition which had served with distinction in Burma under Major General Pete Rees and he would near nothing against them. In fact nearly all their British officers had been repatriated and many of the experienced rank and file demobbed, their places being filled by raw recruits. When your reviewer was Brigade Major of the Amritsar Brigade of the Punjab Boundary Force a riot broke out within sight and sound of his office. Armed Sikhs were attacking a party of unarmed Muslims which included women and children. He found a platoon of Hindu soldiers on internal

Security duties standing idly by, but when ordered to break up the riot they said nothing but turned their backs on the scene.

A horrifying report from the *Times* correspondent in the Punjab is included as an annex. Perhaps he was afraid to come to Amritsar where conditions were far worse. The only correspondent who did turn up there was from the *Toronto Evening Star.*

Apart from misprints there are many errors in the text. The diary would benefit from being edited to exclude trivialities and make it more readable. On the whole "Disastrous Twighlight" is an excellent title for the book, and the serious student of this period will be grateful to General Shahid for throwing some light on the scene from the angle of the last CinC in India.

WGAL

## THE AUTOMATED BATTLEFIELD

FRANK BARNABY

*(Published by Sidgwick & Jackson—Price £12.95)*

THE relationship between tactics and technology has always been of interest to the professional soldier. Even Lenin, despite his revolutionary nature, accepted that "wars are not won by mere enthusiasm but by technical superiority". Thus, today, with military opinion divided on such important issues as the most effective balance between direct and indirect fire and on the extent to which "operational" surprise is still possible in the age of AWACS, Mr Barnaby's book, *The Automated Battlefield,* should have made it interesting reading. Unfortunately, it is disappointing. Whilst it contains plenty of low-level, factual information, indeed hardly a missile is mentioned without the reader being told its weight, length, diameter and country of origin, it lacks the rigorous analysis which is so essential if the book is to be of value to the professional soldier.

Despite the analytical weakness of *The Automated Battlefield,* Mr Barnaby does not hesitate to make definite pronouncements. By page 19 we are told that "military combat aircraft are rapidly becoming so difficult to fly, without having to fire and control the weapons at the same time, that the only solution will be to eliminate the pilot altogether". By page 66 not only long-range combat aircraft but also "battle tanks and warships are, or will soon become, obsolete as manned weapons of war". Furthermore, from the scenario painted at the start of Chapter 3, it is clear that Mr Barnaby sees a battlefield of robot driven, anti-tank vehicles existing by 1995—a mere nine years away! Who is to say that Mr Barnaby's ideas about the future battlefield are wrong? He has as much right to his opinions, for that is what his book contains, as the next man. However, after reading *The Automated Battlefield,* one is left with the impression that he underestimates the ingenuity of both the soldier and the military scientist: every measure produces its own counter measure. The decision as to whether, at any particular time, the advantage lies with the attacker or with the defender is probably more difficult than Mr Barnaby would have us believe.

In its consideration of NATO's strategy, the book's lack of rigour is most graphically illustrated. In particular, it fails to highlight the non-aggressive nature of the NATO Alliance. Thus, on page 146, without quoting its source, it claims that two of NATO's currently stated missions are "to defeat the Warsaw Pact and to deny the Soviets the oil resources of the Middle East". However, even a cursory examination of The North Atlantic Treaty would show that NATO is a defensive alliance (Article 5 of The Treaty) and that it operates within well-defined territorial limits (Article 6 of The Treaty). Thus, the role of NATO, and it is perhaps worth remembering this role when reading Mr Barnaby's book, is: first, to safeguard the security of member nations by deterring aggression; and, secondly, if deterrence should fail, to re-establish the territorial integrity of the North Atlantic Area.

SCG

## A SAPPER IN THE FORGOTTEN ARMY

JOHN HENSLOW

*(Published by Portis Press Limited—Price £12.50)*

A SAPPER in the Forgotten Army is the account of the last two years of the War in Burma by a sapper subaltern serving with the Madras Sappers and Miners. His story takes him from school in England, through a University short course, on the long journey by sea and rail to Bangalore and then to a field company with the 23rd Indian Division at Tamu. From here he moves to the 7th Indian Division in the Arakan, to Kohima and thence getting on the long trail in pursuit of the retreating Japanese. The final chapters describe the surrender in Thailand and the early days after the war in Malaya.

The author's style is such that the book cannot be rated as a literary masterpiece. It is, nevertheless, a very readable book that will take those who took part back over the years to relive the extraordinary mixture of excitement, muddle and red tape that, when blended with comradeship and courage, made the ingredients of this war for the junior officer.

Being no respecter for humbug, John Henslow has spared no punches in his descriptions of the peacetime mentality of sections of the Army in India that supported field formations in Burma. But then the distances were vast and the battles of the Arakan and Assam must have seemed a long way from the comfortable cantonment life in Bangalore and Poona. Even in 1945 breakfast at Firpos restaurant in Calcutta, only 300 miles from the battle zone, was still running to nine courses!

John Henslow died before his book was published. He was a blithe spirit and has written a blithe book that, for £12.50, will not only give pleasure to those who took part, but will give others of all ages an insight into the life of a subaltern during the Burma campaign.

SEMG

## THE VICEROY'S FALL

PETER KING

*(Sidgwick and Jackson, £12.95)*

POLITICAL skullduggery is newsworthy stuff. The ingredients of *The Viceroy's Fall* recall those of the more recent Westland affair; a bone of contention relatively minor in itself resulting in a public row between two eminent men; press leaks, accusations of lying and declarations of innocence; government action driven by political considerations more than the pure merits of the issue; personal ambitions for power laid bare. The similarities should not be pursued too hard, the issues and consequences of *The Viceroy's Fall* being of more far-reaching significance than Westland so far as it is possible to judge at present, but this book will certainly appeal to anyone who found that the Westland affair excited them.

*The Viceroy's Fall* is the story of "how Kitchener destroyed Curzon"; this, the very subtitle of the book prepares us for the openly tendentious reporting of the row between Kitchener as CinC India and the Viceroy, Curzon, over Kitchener's attempts to abolish the Military Department of the Government of India and bring the Army's supply and administration under his own control. Space prevents a proper discussion of this issue in the book (let alone this review), and so the rights and wrongs are inadequately explored. To a professional soldier this is a severe disappointment but the author's acceptance of Curzon's case for retention of the system seems acceptable as an assumption until he lays at Kitchener's feet the blame for the failed Mesopotamian expedition of 1915–16 and the tragic aftermath of the fall of Kut. At this point the credibility of the anti-Kitchener thesis breaks down.

The main theme of the book however is the development of the feud between Curzon and Kitchener through the exchanges of correspondence not only through official channels but also through personal arrangements carefully established by Kitchener with friends who were influentially placed. The way in which such as politicians' wives, relatively junior officers in the War Office and journalists could be manipulated by Kitchener to win the propaganda war is totally fascinating and rings entirely true. The sketches of the background and personalities of both protagonists are both illuminating and relevant. The author makes no attempt to conceal his contempt of Kitchener and his admiration for Curzon, but this is not a book for anyone seeking a balanced biographical assessment of either. It is a thoroughly researched account of an intriguing episode in history presented in an aggressively one-sided manner and, accepting this qualification, can be read with pleasure.

GWAN

## HUMAN RELIABILITY WITH HUMAN FACTORS

DR BALBIR S DHILLON

*(Published by Pergamon Press, Inc., Maxwell House, Fairview Park, Elmsford, New York 10523—Price $24.50)*

CHERNOBYL has reminded all of us that the study of human reliability is important. So is the study of those human factors which make a machine or equipment easy to use. Dr Balbir S Dhillon, Professor of Mechanical Engineering at the University of Ottawa, describes both in his book: *Human Reliability with Human Factors.*

The thirteen chapters in the book seem to fall into two categories. There are the carefully researched chapters of mathematical equations and logically developed argument on human reliability, and there are the chapters on human factors which are little more than collections of lists with little or no supporting argument. The former appear to be based on papers presented by the author, while the latter seem to be the viewfoils he uses in lectures without the logical glue provided by his spoken word. Dr Dhillon's dual standards are emphasised because the simplicity and force of much of what he has to say is destroyed by the back-to-front style of his English. His North American readers may be at home with this kind of writing, but he will find few friends here.

Those who are interested in the mathematics of human reliability, in developing Markov models and in a collection of formulas used in instrument and display design will find this book helpful. Commanding Officers, workshop commanders and those responsible for equipment procurement will find some useful material in the chapter on maintenance and maintainability. Unit Safety Officers could usefully read the chapter on safety, although many of the lists in it are also presented in more readable references they will already have.

RHS

## BOOK NEWS FROM INSTITUTION OF CIVIL ENGINEERS

*All books in this section are published by Thomas Telford Ltd and are obtainable from Thomas Telford Ltd, Telford International Bookshop, 1–7 Great George Street, London SW1 3AA.*

PROBABILITY AND STATISTICS IN CIVIL ENGINEERING
AN INTRODUCTION
*G N Smith: Price £22.50*

ONE of the first books to be published on the subject, this volume presents a straightforward summary of the most important aspects of statistics and probability theory that are relevant in civil engineering, particularly in the field of soil mechanics.

INFORMATION SYSTEMS IN CONSTRUCTION MANAGEMENT
Principles and Applications
*Paul Barton: Price £14.25*

AN introduction to the use of small computer systems in construction management covering the general characteristics, and operation of such systems, their specific applications in the industry and the organisational framework in which they have to operate.

ENGINEERING SURVEYING MANUAL
*An ASCE Publication: Price £42.00*

DIRECTED to the engineering manager who is responsible for planning and executing projects that require the assistance of specialists in engineering surveying. It examines topics requiring attention in the proper direction of most engineering surveys; covers engineering surveys for specific types of projects; and deals with special types of engineering surveys or with special problems relating to surveying.

QUALITY ON SITE
*Ian Ferguson and Eric Mitchell: Price £11.25*

THE achievement of quality on site requires all members of design and building teams to be aware of those areas where failure is most likely. The text discusses the areas of potential failure in detail and shows how quality can be improved. It pays special regard to project documentation and to the problems of site supervision, drawing upon the latest research and the extensive practical experience of the authors.

DESIGN OF STRUCTURES TO RESIST NUCLEAR WEAPONS EFFECTS
*An ASCE Publication: Price £33.50*

PROVIDES guidance to engineers engaged in designing facilities intended to resist nuclear weapons effects. It presents a balanced treatment of various topics, although emphasis is placed on blast resistant design other effects are treated in some detail.

EARTH PRESSURE AND EARTH-RETAINING STRUCTURES
*C R I Clayton and J Milititsky: Price £40.50*

THIS manual covers the field of earth-retaining structures and is conveniently divided into two parts. In Part One, the mechanisms of earth pressure are treated in detail, and are developed into the theory of earth pressure. Part Two is concerned with design. This combination of theory and practice will be valuable to practising geotechnical and foundation engineers, structural engineers and engineering geologists.

MANUAL OF SOIL LABORATORY TESTING
Volume 3—Effective Stress Tests
*K H Head: Price £44.50*

DESIGNED to present current accepted laboratory practice in geotechnology. Provides step-by-step details of procedures for carrying out tests on soils including not only those covered by British Standards but also some based on accepted practice or on US (ASTM) Standards.

PRECAST CONCRETE PILES
*FIP Technical Report: Price £14.00*

THIS technical report deals with the design, production and installation of both normal steel reinforced piles and prestressed piles. Environmental effects of noise and vibration are discussed, along with methods of dealing with obstacles and changes of strata etc. Controls and checks in the factory are dealt with extensively.

# Awards for the June Journal

THREE merit awards for articles in the June Journal were made as follows:

"Mount Pleasant Airport Construction" by Major H M Hoey, £60
"The Dykes of Walcheren" by Major I H Johnson, £40
"Einstein" by Major V G Iwanek, £20.

* * * * *

# 72 Engineer Regiment TA Prize

THANKS to the good offices of Lieut Colonel L McLeman, recently Commanding Officer of 72 Engineer Regiment (V) a prize is now offered for which the conditions have been agreed as follows:

> "Offered by 72 Engineer Regiment for the best article published in the RE Journal on a subject connected with the Territorial Army of Reserve forces. Open to officers and soldiers of any rank, regular or TA, serving or retired. Articles by foreign or commonwealth engineers would also be eligible. Value £60, awarded annually provided there is an entry of sufficient merit."

The first award will be made for articles written in 1986 provided they are judged to have reached the standard.

* * * * *

# Minewarefare on Land

BY
LIEUT COLONEL C E E SLOAN RE

*(Brassey's Defence Publishers—Price £15.00)*

THIS unique book provides a wide-ranging review of land mine warfare, that covers both mines and counter measures, past, present and future. Tactics, techniques and equipment are combined for the very first time to illustrate the advances in mine warfare, and the potential for this vital component of combined arms combat. The book is well illustrated with maps, drawings and photographs.

* * * * *

# A Model Young Officer

OVERHEAD during a recent discussion on reducing the length of the YO course:

"Why can't you just show them a model of a YO?"

* * * * *

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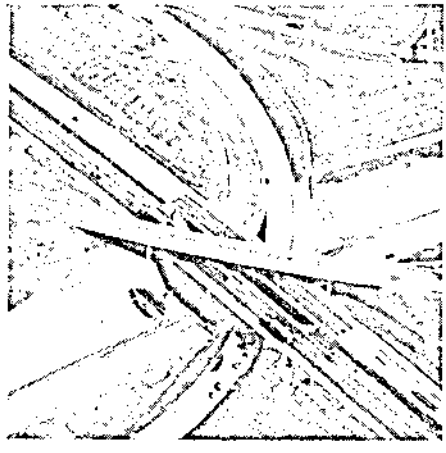
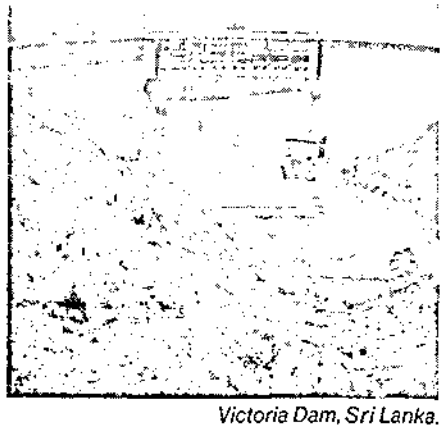


*Quay wall construction.*



*Victoria Dam, Sri Lanka.*

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