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The West Beyne Bridge

THE WEST BEYNE BRIDGE.

By Capt E. P. Anderson, R.E.

The recent increase of traffic on Indian railways, due to the rising prosperity of the country as a whole and more particularly to the large exports of grain, has rendered necessary a considerable amount of work in the improvement of the existing railways with the object of increasing their carrying capacity. This has been done by doubling existing single lines where traffic was very congested, and strengthening the road so as to take heavier engines and correspondingly increased train loads.

The N.W. State Railway has proved no exception in this matter. It forms the main link between Delhi and every part of the North-West Frontier, and also provides by its line to Karachi the outlet for the export of wheat produced in the great irrigated areas of the Punjab, so that improvements, such as those referred to, have there a double value from both the strategic and commercial points of view. The doubling of the line and replacement of the old girders of the West Beyne Bridge, which are dealt with in this paper, formed part of a considerable scheme for such work recently carried out between Amritsar and Umballa on the Delhi-Peshawur main line.

The West Beyne is a tributary of the Beas, which rises in the foothills of the Hoshiarpur district. At the point where the railway crosses it, some 15 or 20 miles above its confluence with the Beas, there is no appreciable watershed between them, and twice at least since the construction of the line in about 1870, a stretch of country some 6 miles wide has been flooded by the Beas, and most of the bridges on this length of line have been completely washed out. The exact records of this bridge are most incomplete, but during the progress of the work now described remains of old foundations were discovered, from which it is surmised that the original bridge was one of two spans of about 100 ft. each, and that it was subsequently increased to three and later to four such spans, as now exist. To prevent further damage by scour, large quantities of loose stone, in pieces about the size of a man's head, had been deposited round the piers, a method of protection not altogether in accordance with modern views on the subject, and one which caused some little trouble in carrying out the extensions of piers and abutments.

The piers of the old single-line bridge were each founded on two wells of 13 ft. diameter and of unknown depth, and were not long enough for the second track. It was therefore decided first to lengthen them in the upstream direction and complete the girders for the new track, and then to divert the single-line traffic over this while the old girders of the original single line were being replaced. The new track thus formed the "down," and the old one the "up" line of the reconstructed bridge.

In designing the doubling of the bridge five possible methods were considered :—

1. Open foundations on concrete close to the old wells.
2. Well foundations on the ordinary Indian method close to the old ones.
3. Foundations similar to the above but sunk by the compressed air method.
4. Reinforced concrete piles driven close to the old wells.
5. The construction of a separate bridge for the new down line at a distance of 100 ft. or so upstream from the existing one.

Of these alternatives Nos. 1, 2, and 3, were considered impracticable owing to the risk of a "blow" causing settlement of the existing piers, over which traffic was running all the time. No. 2 was also impossible owing to the presence of the pitching stone round the old piers, which would have made well sinking most difficult if not altogether impossible, as isolated stones are met with at all levels below the bed and might cause the wells to tilt out of the vertical.

The construction of a separate bridge (No. 5) would have been a quicker plan as things actually turned out, but was vetoed on the ground of the sharp reverse curves in the main line which it would have necessitated, owing to the length of line available for them being limited by two long arched viaducts, one on each side, which were already well in hand. For a line on which speeds up to 60 m.p.h. are obtained this objection is a serious one.

Alternative No. 4 (reinforced concrete piles) was therefore adopted, and it is believed that this is the first large railway bridge in India where this method of making the foundations has been entirely used.

In August, 1908, the manufacture of the piles was started. The design adopted was square in section to facilitate moulding. The piles were 14 in. square outside, reinforced with four longitudinal mild steel bars 1¼ in. in diameter, whose lower ends were bent in to meet the forged shoe. The bars were held apart by cast iron ⌶ shaped struts at intervals of 2 ft. 6 in. which were merely used to prevent their displacement during the ramming of the concrete. Transverse rein-

forcement was given by welded links of ¼-in. diameter wire at a spacing varying from 1½ in. to 3 in. In the later design of piles this type of transverse reinforcement was abandoned owing to the large number of defective welds which were found in the links on test, and to the difficulty of getting the links made of exactly equal size, which resulted in their becoming loose and displaced during the ramming of the concrete. As a substitute for the links it was arranged to make the transverse reinforcement by winding the wire on to the longitudinal rods in continuous lengths. A tight spiral was first of all wound on a hand winch with an extemporized square barrel of a size exactly equal to the outside dimensions of the reinforcement. This was then slid over the longitudinal rods, spread to the required pitch (1½ in. over a length of 2 ft. 6 in. at each end and 3 in. in the middle of the pile) and the whole tightened up by the insertion of the cast-iron struts. The longitudinal rods were bent inwards at the foot of the pile to rest on the forged shoe, which was also held in place by arms which projected into the concrete.

The reinforcements for the piles were thus made in the form of rigid skeletons which could be conveniently handled and placed in the moulding boxes. These boxes were made of deodar in five pieces, viz., two sides, a bottom, and two ends. The sides and bottom had wedge-shaped pieces nailed to them to mould the taper portion of the lower end of the pile. The piles, which were 27½ ft. long, were moulded horizontally and no defects were noticed on this account. The sides and bottoms of the boxes were held together by an arrangement of iron clamps secured with small bars and cotters. As they get very rough usage, screws or nails are quite unsuitable for this purpose. Great economy can be obtained by making such moulds substantial, so that they can be used over and over again, as was done in this case, and it certainly pays to make them of good material and ample thickness. In this case the planking was 1½ in. thick, which is fully light for such work; 2 in. would have been better. Before placing the skeleton in the box all parts of the latter in contact with the concrete were painted with a wash made of two parts by weight of white lime (as used for whitewashing), and one part of soft soap, mixed with water to a thick creamy consistency. This was quite effective in preventing the cement from adhering to the wood.

The materials for the concrete were a source of a good deal of trouble, largely owing to the lack of practical experience on the part of the staff concerned. There is no doubt that only the very best of everything will do for such work, and it is useless to attempt it otherwise. The first large consignment of English Portland cement received gave such unsatisfactory tests at the site

of work, that a complete analysis and test by an independent expert in accordance with the British Standard Specification was ordered. The result was so unsatisfactory that the cement was condemned and much valuable time was lost in purchasing a supply of satisfactory quality in India. This is not an isolated case within the author's experience, and the subject of cement for use in India is of such importance to engineers, especially in connexion with reinforced concrete structures, that no excuse is offered for a short digression on the subject.

No cement is fit for use in important work which does not *at the time of actual use* comply fully with the British Standard Specification, which may be regarded as an absolute minimum; many makers now produce cement which far exceeds its requirements. Samples on which the acceptance of a consignment depends are usually tested at home before shipment. But there seems little doubt that changes take place, even where the barrels are treated with unremitting care, during the period of six months or more which elapses between the manufacture of the cement and its use in India. For use in tropical climates, especially dry ones like the Punjab, cement must be "slow setting." This is sometimes, apparently, attained by the addition of gypsum during or after manufacture. There is some reason to suppose that the effect of this gypsum wears off in a few months, the cement returning to the state of a "quick-setting" one, and then maturing later in the usual way to become again "slow setting" after a further lapse of time without any aeration or treatment whatever. The moral seems to be to exclude by specification the addition of gypsum, and in addition to the usual tensile tests at site of work, which in inexpert hands may give erroneous results, to make careful tests for setting time and soundness by any of the recognized methods. Those given in the British Standard Specification are easily carried out, though the prolonged boiling of a briquette, or thin pat, is considered by some authorities a more sensitive test for soundness than the Le Chatelier method. For reinforced concrete work it need hardly be urged that an absolutely "sound" cement is a *sine qua non*.

Aeration of cement at site of work in India is of doubtful utility, considering the length of time which necessarily elapses between its manufacture at home and use in India. If samples taken straight from the barrels give satisfactory results on test, it will probably be better to use it straight from the barrel without any aeration whatever. If the samples appear unsound it may be improved by aeration; while if the cement is too quick setting, it seems quite as likely to improve by storage for some months in the barrels as by aeration for any period.

The sand at first used in this work was obtained locally at Hamira.

It was a very fine river sand with a good deal of earthy and micaceous matter which repeated washing did not entirely remove. The resulting concrete in the first piles tested was found to be spongy and unsatisfactory in consequence, and the use of this sand had to be abandoned. After examining samples from several different localities, it was found necessary to import soft sandstone from the neighbourhood of Delhi, and to produce a satisfactory sand by passing it through a Carter's disintegrator and then twice screening the result, the portion used being that which passed a screen of $\frac{1}{8}$-in. mesh and was retained on one of $\frac{1}{30}$ in. Latterly the stone-breaker established at the ballast siding at Pathankot was found to produce an excellent sand for the purpose, clean, sharp and of suitable size. The broken stone used was obtained by breaking up boulders taken from the bed of the Chakki River at Pathankot. This was at first done entirely by hand, a slow and expensive method even with the relatively cheap labour available. During the progress of the work a Baxter stone crusher was established there, which produced admirable material. The stone had to pass a $\frac{1}{2}$-in. screen, and round pebbles from the river bed were rigorously rejected. The material used in the reinforcement was ordinary mild steel bars and wire.

The proportions of the materials originally used in the concrete for piles were 1 : 2 : 4, the percentage of voids in the aggregate unrammed having been found by experiment to be about 44. But experience showed that, with the limited amount of ramming possible owing to the closeness of the spacing of the reinforcement, the resulting concrete was not quite so solid as could be wished, and the proportions were altered to 1 : $1\frac{1}{2}$: 3 which gave entirely satisfactory results. The quantity of water used with the concrete was also the subject of experiment. It was found that a distinctly wet mixture gives the best results as it flows most easily into the interstices of the box and reinforcement, and results in sounder work. It was fixed at 12 gallons per c. ft. of cement.

The mixing and laying of the concrete was carried out entirely by hand, labour being relatively cheap. A dry brick floor was made, on which the boxes were laid. The ingredients were measured out in boxes of 1 : $1\frac{1}{2}$ and 3 c. ft. capacity respectively, and placed in separate heaps. A box of sand and one of cement were then mixed together dry by turning over with a shovel, and placed on the top of the corresponding boxful of broken stone which had been previously slightly damped to reduce its temperature. This heap of dry ingredients was then twice turned over with shovels, the measured quantity of water added from cans with fine roses as the materials were being turned over a third time, and the wet concrete was again turned over twice. Each boxful of stone with its corresponding cement and sand was treated separately, and not wetted till the

previous one was almost used up, to ensure the concrete being finally laid and rammed before any setting action had started. The wet concrete was carried by coolies in iron mortar pans to the pile boxes, deposited by them, and then rammed by a specially trained gang of six men, the whole work on each pile being pushed through as fast as possible so as to let no part of the concrete be disturbed more than 20 minutes after it was first wetted.

After moulding, the piles were covered with sand kept very wet for a week, at the end of which time the sides of the boxes were removed. At the end of four weeks from first moulding the pile was rolled over sideways by a gang of about 25 men and the bottom of the box removed. The manufacture was always so far in advance of the driving that the piles were not used for two or three months after manufacture, though they appeared quite fit for use after six weeks. The piles were made and allowed to set in a shed made of thatch with all its sides quite open. This was necessary in order to prevent the concrete being spoiled during setting by the high temperature of the direct rays of the sun.

After a number of piles of the original type had been made and matured experiments were made in driving them. The only steam pile driver obtainable had a 1-ton monkey and was of a very old pattern made by Sisson & White. Driving was tried both with and without a helmet to protect the head of the pile, and in both cases resulted in a failure. The pile heads cracked very badly before the pile had penetrated more than a few feet in each case. This was principally due to the fact that the monkey (1 ton) was so light in comparison with the pile (2¼ tons) that a very high drop was required to produce any effect, and this resulted in a shattering blow. The effect may be compared with what happens when one tries to drive a heavy picket into the ground with a light hand hammer instead of a heavy mallet or sledge hammer. The shattered concrete of the piles was also found to be rather porous, and it was decided to make the change in the sand already referred to. But although this was an undoubted improvement it is interesting to note that piles of the original pattern were later driven by the new pile driver with entire success.

No more powerful pile driver being obtainable in India, an urgent order was cabled home in July, 1909, for a new one of the Southgate pattern with a 2-ton monkey. Owing to most unfortunate delays in its manufacture, it only reached the work in May, 1910, just in time to be erected before the river came down in flood and stopped further work for the season. This pile driver works on the principle of an inverted steam hammer. Steam is admitted through the hollow fixed piston rod and raises the cylinder attached to the monkey, which falls by its own weight when steam is cut off by a

hand-worked piston valve. The whole machine is carried by a frame attached to the steel helmet which rests on the pile head throughout the operation, thus subjecting the pile to this dead load all the time.

At the beginning of the cold weather of 1910 the necessary excavations and temporary dams were made, and actual pile driving started in October. Progress was very slow at first owing to lack of experience with this type of pile driver. The bolt through the helmet broke frequently owing to a slight movement of the latter under the blows. Even when this was corrected as much as possible by wedging the pile head tightly into the helmet with wooden wedges all round, these bolts never lasted for more than half-a-dozen piles. It is believed that the makers have since altered the design of this detail. The flexible steam pipe was also a source of trouble, as the india rubber perished very quickly. This was got over by the use of a flexible metallic pipe which stood very well.

Various parts of the pile driver were made of cast iron, a material quite unsuitable for a machine subject to sudden shocks. One of these was the shell of the main steam valve, which was twice replaced ; the last one, made by the Loco. Supt. of the line of a special gun-metal, stood admirably. A cast-iron guide block on the helmet was successfully replaced by one of hard wood, which was only renewed twice. A number of other minor failures occurred, which were repaired on the spot.

The steel helmet was divided into two parts by a horizontal diaphragm. The lower one fitted over the pile head, above which was a piece of wood about 3 in. thick faced with a $\frac{3}{8}$-in. steel plate next the pile. The upper portion was filled nearly to the top with sawdust over which was a hard wood block which took the blow of the monkey. This arrangement is most convenient as the sawdust does not need to be disturbed for each pile. Wedging the pile into the helmet with wooden wedges all round, referred to above, was found to be of the utmost importance. The wedges had to be tightened up at intervals during driving.

At first only one pile a day was driven owing to the difficulties referred to above. But after they had been surmounted the work was taken on contract by the headman of the Lascar gang employed on the work, and three piles were regularly brought to site and driven in a day. The damage to the pile heads was surprisingly small as may be seen by the *Photo*.

Before starting work at any pier, a trolly line was laid to bring the piles up to it, and as much as possible of the old pitching stone round it removed ; this enabled the piles to get a fair start, and if they met odd stones lower down no difficulty was felt in driving through or

past them. The pile driver was carried on sleeper cribs which supported the baulks and rails on which it ran. It was fitted with an excellent steam winch, which lifted the piles into position, placed the pile driver on them, and after driving warped the whole machine along to the position of the next pile.

To get at the piers and one abutment which were not left dry in the cold weather, owing to the water being held up by an irrigation weir lower down the river, two dams were made above and below the bridge at a distance of about 100 yards. These were made by driving two rows of wooden piles 9 ft. apart, a distance about equal to the depth of water, and at intervals of 3 ft. or 4 ft., then laying a 6-in. thickness of brushwood on the surface of the water and tipping earth on top of it. The stream was very slow and this method proved quite successful. Owing to the irrigation weir the river normally has a very small discharge in the cold weather, and was diverted into a 15-ft. channel through the middle of one span. But in January, 1911, unusually heavy rain for the time of year caused a sharp rise, and the dams were washed away. This fortunately did not hinder the pile driving which was still going on at the east abutment. The dams were reconstructed in the same way as before but $2\frac{1}{2}$ ft. higher and proportionately wider, and in addition a central longitudinal dam was made by orders from headquarters with the object of localizing any further damage.

In March, 1911, the wisdom of this was apparent, for a record fall of rain—absolutely without precedent at this time of year—took place, the river rose to its summer level and half the dams were swept away. The central dam saved the pile driver which was then working at No. 3 pier. One of the traction engines used for driving the centrifugal pumps, which kept the space inside the dams dry, was cut off on the downstream dam and only saved by the hasty deposition by boat of a lot of sandbags round it to check the erosion. When the river fell it was brought ashore over a temporary bridge made with two old 30-ft. plate girders on sleeper cribs specially for the purpose. This flood made extensive changes in the channel, and the pile heads at No. 2 pier were found to be in 12 ft. of water (see *Plate*). A small dam had to be made, in a similar method to that already described, round this pier to complete the concrete slab and brickwork.

After completion of pile driving at any one abutment or pier, the heads of the piles were cut off to an exact level, their vertical rods being left projecting 1 ft. above the concrete. Over these was placed a frame of 12 in. × 5 in. steel I-beams, joined with riveted knees in each angle. The rectangles between the beams were filled with reinforced concrete slabs made *in situ*, the concrete completely surrounding all the steel of pile heads and beams. The bottom reinforcement of the slabs consisted of $\frac{3}{4}$-in. diameter steel rods spaced from $2\frac{1}{2}$ in.

to 7 in. apart according to span, and owing to their being partially "fixed" an equal reinforcement was provided at the upper edge for 2 ft. 6 in. on each side of the beams. A short reinforced concrete cantilever of similar construction was made to carry the curved brick cutwater at the upstream end of each pier.

The concrete in these slabs was made in an exactly similar manner to that used in the piles, the proportions being 1 : 2 : 4. Mixing in small batches of 8 c. ft. or less was carried out by hand on a floor of dry brickwork as close as possible to the site. The mould for the slab was formed by laying a floor of old bricks round the piles and plastering it with the mud, cow dung, and chopped straw mixture, which is extensively used on inferior walls in India. This floor was of course never renewed. The sides of the mould were made of sleepers on edge secured to long pegs driven into the ground.

Brickwork on the piers was started a week after concreting, the slabs having been kept entirely under water in the interval.

Bedstones of Serai Kala limestone were used under the girder saddles in all cases except one. In this, the W. abutment, reinforced concrete blocks 4 ft. 8 in. × 4 ft. × 2 ft., with a double reinforcement of $\frac{3}{8}$-in. dia. rods spaced 6 in. apart, were used instead, owing to the contractor failing to deliver stones in time. These blocks were made *in situ*, and are apparently quite as satisfactory and cheaper than stones.

The loads on each of the piers, of which this completes the description, were as follows :—

	Tons.
Train load, including impact*	220
Girders	100
Ballast	50
Rails	26·5
Sleepers	4·5
Brickwork...	392
Total	793·0 tons.

Using 18 piles per pier, the load on each = $\frac{793}{18}$ = 44 tons. It was assumed that the load might be considered as evenly distributed over all the piles without sensible error in this case.

The bearing power of piles was calculated by Ritter's formula, as recommended in *Reinforced Concrete*, by Marsh & Dunn, whose methods of calculation were followed throughout the designing of the reinforced concrete work. The specification for driving of the

* Calculated according to Standard B of the Government of India Bridge Rules plus 25 per cent.

piles was therefore that the average penetration per blow in the last five or ten blows with the 2-ton monkey and a 4-ft. drop, must not exceed $\frac{1}{10}$ in. With the factor of safety of 10 recommended, this gives about 48 tons per pile safe bearing power.

This appears to be well on the safe side, and it is probable that full-sized experiments would prove that a less severe specification would be quite safe enough. But such experiments would be a matter of great difficulty, in that some 400 or more tons of dead weight would have to be applied to each pile head and measured, and they were not for this reason attempted.

In several cases it was found that the required resistance was not obtained when a pile had been fully driven. Rather than delay the work by the time necessary to lengthen such piles, a second pile was driven at a distance of about 18 in. clear from the first. These second piles were usually found very "stiff" ones and no trouble was found in keeping them straight. A short piece of R.S. beam was fixed across the heads of such a pair of piles below the main frame, and by bringing the ends of the members of the latter on to its centre, the load was evenly distributed between the two piles. The R.S. beams were as usual covered in with concrete. The erection of the N type "through" girders, with trough flooring to carry a ballasted road, was carried out by means of Sullivan's staging. Where a bend of the staging, of which there were three per span, had to rest in the water, it was carried on six wooden piles 9 in. dia. driven "hard" by a hand-ringing engine with a monkey of about 1 cwt. Riveting was carried out entirely with compressed air plant, which has every advantage for this class of work. Its results can only be surpassed in India by hydraulic plant, which is difficult of application, or by the very highest class of skilled hand labour, which is not easily obtainable. The points requiring most attention are the maintenance of the air pressure at a minimum of 100 lbs. sq. in. at the hammers, and the proper heating of the rivets. If a contractor is employed he must be responsible for maintenance of the joints in the air-pipe, as leakage means a considerable waste of coal. The gangs employed consisted of

2 hammermen,
1 dollyman, using hand or pneumatic dolly,
1 heater,
1 boy to carry rivets,
1 ,, work air valve on main.

It was found economical to cut off the air supply to the hammers whenever any delay whatever occurred between successive rivets. The output of a gang as above varies enormously with the position of the rivets. In girders such as these the biggest joint has less than 100

rivets on one side, so shifting furnace and pipe connections occupied a large proportion of the time, and an output of 100 per day was a good average. In straightforward work, such as the trough flooring, three times this may be expected.

In ordering and shipping girders in pieces from home, much trouble at site of work can be avoided if the following points are attended to :—

1. Paint all the parts of one span the same colour, and use a different colour for each span.
2. Stencil the name of the bridge on every piece or packing case containing its parts.
3. When sending girders forward by rail from port of arrival, try not to load parts of different colours or different bridges in the same truck.
4. Girder parts are often very roughly handled in transit, and strong protection of ends where joints have to be made is essential.
5. Rivets are usually $\frac{1}{32}$ in. less than the diameter of their holes. A bad contractor may easily use up more than the allowed percentage of spares, and a further supply has to be obtained in a hurry. This is much simplified if in the design rivets are used of the standard market sizes—*e.g.*, $\frac{3}{8}$ in., $\frac{7}{8}$ in., etc.—and the clearance given by drilling larger holes—*e.g.*, $\frac{21}{32}$ in., $\frac{29}{32}$ in., etc. If the converse method is adopted it may be found that rivet iron of the odd sizes, *e.g.*, $\frac{19}{32}$ in. to fit a $\frac{5}{8}$-in. hole or $\frac{27}{32}$ in. to fit a $\frac{7}{8}$-in. hole, is unobtainable at short notice.

II. Replacing the Old Girders.

The new down line bridge was completed and opened for traffic on 11th July, 1911, the single line being diverted over it. This left the old bridge clear for the work of replacing its girders. Owing to the lateness of the season it was considered inadvisable to use any false-work resting in the bed of the river for building the new girders ; floods were expected and might have caused a serious wreck. It was therefore decided to support the new girders on the old ones during erection, and then remove the latter.

The track and floor members of the old bridge were first removed by trollies to the west abutment (the new material being already stacked at the east abutment). A 12-in. baulk resting on the top booms with a block attached to its centre, through which the wire rope from the steam winch was led, served to lift the cross girders. But some little difficulty occurred at times in swinging the larger pieces back to the trolly, and it might be better in a similar case to

make some provision for running the baulk on wheels along the top booms of the girders.

Sleeper crib extensions, filled solid with pitching stone, were made at the downstream end of each pier, resting on the stone pitching surrounding the old piers. When the floor system had been removed, each girder was raised about 6 in. by hydraulic jacks, and two well-greased rails were inserted under each end. The girder was then slid outwards by jacks working horizontally till it was 14 ft. 5 in. from the centre line, a distance sufficient to allow room for the erection gantry and the new girders inside the old ones.

The depth of the new girders being greater than that of the old ones necessitated the lowering of the bedstones on the piers, and of the old girders, whose bottom booms had to be about 3 ft. clear below the bottom booms of the new girders to allow for the supporting beams, camber jacks, etc. The lowering of the old girders was done by hydraulic jacks at each end. This operation required a good deal of care as a single girder is a very top-heavy load. They had to be very heavily guyed, and the guy tackles required constant tending as the girder was lowered. Three guys were used on each side, each consisting of a doubled 4-in. manilla rope, or a single $2\frac{1}{2}$-in. wire rope, controlled by a tackle attached to an anchorage of buried sleepers. It was found safer to lower one end of the girder at a time; a difference of level of as much as 18 in. between the two ends had no bad effect. It took a gang of 20 lascars one day to slide out and lower a pair of girders in this way.

After the old girders had been lowered till the downstream ones rested on the sleeper cribs referred to, and the upstream ones in recesses left for the purpose in the brickwork of the extension of the piers, temporary cross girders, formed from the double 12 in. × 6 in. I-beams of the Sullivan's staging, were fixed across their bottom booms. They were secured, by coach screws, to wooden blocks fitted tightly in the ⌴-shaped bottom boom of the old girders. On these were laid baulks to carry the travelling gantry and camber jacks, and erection of the new girders proceeded exactly as before. It should be particularly noticed that the extra time and trouble spent in lowering the old girders resulted in it being possible to build the new ones at their final level and alignment, and no jacking into position of the completed new spans was necessary, a process which is liable to slightly buckle the girders, apart from any difficulty in carrying it out.

On completion of the new girders and the track across them, the removal of the old girders was taken in hand. They had only to be removed a distance of a mile to a siding at Hamira, and it was decided to do this without cutting them up. To lift them up clear of the abutment and carry them away, two of the largest 4-wheeled

high-sided trucks were borrowed from the Traffic Department, and sleeper cribs built in them, of a height sufficient to be clear above the tops of the new girders. Across each of these was put an old 30-ft. plate girder, spiked to the top layer of sleepers of the crib, and fitted on both sides with heavy timber struts, to prevent it capsizing. The whole was finally secured by a 2½-in. wire rope passed over the girder and under the truck floor, and tightened up with screw couplings on each side.

These two trucks were placed one at each end of the span, with three dummy trucks between them to preserve their spacing. From the ends of the 30-ft. girders differential tackles were slung by wire rope slings for lifting the girders. The slings were made by simply joining the two ends of a piece of wire rope with a single sheet bend, and seizing the loose ends carefully to the standing parts. This is quite a safe method for temporary use and much quicker than splicing.

The differential tackles were a source of much trouble and some anxiety. Each old girder weighed about 23 tons, and the only tackles available were of 10 and 5 tons capacity, *i.e.* marked by their makers "to lift 10 (or 5) tons." It is not apparent whether any factor of safety is allowed or any proper test applied when this marking is done. In this case two "10-ton" tackles on one end of one girder, that is carrying 11½ tons between them with the load correctly distributed by the device described below, showed distinct signs of failure by breakage of some of the teeth of the spur gear which drove them. The other tackles were driven by worm gear, and gave no trouble; this type seems a much safer and stronger one than that with a simple spur gear.

The tackles were attached to the girders by placing two short pieces of F.F. rail in an inverted position under, and at right angles to, the top boom. These were coach screwed to a wooden block jammed between the side plates of the top boom, a space of about 2 in. clear being left between the heads of the rails. Steel pins 2 in. diameter were inserted in holes drilled in the webs of the rail pieces, and the tackles hooked direct to these. When the two tackles at the end of one girder were of the same capacity, the pins were placed equidistant from the centre of the top boom; when of different capacities, the spacing of the pins was altered to divide the load in the right proportion.

After lifting was completed the girders were secured for travelling by simple rail slings in addition to the tackles. An engine was attached to the load and the whole pulled at a walking pace to the siding arranged for the reception of the girders, a distance of about a mile. Special preparations had to be made for this owing to the extreme width of the "train," and both lines of rail had to be blocked for the purpose. The

girders were guyed forward and back to the trucks and travelled with surprisingly little oscillation. After the gang had got accustomed to the work, the time taken to lift, remove and lower a pair of girders in the siding was about five hours; but owing to traffic considerations not more than one span was ever done in a day.

The bridge was completed and opened for traffic by the Senior Government Inspector on 11th September, 1911, just two months having been taken in replacing the four old spans.

The work was carried out by the writer as subdivisional officer under the orders of Mr. E. A. C. Lister, the designer of the pile foundations, who was succeeded as Executive Engineer of the Lahore District by Mr. R. B. Addis when the work was well advanced, Colonel S. L. Craster, R.E., and Mr. A. Pakenham-Walsh being successively Superintending Engineers. The author's thanks are due to Colonel Craster for much valuable criticism in the preparation of this paper, and to Sir H. P. Burt, K.C.I.E., the Manager of the N.W. Railway, for permission to publish it and to utilize the official records from which some of the plates have been prepared.

APPENDIX ON COSTS.

[1 Rupee = 1s. 4d.—15 Rupees = £1 sterling].

The final accounts of the work had not been completed at time of writing, but the following particulars may be of interest to officers serving in India :—

Reinforced Concrete Piles.

I. *Manufacture.*

(*a*). Materials—

	Per Pile. Rs.	
Cement ... 9 c. ft. at Rs. 1.75 per c. ft....	15.75	
Sand ... 13½ „ „ Rs.33 „ „ ...	3.5	
Stone ... 27 „ Rs.18 „ „ ...	4.85	
1½″ dia. steel rods, 5.57 cwt. at 7/- cwt. ...	39.0	
¼″ dia. wire, 97 cwt. at 12/- cwt.	11.6	
Forged shoe and C.I. struts, lump sum 15/- ...	15.0	
	89.7	
Moulding boxes	8.68	
		98.38

(*b*). Labour—

Making reinforcement and fitting up in box ...	8.5	
Concreting—30 men for ¼ day at -/8/- per day	3.75	
Removing boxes, loading, and unloading ...	6.69	
		18.94

II. *Driving.*

Contract rate with Lascar gang for driving only...	20	
Shifting machine from pier to pier	2.25	
Engine staff (1 driver, 1 fireman, 1 fitter) and 1 carpenter for wedges including stoppages for repairs of machine	5.67	
Cost of repairs to pile driver	10.0	
Coal, 10 cwt. per pile at Rs.14/- per ton ...	7.0	
		44.92
Total per pile		162.24

Or Rs.5.91 per l. ft.

REINFORCED CONCRETE SLABS OVER PILE HEADS IN A PIER.

(*a*). Materials—

R.S. beams	... 64.3 cwt.		
Plates ...	... 1.0 ,,		
Rods ...	... 39.87 ,,		
Knees and rivets	4.5		
Total	... 109.67 cwt. at Rs.7.5 per cwt.	Rs.822.0	
Cement—97 c. ft. at Rs.1.75 per c. ft.	... ...	169.5	
Sand—184 c. ft. at Rs.33 ,, ,,	... ...	60.6	
½-in. stone—368 c. ft. at Rs.18 ,, ,,	... ...	66.2	
			1118.3
Labour for laying reinforcement, 109,67 cwt. at 3/-/- cwt.	... ...	328	

(*b*). Labour—

For concreting	... ...	30.3	
			358.3
[A gang of about 50—60 men—cost = Rs.8.25 per c. ft.]			
Total	... ...		1476.6

Or approx. Rs.4 per c. ft.

The abutment slabs had rather more material in them and worked out to a total of Rs.1654 each.

GIRDER ERECTION.

The contractor was lent all the plant, and had to find labour, fuel, and oil. He was paid Rs.20 per ton for finished work, including erection and removal of staging.

The pneumatic riveting plant was old and required much attention to keep it going. The cost of this worked out to Rs.3.45 per ton.

REMOVAL OF OLD GIRDERS.

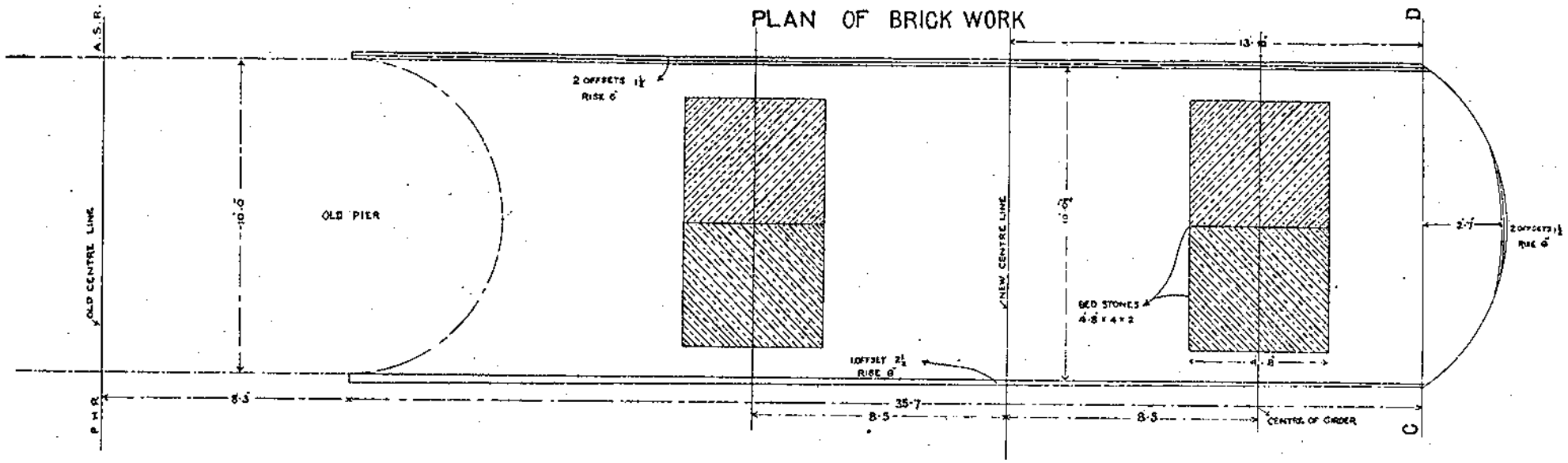
The labour employed on removal of the old girders worked out to Rs.2.5 per ton.

Hire of trucks, engine power, etc., cost Rs.2.4 per ton.

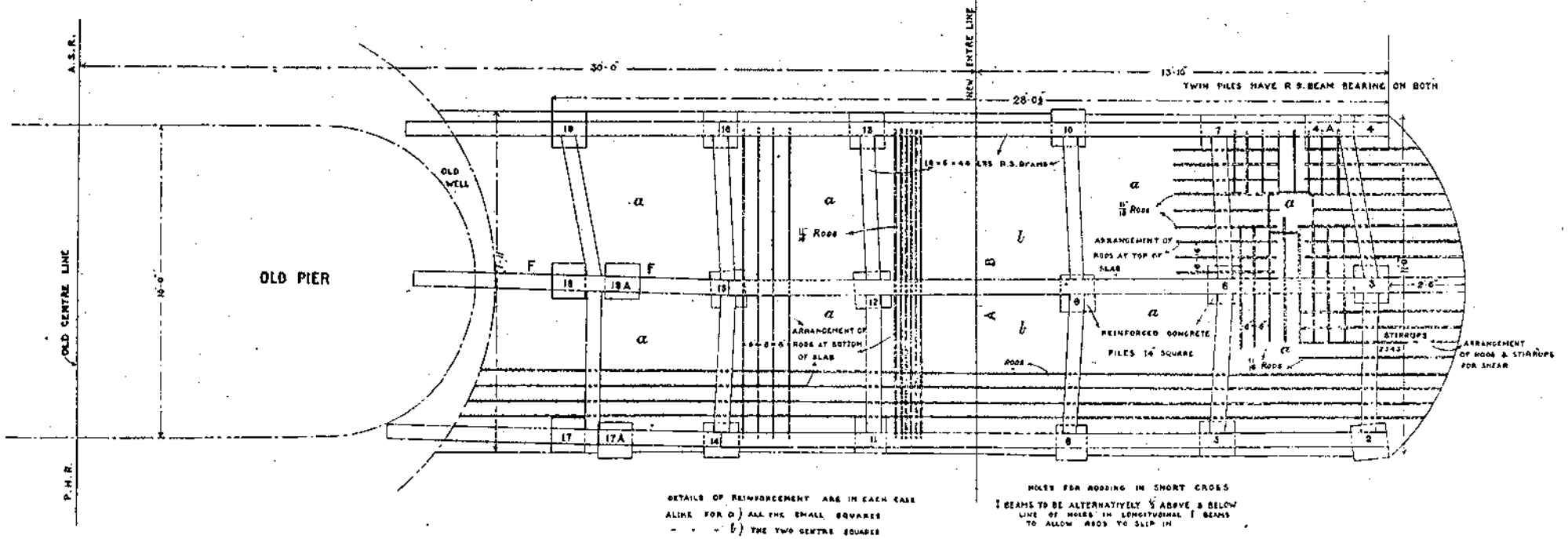
This includes building the cribs and fitting up all the gear, but not dismantling it.

THE WEST BEYNE BRIDGE.

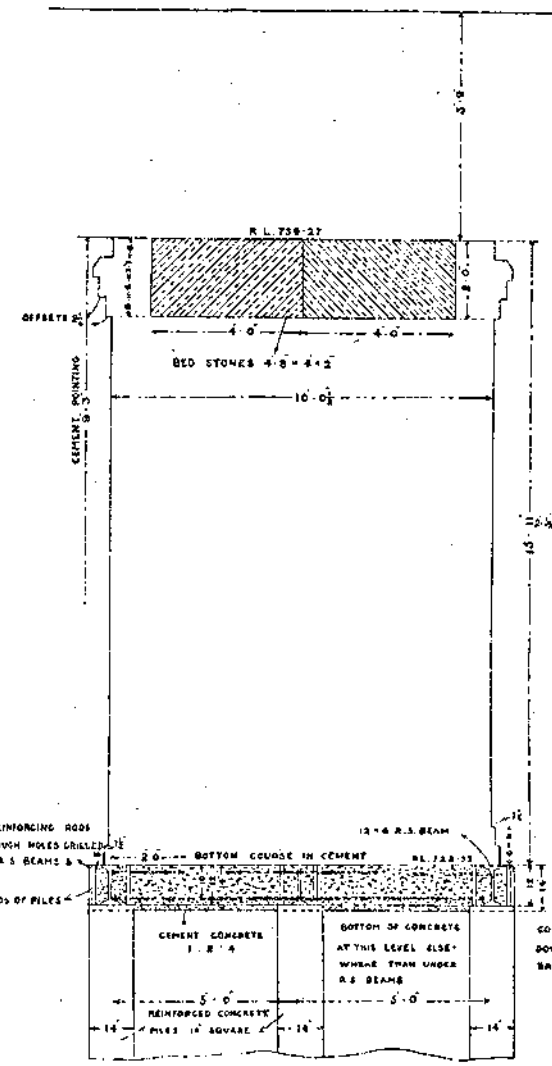
PLAN OF BRICK WORK



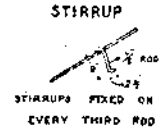
PLAN OF FERRO CONCRETE PILES, BEAMS & RODS



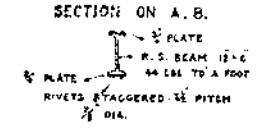
SECTIONAL ELEVATION ON C.D.



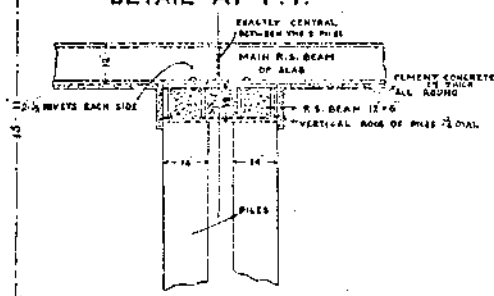
STIRRUP



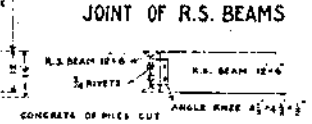
SECTION ON A.B.



DETAIL AT F.F.



JOINT OF R.S. BEAMS

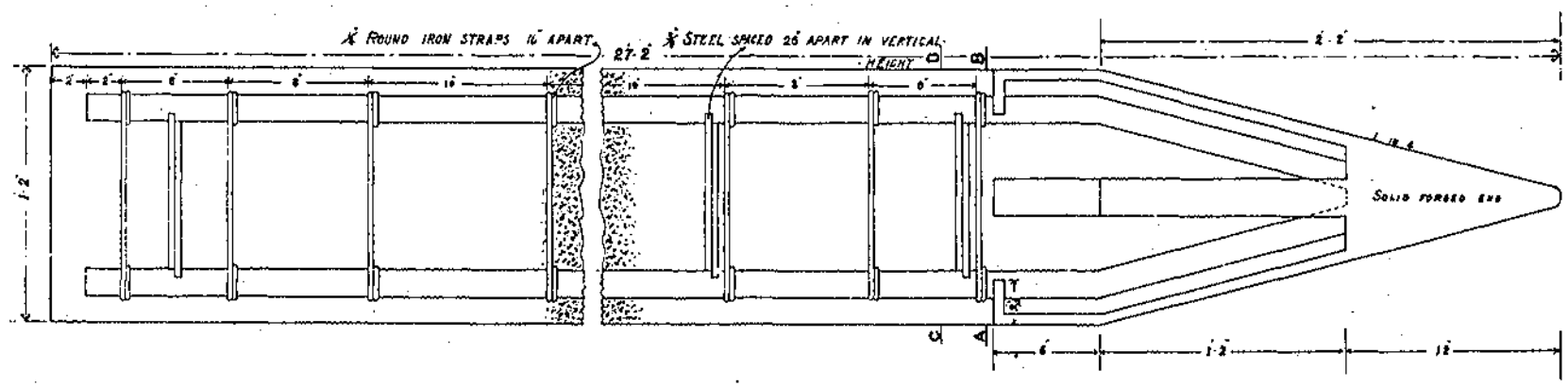


ALL PIERS & ABUTMENTS

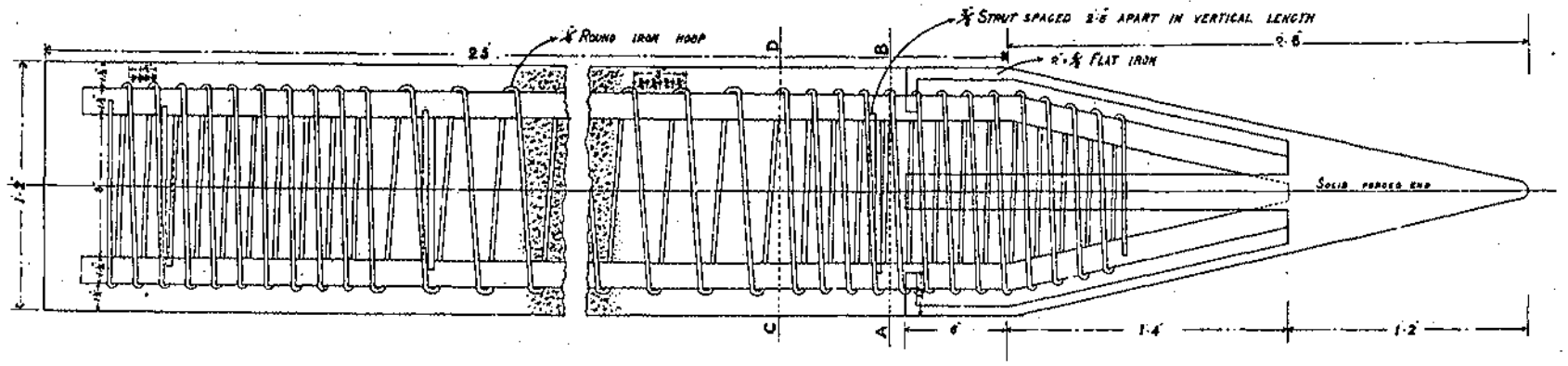
IN ALL CASES GIRDERS ARE FIXED BY L IRON KNEES AS ABOVE
BEAMS OVER TWIN PILES RIVETTED BY 4 No ⅞ RIVETS TO MAIN BEAMS

THE WEST BEYNE BRIDGE.

ORIGINAL DESIGN. REINFORCED CONCRETE PILES.

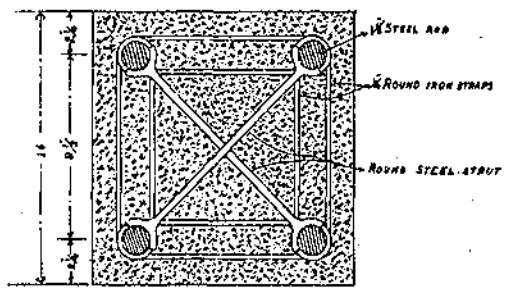


REVISED DESIGN.

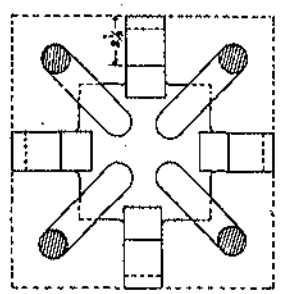


SECTIONS.

ORIGINAL DESIGN.



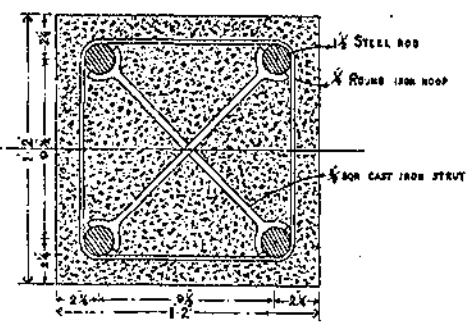
ON CD.



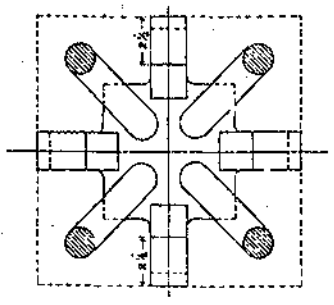
ON AB.

Concrete removed.

REVISED DESIGN.



ON CD.



ON AB.

Concrete removed

SIEGE WARFARE.

By Capt. E. Rogers, R.E.

Fortress Warfare is a branch of the Military Art more affected than perhaps any other by the periodic ebb and flow of opinion. The influence of fortresses on the trend of military operations is as susceptible of proof, and as well supported by historical evidence, as any other of the main causes of defeat or victory, but yet it is undeniable that the subject has, from time to time, been strangely neglected by the leaders of military thought. Such a period of neglect occurred during the latter portion of the past century, and it was left for the twentieth century to establish the subject in a definite light, and return to it something of its bygone importance. France, Austria, and Germany in turn have begun to devote attention to it, and the result has been seen in the publication of a number of official textbooks, and in a still greater number of works by military writers of all classes. The revival of interest in this subject has been greatly stimulated by the events of the Russo-Japanese War of 1904–5, which, with the capture of Adrianople, provides the only examples of which the details are at present available of the attack of a fortress under modern conditions. German military opinion in particular is almost unanimous in asserting the future importance of the *rôle* of fortresses, as the following extract will show :—"The future will probably bring with it a closer connection between Field and Fortress Warfare ; a modern army must *henceforth* be always ready for the latter. Inadequate preparation in this subject, which appears constantly throughout military history, is likely in the future to have severer consequences than in the past."* The recently published works of another German writer which have received considerable attention in that country are of especial interest in view of the developments of the Balkan War. Colonel Frobenius,† in considering the influence of fortresses on the issue of a war, arrives at the conclusion that in the general case it will be essential for an army, carrying out an offensive campaign, to attack one of the frontier fortresses at the outset of the campaign. Since he bases his argument chiefly on the Franco-German War of 1870–71, he states as an axiom that the fortress to be attacked will be the frontier fortress "Sperrfestung" which lies astride of the line

* *Studien zur Kriegsgeschichte und Taktik. IV.*
† *Kriegsgeschichtliche Beispiele. XII.*

of railway which is of most importance to the attacker. He goes on to show that, in order to bring the war to an end, it will frequently be insufficient to defeat the opponent's field armies; "the resistance of the enemy after the defeat of the field armies can only be broken by the capture of the important fortresses."* Therefrom Frobenius derives the necessity of no longer treating fortress warfare as a secondary operation, as Moltke did in his projects for the war of 1870–71, to be conducted by the landwehr and reserve formations; preparations for fortress warfare must exist in peace, be put into operation immediately on mobilization, and the operations carried on with the same energy and sacrifice as those of the field armies. To turn for a moment to the Balkan Campaign; here we find no frontier fortresses, but the definition given by Frobenius of the fortress to be attacked is clear; it is that used by Chesney, "fulfilling the necessary conditions attaching to important strategical points."† Adrianople, at the junction of the Maritza and its tributary streams, and astride the main line of railway crossing the Bulgarian frontier, fulfils these perfectly, and its influence, therefore, on the campaign has been considerable, and would in the hands of a commander of more offensive instincts than Shukri Pasha have been greater still.

How the awakening in Germany has come about can be gleaned from the introductory words of Major Scharr to his work on the engineer operations of a siege‡: "Interest in the subject of Fortresses and Fortress Warfare has been aroused during the past ten years by means of lectures, fortress war games, and staff rides, and by an extension of the Staff College course of Fortifications and Fortress Warfare."

In England, however, the interest in this particular direction is less marked. British military thought has, indeed, been revived by the lessons of the recent campaigns in South Africa and Manchuria, but it has been exercised in other directions. Leaders of military opinion have, not unnaturally, been preoccupied with our own army reorganization, which has made such strides during the past decade. In consequence this branch of training has not yet received the same amount of attention as in the countries already referred to.

It will probably be urged, by the opponents of fortress warfare, that the same standard of preparation is not required of us as for the Continental nations; and although such an argument might have been admissible in former times it is scarcely so under present conditions, and we should be prepared for the solution of all problems with which it may meet—"Neither the higher leaders nor their forces should be called upon to enter on Fortress Warfare, as on something unfamiliar to

* Frobenius. p. 24.
† Chesney. *On the Value of Fortresses.*
‡ Scharr. *Der Festungskrieg*, 1905

them. It cannot be required of every general and staff officer to be both engineer and artilleryman, but they must be so far masters of the chief technical considerations as to be able in every case to make such a decision as will meet the circumstances of it."*

The general aspect of the case is, however, beyond the scope of these notes, in which it is proposed to consider the question from the standpoint of the technical troops, and it is proposed to briefly discuss the demands which would be made on these troops only when engaged in fortress warfare, to examine the provision made by foreign armies to meet these demands, and then to attempt to define our own particular requirements.

It will be well to commence by saying that the work of the engineers during a siege has increased to an even greater extent than in field operations. Up to the time of the Peninsular War, the artillery were considered capable of carrying out almost unaided the preparatory stages of the attack, viz. the paving the way for the infantry assault. That this was so in our own army is not surprising, there were no engineer troops. Up to about this date the duration of a siege in fact depended upon the amount of resistance which the fortress enceinte could offer to artillery fire, and once a practicable breach existed, it was generally held that a commander was justified in surrendering.†

For long after the Peninsula even, breaching tactics of the artillery were continued,‡ but with the gradual improvement in armament, and the consequent disappearance of stone revetment there came an increased demand for engineers, and the Siege of Sebastopol marked an era in the history of siege works.

The great importance of the siege artillery, however, remained, and the war of 1870–71 did nothing to shake the confidence in this arm. In the meantime the opinion grew, with the rapid improvement in armament, that resistance to a well-directed siege attack supplied with modern artillery would be in the future impossible. The experience of Port Arthur shows how unfounded was this belief, and has proved incontestably that the improvement in armament is as much, or more, to the advantage of the besieged than of the besieger,§ if only from the fact, that the increase in the perimeter of the fortress has denied to the artillery its old advantages of bringing enfilade fire upon the works, and has incontestably magnified the difficulties of the close attack. How overrated the power of the artillery has been can be judged from the history of the Siege of Port Arthur. Previous to the first general assault, the north-east front of the fortress was subjected to a terrific bombardment on 19th and

* *Studien über Kriegführung.* v. Freytag Lornighoven.
† Frobenius. *Kriegsgeschichtliche Beispiele.* p. 6.
‡ Jebb's *Siege Duties.* 1849.
§ Frobenius. p. 59.

20th August, 1904, in which every available gun and howitzer took part—including field guns, a total of 258 pieces. The 37 Russian guns were unable to make any adequate reply, and at the end of the bombardment it seemed as though the permanent works must be a mass of *ruins*. But although 37 per cent.* of the Russian artillery was put out of action, chiefly owing to faulty siting of the batteries, the garrisons of the forts were unshaken, and the assault following the bombardment, after a continuous struggle night and day from the 21st to 24th August, ended in almost complete failure.

It remains therefore for the engineers to take up the old *rôle* of the artillery, viz. that of preparing a path for the final assault. By their unaided efforts they are incapable of doing this, and it is here that co-operation, the spirit of modern warfare, becomes of such vital importance. The ideal action of the engineers in co-operation with the infantry is well expressed by Colonel Frobenius. No longer are they the task masters in an unpleasant duty,† but "both arms would in my opinion more rapidly accomplish their task if they work together in comradeship. Let the sapper first work, and an infantryman with his rifle in his hand keep guard; then when the sapper after a time feels weary, let them change parts, the infantryman continue his work, and the sapper take over the duty of protection."‡ As the approach works get nearer to the fortress, the bulk of the work falls more and more heavily on the engineers, until, as was shown in the Siege of Port Arthur, the approaches in the immediate vicinity of the works can only be carried on by that arm, and then under the greatest difficulty. The work of preparing the assault will, to a great extent, be entirely an engineer matter. Major Scharr gives the following list of duties which the artillery is unfitted to accomplish against a modern fortress§ :—

(1). The removal of protected obstacles.
(2). The destruction of ground mines.
(3). Destruction of the flanking defence of the ditch.
(4). Blowing in the counterscarp.
(5). Complete destruction of the armoured turrets.

To consider a single one of these duties, viz. the destruction of the flanking defences of the ditch. The experience at Port Arthur is fresh in our minds. Here the approach to the ditch was not seriously contested. The Russians up to October had made no attempt at countermining, and the Japanese established themselves above the counterscarp in each of the three main works of the

* Frobenius. p. 70.
† *Sevastopol.* Jones & Elphinstone.
‡ Frobenius. p. 132.
§ Scharr. *Festungskrieg.* p. 85.

Eastern front without having recourse to mining. From this time, however, until the defences of the ditches were finally destroyed, over a month elapsed, during which time constant warfare of a most desperate character was carried on in the ditches and the galleries under the counterscarp.* How the difficulties of the Japanese engineers would have been increased had the Russian works been provided with such a network of subterranean galleries as that in front of the Flagstaff Bastion at Sevastopol,† one can only imagine.

It is evident that none of the engineer operations above referred to can be carried out without loss, and the expenditure in *personnel* in this arm is, in fact, out of all proportion to that sustained by other arms, during the preparatory phases of the attack. Before Port Arthur the casualties of the engineers engaged in the approaches alone amounted to no less than half of those of the infantry engaged in the same work, and the Japanese, in addition to forming five fresh units, were compelled to withdraw every trained miner from the field army units engaged in Manchuria, thereby depriving them of the possibilities of making use of mining operations in the field on occasions such as during the Battle of the Shaho, when it would have been of the greatest value to them. At the end of November, 1904, out of a strength of 800 engineers attached to the IXth Japanese Division, only 60 were fit for service, and all the engineer officers had been killed or wounded.‡

Without entering further into the question it will be clear that special provision for an increase in *personnel* of engineers is essential to the conduct of a siege, and it will be interesting to examine briefly how this special provision is made in other armies.

In general the method adopted is (1) the formation of special combatant units in addition to the engineer field units attached to divisions, corps, and armies, and (2) the formation of other special units whose duties are of a secondary nature, and concerned with the preparation, storage, and issue of the technical material. The latter are known as Siege Trains or Siege Park Companies.

In the Russian Army the special units are formed from the specialist miner sections attached to both field and fortress companies. These sections, as their name imply, receive more advanced instruction in siege warfare than the remainder of the units, and are assembled periodically, brigaded with those of neighbouring units, whether field or fortress, and take part in combined fortress operations. The training of miner sections of fortress companies, however, is carried out on purely defensive lines, "their work should be directed to the conditions of defensive warfare only, . . . and

* *Port Arthur.* Schwartz & Romanoffsky.
† *Sevastopol. Opérations du Génie.* Niel.
‡ *Port Arthur.* de Grandprey.

should always be carried out in the direction of the opponents." The Siege Park Companies exist only as cadres during peace, and are organized on mobilization. Each section of a siege park contains sufficient tools and stores for the siege of an ordinary fortress.

The German special engineer units are organized on a regimental basis, each of two to three battalions. They are formed by expansion on mobilization from certain battalions trained in siege duties. To each regiment is attached a siege train.

The French preparations are somewhat similar to the Russian, but siege training is, consonant with French tradition, assigned a much higher importance. The Siege Regulations foresee the necessity of reinforcing the field engineer units even during the attack on the covering position.* The French siege units are the *équipages de siège*, and are formed from the ordinary *sapeurs-mineurs* companies. The first year's instruction of a sapper recruit includes a considerably greater proportion of siege works than in other armies, and a certain proportion qualify as first-class miners and as such are distinguished by a special badge. The training of the miners is carried out annually at a special siege camp. The *personnel* of the siege train is formed on mobilization, but the material is stored in peace time.

Turning to our own army we find that our divisional organization is supplied with an engineer *personnel*, and that the necessity of further organization for siege purposes is recognized. It is of interest to consider what this provision would probably need to be so as to meet our own special needs, and for this purpose it appears reasonable to assume that each of the special units required for siege purposes should be of such a nature as to supply the whole of the staff and *personnel* required to undertake a certain definite task. Such a task might well be the attack of a defined sector, *i.e.* one of the permanent *points d'appui* of the perimeter together with the subsidiary works in advance and on either side of it, which together go to make up one of the self-contained organizations of the defence. As all these works will be mutually self-supporting it follows that the attack delivered against the whole group must be co-ordinated, and as it would usually be entrusted to a definite infantry unit, so also must the special engineer troops be contained under a single directive engineer staff. This is in fact the principle adopted in the French army.† Each of the *équipages de siège* previously referred to is composed of eight *sapeur-mineur* companies, formed for convenience in administration in two battalions, but grouped under one directing officer with his staff. The total strength of the unit is therefore about 2,000. The German organization is similar; if we take a siege regiment on the lower establishment it would be about 1,500 strong,

* *Instruction sur le service du génie dans la guerre du siège.* p. 46.

† *Instruction générale du* 30 *Juillet*, 1909, *sur la guerre de siège.* p. 30.

and would probably be allotted a similar task—the disparity is due perhaps to the fact that the Germans look to their infantry for a greater measure of co-operation in the close attack than do the French.

We can, however, arrive at an estimate of the numbers required from an independent calculation, based on the work to be done. For the sake of this calculation we will consider a single stage of the close attack—the mining operations—here we find we have a certain amount of evidence to go upon. It is of the utmost importance, once the mining operations have been commenced—and it will often be impossible to dispense with them—that they should be carried on without pause. Such a delay as occurred in the French operations before the Flagstaff Bastion at Sevastopol, when it was necessary to withdraw the whole of the mining engineers to the Malakoff,* would be fatal to the success of the attack. The whole chances of the attack depend on the defender's miners being allowed no time to repair the damage caused to their galleries by the overcharged attacking mines, on their attention being constantly absorbed by means of false galleries, by shafts hastily sunk at a distance from the main galleries, by charges fired from bored mines, and in fact by their being prevented by every artifice of an energetic attack, from forming new galleries in the line of the main advance. At Port Arthur it was found necessary not only to construct underground approaches against the main works, but also against the intervals. It is not difficult to calculate the number of men required for a single gallery or line of galleries under peace conditions. But under war conditions it is important to make reliefs as short as possible, and it is certain that to drive a line of six galleries no less than 250 engineers are required, in addition to assistance from infantry parties in removing earth, etc. Against an active defence it will probably be necessary to allow a minimum of ten galleries against the main work, and if we allow an equal number against the interval works we reach a total of 800 men for the mining operations alone. But the effective numbers of the siege engineers will have been diminished by at least one-half during the preceding phases of the close attack, and we therefore arrive at a unit some 1,600 strong, a number which is intermediate between the strength of the French and German units.

It is evident that such a number is out of all proportion to the normal allotment of engineers for the attack of field defences of similar extent, especially when it is borne in mind that these numbers must be regarded as over and above the strength of the field units. The latter will be kept busy supplying the immediate needs of their own divisions, and cannot be considered as available for the close attack.

* *Sevastopol.* Niel.

How many of these siege units are needed, depends upon the task to be accomplished. It is generally accepted that the zone of the close attack must embrace not less than two of the permanent works. But, however that may be, no smaller unit can be formed, as the task to be performed by it cannot be further subdivided. Moreover, no such important task as the siege of a great fortress has ever been carried out by mere numbers, however great. Nor will a more thorough training of the technical arm alone suffice, without the co-operation in practice of the other arms. How this ideal training is to be realized is suggested in the following words in a work already referred to in the course of these notes:—"Let the Siege Manœuvres be carried out not as up to the present, but at the great training grounds of the Infantry and Artillery, let there be constructed there a permanent skeleton of strong Fortress works, let the different arms carry out their own technical work in attack as well as in defence under specified conditions, and as far as possible let the Artillery bombard the works, and the Engineers carry out actual demolitions."

The writer adds "We must not be deterred either by the high cost of these operations, or by the danger to *matériel* or *personnel* under service conditions. All this is as nothing compared with the danger of our being found wanting at the decisive moment."*

* *Festungskrieg*. Scharr. p. 87.

BELL BUNDS.

By MAJOR H. E. C. COWIE, D.S.O., R.E.

IN Capt. F. C. Molesworth's "Training Works in the Swat River" which appeared in the February number, 1913, of the *R.E. Journal*, allusion is made on page 71 to "Bell" bunds. As many officers may not be acquainted with the meaning of a Bell bund, the following notes may be found useful.

The Bell bund as applied to sandy river beds is thoroughly elucidated in Technical Section Publication No. 153 of the Indian Public Works Department, by F. J. E. Spring, price 10s. 6d. In these notes some of the principles will be indicated, and it is hoped that officers may be induced to criticize and give further remarks of their experiences.

Nearly all unstable waterways in India have an area over which the water channels meander; this area is known in India as the "kadir," and is bounded by more or less permanent banks which the water channels seldom transgress (*Fig.* 1).

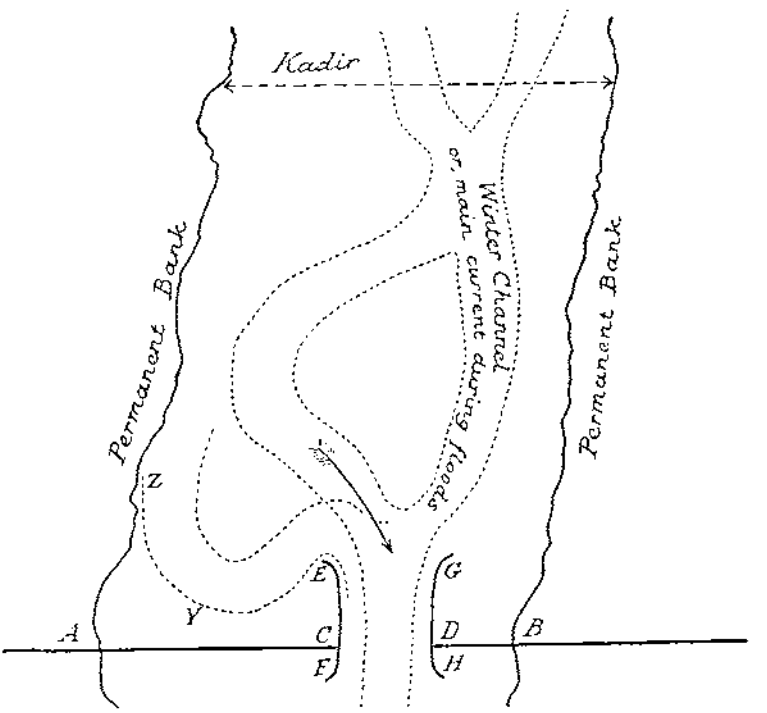


FIG. 1.

This kadir may be anything up to 10 miles wide, as for instance the kadir of the Lower Ganges from Monghyr to the sea, and in flood season is nearly covered with water, but in the winter, or low water season, water will be confined to limited channels as indicated by the dotted lines. The main current during floods, or the water channels during the winter, may take up any position between the permanent banks, and will seldom be the same in two consecutive years. The position of the main currents during floods will not necessarily be the position of the ensuing winter channels.

But suppose a bridge is to be built across AB. It is beyond the bounds of practicability to make a bridge of length AB, so the waterway must be confined. The roadway must run on made-up banks, AC, DB and the bridge between C and D, the location and width being chosen by common sense and certain rules, which are laid down at length in No. 153. It is evident that if permanent bunds EF, GH can be made and AC, DB protected against any possible attack, the waterway will become stable between C and D, and the bridge will be safe.

First of all what will protect AC against attack? In the main, it is the length CE, for if CE is made long enough the water must curl back to flow between CD before it can reach AC. Now the sharpest bend that a river can take can be ascertained from surveys and observation. It depends on the velocity of the water, on the nature of the soil of the kadir whether sand or shingle or so on (*vide* No. 153), but a survey of 20 miles of the river will show what the sharpest curve actually is for the river at the locality in question.

Having determined the sharpest radius that the river takes, CE must be made long enough to ensure that the water will bend back past the point E before it can touch AC, as indicated by the dotted line ZYE, where $\frac{ZE}{2}$ is the smallest known radius that the river ever takes in the vicinity.

Similarly for DG. The lengths CF, DH are determined by similar reasoning, that is to say, the water after passing F and H must never be able by means of swirls and eddies to bend back and attack AC, DB. Swirls and eddies should not be set up anywhere, and if they are observed, the design is at fault, that is, CE is not long enough or the curves of the bunds at E and G are too sharp. It is usual to make both bunds EF and GH exactly similar, as the more symmetrical these bunds are, the less likelihood of swirls. Other things being equal, CE and DG are each made equal to CD.

The width CD to take the water, is determined from observations of the maximum discharge in flood season, the maximum velocity, and the maximum scour anywhere in the vicinity. These considerations for rivers with sandy beds are fully given in No. 153, and would

probably be sufficient guide in cases of rivers with beds of a different nature. Roughly speaking the width CD must be such that the flood discharge can be passed without excessive scour, which means excessive velocity, scours and velocities being ascertained from surveys and observations of the river over a distance of some miles above and below the bridge site.

All that now remains is to design the bunds EF, GH so as to be permanent. Permanency depends on two considerations :—

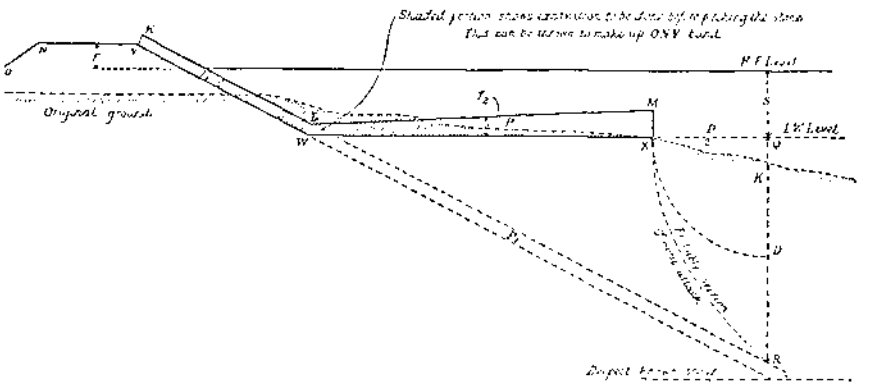
(1). That the surfaces in contact with the water are inerodible. This can be secured in different ways, but the most usual and generally the cheapest is to protect the surface of the bund with blocks of stone or other heavy material that does not weather, the size of each block being sufficient to prevent displacement by wave action or by the current. In broad rivers wave action is of course far more serious than the action of the current. The ordinary brick is said to be sufficient protection against simple velocities up to 13 ft. per second, but in waterways over $\frac{1}{4}$ mile wide, wave action may necessitate the use of blocks up to 80 lbs. each. The protection must also be thick enough to prevent any action of waves or current entering between the blocks and disturbing the soil of which the bund is made.

(2). That the protection mentioned in (1) is carried below any possible depth of undermining action of scour. The difficulty is to carry this protection down to the proper depth and to ensure the completed surface being smooth and even. For any unevenness or hollows induce eddies and whirls, which cause scour far deeper than the scour caused by the velocity simple of the current.

Now it is a matter of experience that stone laid as LM in *Fig.* 2 will in course of time gradually assume the position LR, if the edge KR is of a sandy nature and scour takes place against KR, this edge gradually retreating towards L as the stone from M falls into position R. *Fig.* 2 is a section and *Fig.* 3 the plan of a Bell bund designed to carry out the above considerations.

In *Fig.* 2 the following points must be observed :—

(*a*). The stone in KL must be thick and heavy enough to resist current and wave action. In the part LR, that is the part below low water, the stone has to resist current action only, but as the stone has to be laid as LM, the heavier each block of stone is the better, as then each block is more likely to fall direct into its correct position in LR when the scour KR takes place. The blocks of stone should be angular, as being less likely to roll and when in final position LR they will jamb and be less likely to be displaced. The thickness T, is generally from 2 ft. to 4 ft. If stone is to be hand pitched, stone blocks between 60 lbs. and 160 lbs. is a convenient size, for these can be handled by one man.



MR. SPRING'S RULES.

F = freeboard.
S = rise of flood.
D = deepest known scour = QR.
T_1 = thickness of slope stone.
Area of slope stone = 2·25 T_1 (S + F).
Apron = LM = 1·50 D.
LW = T_1.
MX = 2·76 T_1.
T_2 = 1·88 T_1 = mean thickness of apron stone.
Slope VW = 2 to 1 = desired inclination of WR.
Area of apron stone = 2·82 DT_1.
KVWXML = original position of stone protection.
WR = desired position of stone protection.

FIG. 2.

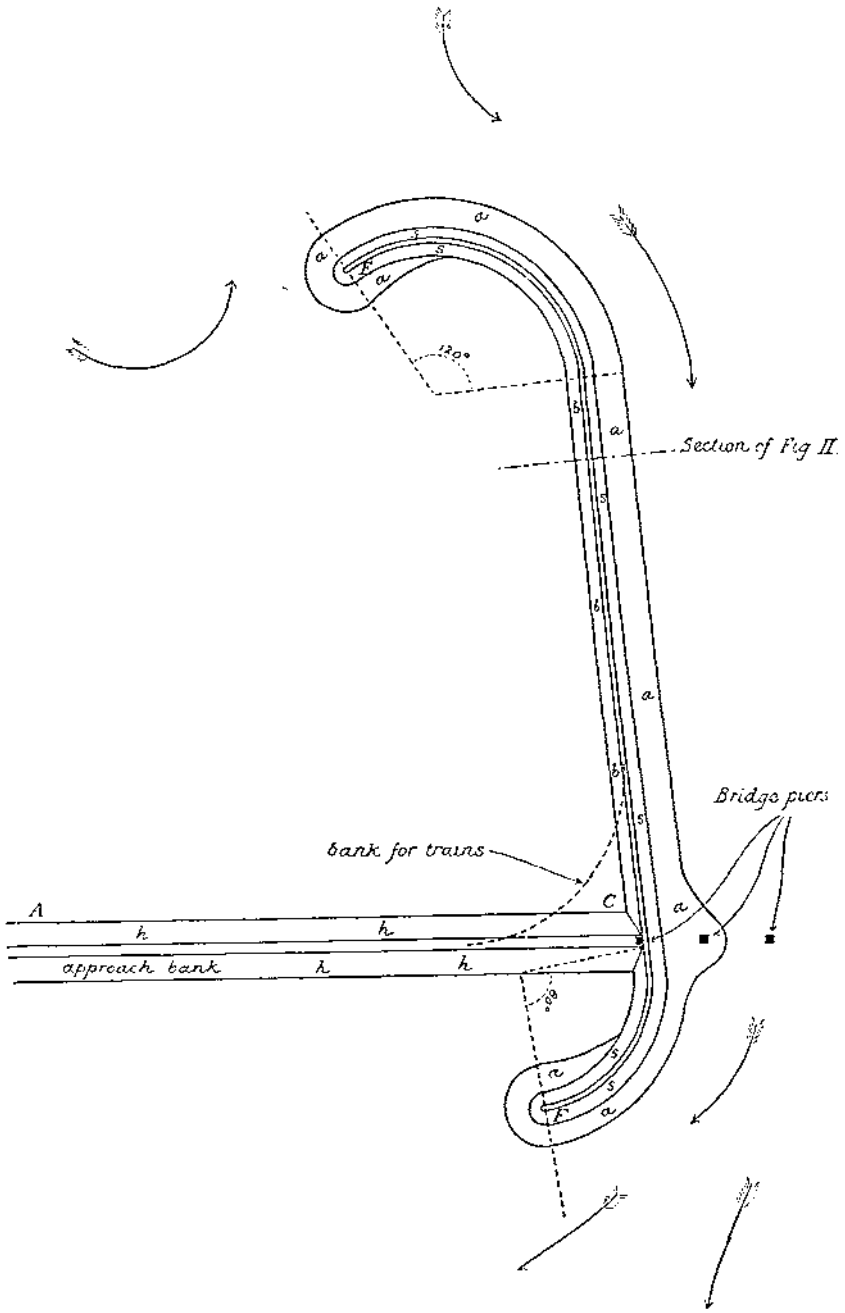
(*b*). The thickness of stone in LM must be greater than in LK, because, when falling into the LR position under water, it is not possible to ensure that each stone will fall properly into its correct place, and so a margin must be allowed so as to make certain that there is a complete protective covering between L and R of from 2 ft. to 4 ft. thick.

A good rule is to make the average of T_2, 1½ times T_1 and to put more stone towards M as the distance the stones have to fall from M to R is greater than from P to P_1.

(*c*). The width NV is usually made wide enough to take a railway track, so that fresh stone can quickly be railed to site, should any of the stone in LR get out of place. For the same reason a reserve of stone is kept near at hand or even on NV.

(*d*). The slope VWR is usually 2 to 1, which is the slope found by experience that stone takes up when falling from such positions as LM to LR.

(*e*). LM, usually called the apron, must be so wide that when the stone takes its final position (it may be after some years) the point R will reach well down to the depth of maximum scour. (This maximum scour is found as described above from surveys and observations of the deepest pools and reaches of the river. In the lower Ganges



aaa = apron.
sss = slope stone.

The area AEC will in course of years silt up. If there is water here the slope stone must be continued to *hh* and on *hh* to protect against wave action. This area AEC is usually strengthened by planting shrubs, trees, etc.

The two bunds are sometimes parallel, sometimes slightly contracted or expanded between E and G (*Fig.* 1).

FIG. 3.

Bridge now being built at Sara, the maximum depth of possible scour has been fixed as 100 ft.).

(*f*). The stone protection LM should be laid at times of low water, so that the stone does not have to fall further than can be avoided. The bund ONVW and protection KLM should be laid during one low water season, as it is important to have the slope KLR as even as possible along the whole length of the bund. If only half the bund is made in one season, it may be impossible to get the bund straight without enormous excavation due to the fact that before the next low water season enormous quantities of sand may be silted up against the unfinished portion, or scour may occur in that portion, making deep water where the bund should be built. It must also be remembered that a bund is not completely safe until finished.

(*g*). The top of the stone at K must be well above any wave action or wash.

As regards *Fig.* 3

(*a*). There will evidently be likelihood of a rush of water round the ends E, F, so that the protection and apron must be carried round as shown.

(*b*). The ends E, F, are generally curved back as shown, the radius being such

(1). That a railway track can go round them.

(2). That water will cling to the curve without forming whirls. It is found that water flowing at 8 ft. to 10 ft. per second will cling to hand-packed stone surfaces of 600 ft. to 800 ft. radius.

(*c*). Extra stone must be given to the apron round the curved ends E, F, because when falling to its final position, R, *Fig.* 2, it will have to cover an increased surface.

The ideas and principles stated in these notes are mainly extracted from Publication No. 153, which deals with rivers in sandy channels, but they can probably be applied to many cases of training works coming under the charge of officers of the Corps, and they should be carefully studied in No. 153 itself, and modified for special conditions. A little knowledge is a dangerous thing.

LEGAL KNOWLEDGE ESSENTIAL TO ENGINEERS.

(*Lecture by* MAJOR W. A. J. O'MEARA, C.M.G., LATE R.E., BARRISTER-AT-LAW, *to Students, Faraday House, 5th March,* 1913).

IT is hoped that the title of this lecture will not have unduly alarmed you. Pray do not run away with the idea that I propose to advocate the view to-day that every engineer should attempt to become his own lawyer; nothing is further from my mind, as I hope to show you later. I neither think that this would be possible, nor do I recommend that, as a general rule, an engineer should attempt to combine the double *rôle*. Indeed, were such a proposition to be put forward, it would stand self-condemned as being opposed to one of the essential principles of economics, which is continually prompting specialization as the readiest means of attaining the highest degree of efficiency.

You may quite rightly enquire why it is then that the particular title given to this lecture has been adopted by me. The theory that every man is assumed to have a knowledge of the laws of the land is probably present in your minds, and you have no doubt learnt, that as in so many other instances in this world, so in this, the requirements of theory are not fulfilled in practice. You may, therefore, well wonder whether there is any particular reason why an attempt should be made to put an additional burden on the poor engineer who has already certainly a sufficiently heavy intellectual load to carry. I should indeed be extremely optimistic, if I could think for a moment, that my opinion alone that an engineer stands in perhaps a somewhat different position to that occupied by men in the majority of other callings, unconnected with the law, could prove a sufficiently convincing argument to support the view expressed in the title of this lecture. I do not, however, propose to adopt any course so dangerous as to ask you to accept my own views unsupported by weightier arguments. It is always well to be frank, and I propose to confess to you that the idea conveyed by the title of this lecture has really been accepted by me owing to the views expressed by Lord Fletcher Moulton, one of the greatest of our Law Lords, in his Introduction to the valuable work by Mr. L. W. J. Costello, entitled *The Law Relating to Engineering*. The following are the words of his Lordship:—"The profession of an engineer involves much more than mere engineering knowledge or even

executive skill. In a large proportion of the matters in which he is consulted he has the responsibility of giving advice, and that advice often relates to acts in which the rights of third parties are directly or indirectly involved. This consideration alone would make it desirable that he should have a sound knowledge of such branches of the law as bear upon the questions he has to resolve. But his need of clear legal conceptions does not depend on this alone. He has not only to administer, but often to frame, contracts of a character which beyond doubt, renders them the most complicated of any that have to be interpreted and pronounced upon by our Courts, and their nature is such that he can only pass on the responsibility to professional lawyers to a small extent. The rest deals with matters so technical that it must remain in his hands."

The above extract expresses with great cogency the peculiar position which an engineer occupies in our industrial organization to-day, and at the same time indicates in some measure how his position differs from that of men engaged in many other callings. It must be borne in mind also, that professional men occupy a peculiar position in the eyes of the law, and to emphasize this latter point I cannot do better than to call your attention to the following extract from Hudson on Building Contracts:—"An engineer must be competent to do what he professes, or take the legal consequences of recovering nothing and being sued for negligence." And by implication an engineer professes to be acquainted with the provision of general and local statutes, by-laws and regulations affecting the works he is engaged upon, and he also professes to have a general knowledge of the ordinary rights of the public.

The object of this lecture, as I have indicated already, is not to impart knowledge which will enable you to become your own lawyer but rather to indicate, very generally, to you what kind of legal knowledge is essential to the engineer, in order to enable him to form a correct judgment as to the situations in which it is desirable that he should seek legal advice, and thus protect himself, as well as his client.

The old adage that "A stitch in time saves nine," is as true in relation to matters affecting legal rights and obligations as in all other departments of life. Money wisely spent on competent legal advice, at the inception of important projects, and in cases in which the question of the infringement of legal rights arise, will often prove a profitable investment and save the expenditure of a larger sum in an attempt to correct an improvident or a careless act.

You are probably all aware that the infractions of law are, for the purposes of justice, divided into two main classes; namely those relating to public and those relating to private injuries. The former class of offences are commonly called crimes, and consist of offences

subversive of law and order; it is not within the scope of this lecture to deal with the offences falling in this category.

Private or civil injuries consist of violations or deprivations of the legal rights of individuals, and it is a knowledge of the principles which govern the rights and obligations in certain classes of cases falling under this category that are of peculiar importance to engineers. Civil injuries are subdivided into two classes, namely, injuries *ex contractu* or those arising out of the violation of duties undertaken by contract, and injuries *ex delicto* (commonly spoken of as "torts") or those springing from the violation of duties imposed by law, to the observance or performance of which every individual in the community is entitled as against the world at large. There is no well-defined border line between these two subdivisions, but they overlap to some extent.

The civil law, in its broadest sense, is based upon a very few elementary principles of justice, fairness, and equity which may be as easily learnt by a layman as by a lawyer. It is the application of these principles to concrete cases, which provides the necessity for the special study which those desiring to follow the calling of a lawyer are obliged to undertake. At one time it was a knowledge of Contract Law alone which was a fundamental necessity to engineers; but owing to the changes which have taken place in the nature of engineering enterprises, engineers must nowadays give increasing attention to matters connected with the general rights of the public, since neglect of them may involve them and their clients in an action for a tort.

Law of Torts Important to Engineers.

It is matters more particularly connected with torts of the following kinds which affect the engineer in his calling in a special degree, namely:—

(i.) Injuries arising peculiarly from acts of negligence,
(ii.) Injuries caused by breach of duty to prevent damage from dangerous things,
(iii.) Injuries or damage caused under circumstances held at law to constitute a nuisance, and
(iv.) Injuries to workmen.

(i.). *Injuries arising Peculiarly from Acts of Negligence.*—Actionable negligence has been defined as the breach of a duty, either

(i.) To do something which a reasonable man guided upon those considerations which ordinarily regulate the conduct of human affairs would do, or
(ii.) To abstain from doing something which a prudent and reasonable man would not do, whereby loss is caused.

In considering cases falling under this category, the real point to be decided is whether the negligence of the defendant was actually the effective cause of the damage. It sometimes happens that although the defendant was negligent, the real effective cause of the damage was either the negligence of the plaintiff or the negligence of a third person. The former is an aspect of contributory negligence and the rule is, briefly, that where the damage would not have happened had the plaintiff himself used ordinary care, the plaintiff cannot recover from the defendant. When the immediate cause of the damage is the interference of a third party, it does not necessarily follow that the defendant is not liable. In every case, it is a question of fact whether the negligence of the defendant was an effective cause of the damage or merely a remote cause. In the former case he is liable and in the latter not. It should be borne in mind that in an action of negligence it is a good defence to show that the plaintiff, with full knowledge and appreciation of the risk of danger arising from the defendant's negligence, voluntarily accepted the risk and exposed himself to the danger.

The onus of proving negligence lies on the plaintiff; and that of proving contributory negligence on the defendant. But where a thing is under the control of the defendant or his agents, and the accident is such as, in the ordinary course of events, does not happen to those having the control of such things and using proper care, the accident itself affords *prima-facie* evidence of negligence. Cases of this kind are of much importance to an engineer. To illustrate what is meant, let us consider for a moment one or two cases which have been decided in the Courts :—A well-known case is one where a man was walking in a public street, and as he was passing by a warehouse a barrel of flour fell upon him from a window of the defendant's house, inflicting injuries to his person. The Court held in this case that there was sufficient *prima-facie* evidence of negligence to cast on the defendant the onus of proving that the accident was not attributable to his want of care—the theory naturally being that barrels do not as a rule fall out of windows in the absence of negligence. In another case, where a railway train was thrown off the line whereby the plaintiff (a passenger) was injured, under circumstances in which the engine, the coaches and the permanent way all belonged to the same company, the Court again held that there was a *prima-facie* case of negligence, as trains do not run off the line unless there is some defect in the track, or the train, or the running of the train. In each case the nature of the accident must be carefully enquired into, and even then it may not be possible for the Judges entirely to agree as to the deductions to be drawn from the evidence. This is proved by a case which recently was carried to the Court of Appeal. The facts of the case are simple : a passenger on an un-

covered tramway car propelled by overhead electric traction sustained damages by the head of the trolley-boom falling on him. Evidence was given to show that the system of electric traction adopted by the defendant company was the best and most widely used, and that the apparatus on the particular car was in perfect order, and further that there had been no negligence on the part of the defendant's servants. The case in question was originally tried in the King's Bench Division with a jury, and the jury returned a general verdict for the plaintiff, with £150 damages. The learned Judge had intimated to the jury that, if they should find for the plaintiff on the ground of negligence, he would ask them to specify the negligence. The jury were unable to suggest what additional precautions could have been taken in this particular case than those disclosed in the evidence; and in consequence the Judge found for the defendants. The plaintiff in this case accordingly appealed. In the Court of Appeal the majority of the Judges (two to one) after listening to the arguments of Counsel in this cause held that, as to the standard of care required in the case of a carrier of passengers, it is sufficient that the carrier should adopt the best known apparatus, keep it in perfect order, and further that the servants employed should work it without negligence on their part. If these conditions are fulfilled the defendant, in the view of the Court, ought not to be held responsible for the consequences of an extremely rare and obscure accident which cannot in a business sense be prevented by any known means.

The dissentient Judge drew the conclusion from the evidence submitted that the truth appeared to be that the accident was so rare that defendants had not troubled to try and guard against it, but had taken the chance. He was of opinion that the verdict referred to, was one which the jury were entitled to give on the evidence. The real issue was whether the defendants had proved affirmatively that they had done everything that skill and care could provide. The above extracts from a case decided only in December last will help to explain how necessary it is for engineers to have some conception of the legal view as to their responsibilities in such matters.

The kinds of cases in which the allegation of negligence, express or implied, may arise are innumerable; it is naturally impossible to deal with so exhaustive a subject in a single lecture, but it is hoped that sufficient has been said on the subject to prove of some real value to you.

(ii.). *Injuries caused by Breach of Duty to Prevent Damage from Dangerous Things.*—It is a rule of law that where a person for his own purposes brings on to his land and collects and keeps there anything likely to do mischief if it escapes, he must keep that thing at

his peril; and, if he does not do so, he is *prima facie* liable for all the damage which may result as the natural consequence of the escape. In cases of this kind a person may naturally excuse himself by showing:—

(i.) That the escape was the consequence of the act of God, or
(ii.) That the escape was caused by the plaintiff's default.

But he cannot as a general rule put forward the excuse that the escape was due to the act of a stranger.

A famous case which well illustrates the principle involved is that in which the plaintiff was the lessee of mines and the defendant a mill owner. The latter had a reservoir constructed on his own property by competent persons, so that there was no negligence on his part. Owing to the existence of disused vertical shafts which had been filled up, and of old workings under the site of the reservoir, the plaintiff's mine was flooded. The plaintiff, in consequence, brought an action for damages against the defendant and won it. The gist of the action in this case was the collecting of the water and not keeping it from escaping, and whether this escape arose from negligence or as the result of a latent and undiscovered defect in the engineering works, was quite immaterial so far as the responsibility of the defendant in the matter was concerned.

The same rule has been applied to the escape of electricity, and, with modifications, is the foundation of the liability for damage done by fire. It should be observed that the liability in cases of this kind does not depend on negligence; the principle of the rule is as explained, namely, that a person who brings a thing, likely to cause damage by its escape, on to his land for his own purposes, is responsible for all the consequences if an escape should actually occur, in spite of the care he may have exercised to provide against its escape.

(iii.). *Injuries or Damage caused under Circumstances held at Law to constitute a Nuisance.*—The injuries under this head may arise either from a public or a private nuisance; the line of division between them is in some cases rather fine. A public nuisance has been defined as some unlawful act, or omission to discharge some legal duty, which act or omission endangers the lives, safety, health or comfort of the public, or by which the public are obstructed in the exercise of some common right. The proper remedy in such cases is either criminal proceedings or an information by the Attorney-General on the part of the public. A private person can only bring an action in respect of a public nuisance where he has personally suffered some substantial particular damage beyond that suffered by the public. Any obstruction of the highway, or anything rendering the use of a highway unsafe or incommodious to the public, as for

instance the digging of trenches thereon or immediately adjoining thereto, the erection of hoarding on a highway, etc., constitutes a public nuisance.

A private nuisance has been defined as some unauthorized user of a man's own property causing damage to the property of another, or some unauthorized interference with the property of another causing damage.

Acts done by a person on his own land which materially interfere with the ordinary physical comfort of his neighbours also constitute a nuisance, and give rise to a cause of action. The maxim of the law in such cases is :—"So enjoy your own rights as not to injure those of another."

The destruction of shrubs from the fumes given off from the chimney of a smelting works ; smoke, unaccompanied with noise or with noxious vapour ; noise alone ; vibrations caused by machinery in motion, may severally constitute a nuisance. Further, any unjustifiable interference with an easement or other servitude is usually classed with nuisances. The easements known to our law are numerous, of which the most familiar are :—

(*a*) Rights to free access of light and air,
(*b*) Rights of support for buildings,
(*c*) Rights of support for land,
(*d*) Rights of way, and
(*e*) Rights to the use of water.

Questions affecting one or other of these rights will often be met with by you in your practice as an engineer, so that it is always well to be on the look-out for their existence.

It is well to remember that it is considered proof of ignorance and unskilfulness not to act in accordance with the rules of a profession. And the effect of this is to render an engineer liable for any damage resulting to his employer from any neglect to employ the usual and proper means for examining the site of a work, etc., and of ascertaining whether there are rights of way, light, support, or other easements before he makes his plans.

(iv.). *Injuries to Workmen.*—Generally a master is liable for the negligence of his servant for acts committed in the course of his employment. However, the liability of a master to his servant for an injury arising from the negligence of a fellow-servant is on a different footing to his liability for an injury to a stranger or third party.

This results from the doctrine of Common Employment founded on the idea that the servant takes all the risks incident to his employment as part of the contract of service. The Legislature has in

recent years created exceptions to the old rule of the Common Law, for :—

(i.) By the Employer's Liability Act, 1880, a remedy by action for damages has been provided in certain specific cases for servants who are injured by the negligence of their fellow-servants in the course of their employment, and

(ii.) By the Workmen's Compensation Act of 1906—which does not, by the way, repeal the Employers' Liability Act—all servants to whom it applies are given a statutory right to be compensated for accidents suffered by them "in the course of and arising out" of their employments, whether such accidents are caused by the negligence of a fellow-servant or not.

Under the doctrine of Common Employment, which remains in force in spite of the statutory remedies referred to, a master is only liable to his servant for damage resulting from his own personal negligence.

Such negligence may arise on the part of the master in any of the following ways :—

(*a*). By the employment of another servant with the knowledge that he is incompetent.

(*b*). By the retention in his employment of a servant known to be habitually negligent.

(*c*). By allowing plant on the premises to be in a dangerous condition.

(*d*). By the breach of an absolute unqualified duty imposed on the employer by Statute to do something for the protection of workmen.

In order that a servant may obtain his remedy under the doctrine of Common Employment there must be both a common master and common employment under that master.

The effect of "The Employers' Liability Act" is to give a workman, as defined by the Act, who suffers an injury by reason of certain specified acts of negligence a remedy against his master, as if he were not his servant but had merely entered upon his premises.

And under "The Workmen's Compensation Act" the liability to pay compensation arises independently of any neglect or wrongful act (otherwise than wilful misconduct) on the part of the master or the servant injured.

There is a difference in the amount of compensation an injured workman may be awarded according to whether he sues under the old Common Law, or seeks his remedy under the Workmen's Compensation Act ; in the latter case a County Court Judge deals with the matter in the capacity of an arbitrator. In the former case the

amount of compensation depends on the amount of the suffering caused to a workman and the expenses of his illness, and the remedy under the Common Law may therefore prove more advantageous to the workman where he has a good cause of action than the remedy under the Act; in the latter case the amount payable is fixed by scale and represents the difference between his wages and earning capacity before and after the accident. It is, as a rule, not difficult for an engineer to take such precautions that, in the event of an accident unfortunately occurring, the workman can have little hope of success in an action under the Common Law. The Workmen's Compensation Act has however considerably modified the old law since it has given the employé very extensive protection, and the only safe course for the employer to adopt nowadays, is to protect himself fully by means of Accident Insurance policies. It must be remembered that under this Act even where the workman has been negligent, or has acted contrary to his master's instructions, yet even in such circumstances the County Court Judge, acting as an arbitrator, may make an award in the workman's favour.

Brief as the foregoing references are, I hope that I have succeeded in putting before you in sufficient detail the more important points relating to the Law of Torts which may prove useful to you at the commencement of your careers. In later years, your every-day work will familiarize you with other aspects of the subject, and I can only hope that the accumulation of knowledge in your case will be gained rather at the cost of other people than at your own expense.

Knowledge of Law of Contracts Essential to Engineers.

I now propose to say a few words concerning the Law of Contracts. Probably during the whole of your professional career you will be concerned with the making and performing of contracts, and therefore a knowledge of this branch of the law is really a fundamental necessity to you. It is difficult to frame a sufficiently broad definition to cover the many varieties of contract, and indeed almost as many definitions are to be found as there are varieties of contract.

Put very briefly a contract is an agreement enforceable at law to do or to refrain from doing a certain act; it may be made by deed, writing, or word of mouth. A contract really consists of an offer made by one party, and acceptance of that offer by the other party to the contract; and in all cases there must be evidence that the minds of the parties have come to an agreement about exactly the same thing; therefore an offer which is not communicated to the other party is of no legal value.

The importance of a contract, from the standpoint of law, lies in the fact, that, whereas it is created by the voluntary act of the parties

thereto, yet, once made, the Courts will enforce it with the same strictness as if it were part of the Statute Law of the land. The Courts extend no protection to the maker of an improvident contract, except in the cases of certain persons, who, for their own protection, are by law declared incapable of entering into a contract. This class comprises infants, lunatics, intoxicated persons, and persons under duress. The law presumes that in making a contract the parties are best able to settle its terms, and, although these may prove oppressive to one party or the other at a later date, yet this is a consideration that can rarely influence a Court of Law which, in the general interests of commerce and industry, rightly endeavours to jealously guard the inviolability of rights acquired by the terms of a contract.

You are all probably aware that in ordinary cases in order to make a binding contract it is strictly necessary to enter into a definite agreement either in writing or by word of mouth; however, if a person goes into a shop and orders goods, the law implies that he has contracted in such a case to pay the reasonable value for the same. Contracts of this nature are termed implied contracts in contradistinction to express contracts, the terms of which are openly expressed.

Implied contracts sometimes present complex problems when questions arise as to whether an individual has not made himself liable to certain obligations by his conduct, although he may not have intended any such result to follow. It is only necessary to warn you here that before accepting a benefit of any kind, it is always as well to ascertain exactly what liability you may be incurring in respect thereof—it is rarely one gets something for nothing in this world.

Express contracts are divided into two classes, namely those made under seal and those not so made. The former class are referred to as specialty contracts, whilst the latter are termed simple, or parol contracts. Simple contracts differ in two important respects from specialty contracts:—

(1). In the case of a simple contract there must be some consideration to render it valid, whilst in the case of a specialty contract it is the form in which it is made that renders it valid apart from consideration.

Consideration in the legal sense may be defined as some benefit to the person making the promise, or some loss, trouble, inconvenience to, or charge imposed upon the person to whom the promise is made. Although consideration is essential to the validity of every promise not under seal, and must move from the promisee, it need not be adequate as long as it is of some ascertainable value, legal, and not past.

(2). The second important difference is that, whilst an action on a

simple contract is barred by the Statute of Limitations in six years, on the other hand an action on a deed or specialty contract is only barred after the elapse of 20 years.

Any person, with the exception of one of the class coming under the disabilities referred to earlier in this lecture, may enter into a contract in relation to any subject matter as long as the same is not contrary to law, morality, public policy, or, within certain limits, impossible. Attention has been drawn to the fact that the Courts have always endeavoured to protect the inviolability of contracts; and this has naturally led to the rule that the agreement on which a contract is based must indeed be a real one in every sense of the word; so that an agreement secured either under mistake, or by undue influence or misrepresentation, duress or by fraud do not fulfil this test, and hence are rendered either voidable at the option of one party or absolutely void. The difference between a voidable and void contract lies in the fact that in the former case one of the parties may at his option either treat the agreement as binding on him or not, whereas in the latter case, the situation in the eyes of the law is simply that no contract at all has been, or could have been made. A great deal more could be said on this aspect of contracts, but the time at our disposal can perhaps be better utilized in touching briefly on several of the more important aspects of the subject rather than going too fully into any one particular matter.

The next point which may usefully be considered here is that connected with the circumstances under which one or other of the methods of entering into a contract referred to should be adopted. As a matter of fact we have not in every case a free choice in this matter.

The Common Law and certain Statutes provide that in particular instances agreements must be under seal, in others that they must be in writing, or in some cases supported by written or other statutory evidence, whilst the remainder may be made verbally or by conduct.

The kinds of contracts, of most interest to you, which are subject to restrictions of form are :—

(1). At Common Law, the contracts of Corporations.
(2). Partly by the law merchant and partly by Statute, the contracts expressed in negotiable instruments.
(3). By Statute only :—
  (i.). Contracts under the Statute of Frauds.
  (ii.). Contracts under the Sale of Goods Act.
  (iii.). Insurances.
  (iv.). Acknowledgment of debts barred by the Statute of Limitations of James I.

(1). *The Contracts of Corporations.*—The general rule in such cases is that the contract must be made under the Common Seal of the Corporation. There are exceptions to the rule in the case of trading corporations which may make without seal any contract which is incidental to the ordinary conduct of their business. Similarly, a non-trading corporation, if expressly created for special purposes, may make without seal any contract incidental to those purposes.

Corporations have at times endeavoured to take advantage of the technicalities of the law to repudiate their obligations, but the Courts have laid it down that a corporation is bound by an obligation implied by law when an individual would be. It behoves engineers who enter into contracts with corporations to take care that all the formalities of the law have been complied with so as to ensure that such contracts are binding. The Courts have, it is true, ruled, that where an engineer has done work or rendered services at the request of a corporation in respect of matters for the doing of which it was created, and the corporation has accepted the benefit of the work and services, the law will imply a contract on its part to pay for the same, and, in consequence, the absence of a contract under seal will not be accepted as an answer to the action. But still, there are circumstances under which the Courts cannot act upon the foregoing equitable principle owing to the existence of Statutes which prescribe a special form which must be obeyed.

Thus by Section of 174 of the Public Health Act, 1875, every contract made by an urban authority, whereof the value exceeds £50, shall be in writing and sealed with the common seal of such authority. The effect of this provision is that without the seal the contract is void, and that an urban authority may make a contract, reap the full benefit, and then decline to pay. Cases falling under the provisions of the foregoing Statute are on record in which engineers have been victims of their own carelessness, that is to say, owing to their failure to observe that the requirements of the law had been complied with so as to protect their interests, engineers have, at times, failed to obtain a judgment in Courts of Law for remuneration in respect of services actually rendered by them. I can only hope that no unfortunate experience of this kind may ever befall you.

(2). *Negotiable Instruments.*—The peculiar contracts entered into by persons who issue or endorse negotiable instruments, that is bills of exchange, cheques, and promissory notes, must by the nature of the case be in writing. Part of the definition of a bill of exchange is that it is an unconditional order in writing. The acceptance of a bill of exchange, though it may be verbal as far as the law merchant is concerned, is required by Statute to be in writing and signed. This subject is a difficult one to deal with in a few words. I can only urge you to exercise, at all times, the greatest caution in dealing with

documents which purport to be negotiable instruments, hidden dangers often lurk in transactions in which such documents play a part.

(3). (i.). *Statute of Frauds.*—It is the provisions of the 4th Section of this Statute which are of most interest to engineers. These provisions require that in certain classes of cases no action upon an agreement can be brought unless there is some memorandum or note thereof in writing, and signed by the party to be charged therewith or by some other person thereunto by him lawfully authorized.

I need only draw your attention to the following three sorts of contracts within the mischief of this section :—

(*a*). A promise to answer for the debt, default, or miscarriage of another person. This is what is known as a contract of guarantee ; and the real object of the contract must be the payment of the debt of another. What you have really to be careful about is, that when a third person undertakes to be responsible to pay for goods which you have sold to another, if this latter person should fail to meet his liability to you, be exceedingly careful that you get this third person to give you his undertaking in writing, otherwise you may be disappointed at a later date. It should be clearly understood that the terms "default" or "miscarriage" refer to wrongful acts creating a liability for damages which are not breaches of contract.

(*b*). A contract of sale of lands, or any interest in or concerning them. The difficulty in this section has been to say what are "interests in or concerning lands." It has been held that an agreement for a person to take water from a well comes within the mischief of the Act. In view of this provision of the law, just consider for a moment what your position would be if you had commenced and completed a generating station, on a site adjacent to the property of a landowner possessing the only available water supply within several miles of the station, on the faith of a verbal understanding with him that he would allow you to obtain your water from his land, and then if he should repudiate the agreement just after your plant is completely installed. Clearly, it would be useless for you in the present state of the law to seek your remedy in any of our Courts of Justice. The subject is too wide to be further dealt with in this lecture, and I can do no more than just draw your attention to the matter here in order that you may be on your guard. Being forewarned, you can readily seek legal advice in all cases of doubt.

(*c*). Agreements not to be performed within the space of one year from the making thereof. This clause of the Statute has provided and continues to provide much material for actions in our Courts. The clause clearly refers to agreements, which from their terms are incapable of being completely performed within the year, and does not apply to those contracts which may be performed on one side within the year though they cannot be performed on the other in

that time. I can only warn you that, in spite of the apparently simple language of the Statute, a considerable amount of care requires to be exercised to determine whether an agreement is within or outside the mischief of this clause. The only other matter I need draw your attention to in connection with the above clauses of the 4th Section of the Statute of Frauds is, that the Statute is satisfied so long as there is a note or memorandum relating to such contracts in writing by the party to be charged or his agent, and that the Statute does not prescribe that the specified contracts themselves shall be in writing.

(ii.). *Sale of Goods Act*, 1893.—Section 4 of the Act which replaces Section 7 of the Statute of Frauds enacts that:—

(*a*). "A contract for the sale of any goods of the value of £10 or upwards shall not be enforceable by action unless the buyer shall accept part of the goods so sold, and actually receive the same, or give something in earnest to bind the contract, or in part payment, or unless some note or memorandum in writing of the contract be made and signed by the party to be charged or his agent on that behalf."

It would seem that when specific goods are sold without regard to the provisions of the Statute, the property passes to the buyer. The purchaser cannot under such circumstances sue the buyer for the price, but if the latter declines to pay, the only course is to treat the contract as rescinded, in which case the property will revest in the original owner.

(iii.). *Insurances.*—The Marine Insurance Act, 1906, requires that policies of Marine Insurance shall be in writing, and that only persons who have an insurable interest in a marine adventure shall be permitted to take out a policy.

It is well to remember that a higher measure of good faith is required from both parties in contracts of this nature than in the case of ordinary contracts. Conditions are implied from the nature and not from the words of the written contract, and terms are incorporated from the conversations of parties, though appearing nowhere in the policy.

The above remarks apply generally to fire insurance policies also.

(iv.). *Acknowledgment of Barred Debts.*—The operation of the Statue of Limitations of James I. in taking away the remedy for a debt may be excluded by a subsequent promise to pay it, or an acknowledgment from which such promise can be implied. The promise or acknowledgment if express must be in writing,—it naturally must be made within six years, unless there is a new consideration—and signed by the debtor, or his agent duly authorized. The reference to this matter will show you the importance of carefully preserving any correspondence which may pass relating to debts of the class referred to here.

Discharge of Contracts.

Contracts may be discharged by :—

(i.). Agreement.
(ii.). Performance.
(iii.). Breach.
(iv.). Impossibility.
(v.). Operation of law.

(i.). *By Agreement.*—As an agreement makes, so can it unmake a contract. It is the act of both parties and results in the rescission of a contract. Where neither party has done his part it may take the form of a release; where, however, one party has performed his part, and the other has committed a breach, the release must be supported by a new consideration which if "executed" is termed an accord and satisfaction, otherwise the release must be under seal. The parties to a contract can also by agreement alter it or substitute a new one for the original. Agreement is a matter of fact and may be inferred from the conduct of the parties.

(ii.). *Performance.*—When both parties have done what they originally agreed to do, the contract is at an end and discharged. This matter requires no further comment.

(iii.). *Breach* of a contract gives a cause of action against the offending party. What amounts to a breach is in some cases a difficult question to determine. The party who suffers damage by the breach of a contract is entitled to pecuniary satisfaction in the event of his success in an action at law. The important matter to remember in this connection is that, in cases of contract, it has been laid down as a proper rule for the Courts to follow, that the damages, which the injured party ought to receive in respect of a breach of contract, should be such as may fairly and reasonably be supposed to have been in the contemplation of both parties at the time they made the contract as a probable result of the breach.

The last sentence is important; what it amounts to is that if, at the time of making a contract, one party makes known that in the event of a failure on the part of the other party to fulfil the contract there are special circumstances which will involve abnormal loss to the injured party, then, in the event of a breach of contract actually occurring, the Court in assigning the amount of compensation to be paid to the successful plaintiff will take the special circumstances into account. Where the defendant is kept ignorant of any special circumstances the Court will always disregard the same in determining the compensation. The moral is, that when making a contract, be sure to let the contractor know of the existence of all special circumstances connected therewith.

(iv.). *Impossibility.*—Where it becomes impossible to perform a contract subsequent to the making thereof, a party is not necessarily discharged from his liability in respect thereof, because in making the contract he might have guarded himself against such an accident. This question is somewhat technical and it would be unprofitable to attempt further to deal with it in the short time at our disposal.

(v.). *By Operation of Law.*—The law operates to discharge contracts in certain cases. All contracts for personal services which depend on the life or health of the party contracting are subject to the implied condition that he shall be alive, or in good health to perform them. Death or ill-health, in such cases, operates as a rescission of the contract.

Similarly, in cases of bankruptcy, an order of discharge releases the debtor from all debts provable under the bankruptcy, whether in fact proved or not. There is another class of cases to which the term "merger" is applied. This amounts to the substitution or acceptance of a security which in the eye of the law is of higher operative value, in place of another. For instance, a simple contract may be merged in a specialty, if the parties embody the terms of an existing contract in a deed. Further, if an action is brought on a specialty or simple contract and judgment is recorded thereon, these are merged in the judgment. In the case of a default of the loser, the winner brings any further action on the judgment and not on the original contract.

There are many other matters relating to contracts which are of considerable importance to engineers, but I must content myself with a reference to one more matter only, namely, that relating to the construction or interpretation of contracts.

Construction of Contracts.

Perhaps there is no duty which an engineer is called upon to undertake which is a more responsible one and requires greater care than the framing of a contract. The importance of the choice of the correct words, and their proper collocation, cannot be exaggerated, for when a dispute arises between the parties to a contract all that a Court of Law can do is to interpret the language contained in the document, which purports to set out the matters on which the parties actually came to an agreement. A moment's reflection will show the serious inconveniences which would arise if the practice was otherwise, and if the parties to an express contract were allowed to argue that language deliberately employed in the written document did not actually set out their intentions.

It is well therefore for an engineer before he signs a contract to analyze closely the expressions which are employed therein, so that he may make certain that the phraseology is so clear, and the terms

so explicit, and every contingency provided for that, if submitted to a Court of Law, the language employed will support the interpretation which he desires shall be put upon it.

Disputes often arise from the fact that the parties to a contract are mistaken in their ideas of their obligations thereunder; it is always a wise precaution in all important dealings to seek legal advice, and in none more so than in the preliminary stages of a large contract, so as to ensure, as far as it is possible to do so, that the real intentions in relation to the contract appear in clear and unambiguous terms. And, where this result has been successfully obtained in the instrument containing the terms of the contract, you may rest assured the Court will give full force and effect to the same, and will not allow any explanation to vary or alter the explicit statements forming the contract. The theory naturally being, that the parties are presumed to know what they intended at the time they entered into the agreement, and chose words to express their requirements with the greatest deliberation and care, and, in consequence, such intention must prevail however burdensome or disagreeable the conditions may prove at a subsequent period. On the other hand, if the matters in dispute are only partially covered by the terms of the contract, and the phraseology employed is susceptible of two or more interpretations, it becomes the province of the Court to determine what meaning must be attached to the language in the instrument. A number of broad rules have been established to guide the Courts, and, in consequence, should be borne in mind by those whose duty it is to frame documents which have a legal value.

These rules are as follows:—

1. Persons are presumed to contract with reference to the habits and customs of a locality, and the Court will take cognizance of such particular usages or customs affecting the subject matter of a contract, unless their operation is excluded therefrom by express words.

2. The words in an instrument will be given their ordinary and commonly accepted meaning, unless from the circumstances of the case it appears that they were used in a special sense.

3. Where the subject matter of the contract concerns a particular trade or business, words having reference thereto will be given the meaning usually ascribed to them in such business or profession.

4. The best way of getting at the meaning of an instrument is to ascertain when and under what circumstances it was made; the Court will have regard to such circumstances to arrive at the real intent of the parties, and will give force and effect to such intention.

5. Where the language of a written instrument is perfectly plain no construction will be put upon it to contradict the language.

6. The contract will be construed reasonably, *i.e.*, not merely the literal meaning, but also the true meaning will be examined.

7. The construction will be on the entire instrument, that is, one clause will not be looked at alone, but the context will be taken into consideration.

8. The language of an instrument will be always construed strongly against the person whose language it is.

The rules are logical and contain the principles of fairness and equity, and I cannot do better than commend them to your serious attention.

CONCLUSION.

I have endeavoured to put before you very briefly some of the salient points of our Common Law. It has been said that lawsuits originate more in the gross misconception of litigants, in their mistaken notions of each other's rights and liabilities, than in positive dishonesty and bad faith. I can only trust that the remarks I have made may prove sufficiently useful to remove to some extent such misconceptions in your case, and help to free you from the burden and anxieties of litigation in your future career.

TRANSCRIPT.

TRENCHES IN HILLS.

Extract from an article entitled "The Influence of the Pyschical Element in Conjunction with other Factors, upon Fortification Types," by V. Polyanski in the May, 1912, number of *Injenerni Jurnal.*

The siting of trenches in hills offers greater difficulties and complications than does that of trenches in level or rolling ground, and as hilly country is so often met with, a satisfactory solution of the questions of what types are applicable, how they are to be applied to the ground, and how concealed, is clearly necessary.

These questions are complicated by the following conditions:—

(1). *The Soil.*—Among hills this is generally rocky with a thin top layer of disintegrated rock, or, in exceptionally favourable circumstances, stony or gravelly. Earth is found only in ravines, sand and occasionally gravel in river beds. In such conditions, with the *rapid* (one night) fortification of a position, in the most favourable case one cannot count upon making a trench deeper than for occupation *kneeling*. With provisional fortification, and with the help of explosives and large entrenching tools, deeper profiles might be excavated.

(2). *Concealment.*—This is much more difficult than in level ground, where the works are seen against backgrounds of other works or of local objects, and the atmosphere is often thick enough to make observation difficult. Here the air is clearer, orientation is simplified, and worst of all lights and shades quickly expose the positions of parapets and trenches.

(3). *Vulnerability.*—The steeper the hill slope the more direct is the exposure of works constructed upon it to the action of hostile shells. Taking into consideration that ranging is more easy and that firing can be continued much later without injuring the assaulting troops, it is easy to conclude that the percentage of hits in trenches sited on hills will be considerably greater than in those on level ground. These three conditions govern the siting of trenches on hills. Hitherto the textbooks have laid down that trenches must be sited where they can obtain the best fields of fire over the front-lying ground, and also if possible the best concealment. For this they should be pushed down the front slopes to the line which is commonly known as the "military crest."

A few years back however a pamphlet was published in which the author severely criticized the standard system, and among other things insisted that rifle trenches should be sited on the topographical crest, where they would retain the distant and near (50 to 60 paces) fields of fire, but sacrifice the command of the lower slopes in their front. In

special cases he even considered it possible to occupy reverse slopes. The following reasons are given for this opinion:—the impossibility of concealing trenches on a front slope, the facility of their destruction by artillery fire, the absence of cover even from shrapnel, the difficulty of manœuvre and of communication with the rear.

This pamphlet raised a storm of controversy, the supporters of the standard system maintaining that the siting of trenches on the military crest must remain a fundamental rule, as it is impossible to allow large areas of dead ground in front of the trenches, and it is essential that the garrison should be able to watch the advance of the hostile attack. Instances from the Russo-Japanese War quoted in the pamphlet, where trenches thus sited were untenable under artillery fire, and where the trenches were demolished and their defenders slain, are true of trenches giving but kneeling cover, but not of trenches of deeper profile which were not demolished and gave ample protection against shrapnel fire. But a glance at the conditions will show that whereas one side was arguing from the point of view of rapid fortification, the other was considering only the conditions of provisional.

The troops must occupy the best firing position in which adequate cover is obtainable. If troops not protected by trenches are posted on the military crest, where they will obtain cover neither from the fire nor even from the view of the enemy, the first rounds of shrapnel will send them flying for shelter behind the topographical crest, which, though a bad firing position would have become for them the only possible one. Trenches which give only lying or kneeling cover do not alter the case. They do not give protection from shrapnel fire and splinters, rifle bullets penetrate their parapets, and it is impossible to conceal them. This was repeatedly experienced in the war in Manchuria. Trenches on the military crest which give only kneeling cover are impracticable, during the artillery bombardment the troops who occupy them must be withdrawn to the reverse slope, and as the bombardment is continued almost up to the time of the bayonet charge it is hardly probable that these trenches will be re-occupied in time. Under the conditions of *rapid* fortification, the firing position must be the topographical crest, and here there should be merely screens, connected with secure shelters in rear of the crest. Dead ground in front should be avoided by the mutual protection given by the combined siting of trenches, by concealed flanking batteries of machine guns, by hand and rifle grenades, artillery cross-fire and by land mines.

Trenches of deep profile on the military crest are not easily demolished by the fire of field guns, and sometimes allow of the defenders being kept in them during the artillery bombardment, though it must be admitted that they do not give security against the shrapnel fire of howitzers. But well-concealed communication trenches are a necessary adjunct to such trenches—these arteries of modern battle by which reinforcements are introduced, troops retired, stores brought up and the wounded removed. In the absence of communication trenches the *moral* of the troops is affected, and they cannot be trusted to await the hand-to-hand encounter.

The influence of the psychological element is well shown in the following words of Colonel Dorokhin, who took part in the late war:—

"Frequently the trenches were sited far down the hillside. In the majority of cases it was impossible to communicate with them. The men knowing this could not endure it, and evacuated them. We tried punishments, prayers, threats, but all to no purpose. The troops either deserted them or were killed, and the trenches, as happened in my sight at Liau Yang, were demolished off the face of the earth. Occupying the crest and without any trench, I suffered loss from the enemy's artillery fire, but none the less I succeeded in defeating all the efforts of the Japanese to carry the crest. The attackers had to clamber up the hill, and before they reached the crest they were generally exhausted. In fact the slope of a steep crest line as an obstacle does not yield place to a wire entanglement."

Trenches sited on a front slope should also be fitted with defensive casemates, which would allow the defenders to open fire on the attacking infantry in spite of high-angle shrapnel fire, which might continue up to the bayonet charge. But trenches of deep profile, communications and casemates are realizable only under the conditions of *provisional* fortification, and they must be ideally concealed. If the attack has howitzers or guns of large calibre, all kinds of trenches on the military crest will be soon demolished. The garrisons would have to be withdrawn, and it is doubtful if they could ever be brought back under the fire of howitzer shrapnel.

It appears therefore that the siting even of provisional works on hill-sides well seen by the enemy is unwise. Commanding heights are extremely important in modern hill fighting as observation stations. It frequently occurs that the whole fate of a battle turns on the struggle for some hill or other. The moral value of such observation posts is immense. The emptiness of the modern battlefield creates extremely difficult conditions for directing the fight, even for the junior commanders, and it is extremely probable that both sides will direct all their energies towards the capture of such a point, from which something can be seen and bearings can be adjusted. The side which possesses such points at once gains great advantages, and this is instinctively recognized even by the rank and file. So that the varying incidents of the fight for such a hill top are clearly reflected in the spirits of the troops.

Commanding heights must therefore be resolutely defended, but this does not necessarily mean that they must be covered with works of defence. The experience of the Russo-Japanese War shows that if works of defence are plainly visible (and on hills they undoubtedly will be so) they will be quickly demolished by artillery fire. The heights should be defended by arranging to command the approaches to them from neighbouring parts of the position. On the heights themselves there should only be ideally concealed observation stations, and on their reverse slopes secure shelters.

The question of the selection of a firing line on hills, therefore, is answered apparently in the following manner:—In cases where the time allows the construction of trenches only of weak profile, or if the enemy possesses guns of large calibre, the rifle position should be the topographical crest, every endeavour being made to conceal the defenders

from the enemy's view. The best firing positions have to be sacrificed, and we have to be content with what is possible and trust to the ground in front being commanded by cross-fire from neighbouring trenches, by hand or rifle grenades, mines, etc. The most important defence works must include earth screens for riflemen, shelters on the reverse slopes, and paths for rapid and unimpeded communication along the front and in the depth of the position.

Under the conditions of provisional fortification when there is time to excavate trenches of deeper profile, with defensible casemates and communication trenches, when all works can be ideally concealed, or when the enemy is known to possess no guns of large calibre, the trenches should be sited on the best fire position, the military crest. But as on the one hand ideal concealment on the military crest can be obtained only under exceptional circumstances—a trench, for instance, without parapet on a fold of the hillside—and on the other, in an attack on a provisionally fortified position guns of large calibre, up to 8 in., will probably be used, and as provisionally fortified positions for large forces are exceptional, we may lay it down that the siting of trenches on the military crest must be considered not as the rule but as the exception.

F. E. G. SKEY.

NOTICES OF MAGAZINES.

Militär Wochenblatt.

The Development of Flying in the Half Decade 1908 to 1912 and its Military Significance.

The following is a *précis* of an article with the above title by Capt. E. Schmidt in the *Militär Wochenblatt* No. 34 of 15th March:—The development of flying tends to make its uses more and more exclusively military. Its possibilities for reconnaissance have increased enormously. Aerial reconnaissance will be particularly valuable against the artificial tactics of the French, with their strategic advanced guards and advanced positions, and their dependence on the sudden and unexpected shock of great masses. Aerial reconnaissance will also be most valuable in fortress warfare to discover the progress of the defenders' works. The use of aircraft for offence, except against hostile aircraft, is gradually taking a secondary place. In the Navy hydroplanes, that can be employed in a rough sea and yet can be stowed on board a warship, are being developed. It is most desirable that aircraft should be completely independent of the surroundings of temporary resting places and should be able to rise vertically. In any case aeroplanes must be built so as to be able to rise from uneven and cultivated ground with a very short run. The author states that whereas English aeroplanes require a run of 200 to 300 yards to get off the ground, the German biplanes at the Berlin Flying Week, October, 1912, only took, on the average, 82 yards, and the monoplanes 132 yards. Aircraft to keep out of reach of hostile fire must travel at least 1,000 metres (3,280 ft.) above the ground, unless they can get the shelter of a cloud. At this height they are also freer from disturbances of the air. Every year shows aeroplanes going higher and higher; in 1912 a height of 19,000 ft. was reached. The speed with which aircraft can rise is of great military importance. The Zeppelin "Victoria Luise" can rise 3,280 ft. in four or five minutes, and thus ought to be able to escape from hostile aeroplanes which can only climb at half this speed. Yet owing to loss of gas at great heights airships cannot ascend as high as aeroplanes. The altitude record for airships is that of the French dirigible Conté—3,025 metres (9,924 ft.). The speed of aeroplanes has greatly increased. In 1909 the record was 47 miles an hour; in 1912, 109 miles. The importance of speed is that the quicker the machine flies the less it is affected by the wind. High speed does not prevent accurate reconnaissance, in fact by flying in a circle round the area, which can be done with little loss of time, better observations can be made than by a flight across it. The disadvantage

of high speed is the danger of landing, for a fast machine easily turns over. The time that a machine can remain in the air has greatly increased. In 1908 the record was 2 hours 20 minutes; in 1912, 13 hours 17 minutes. In the same period the distance travelled in a single flight rose from 77 miles to 630 miles. The weight-carrying capacity of aeroplanes has increased. The author discusses the causes of accidents and classes them as due to atmospheric causes, over-fragility of build, and motor trouble. He concludes by saying that all this progress is useless unless the *personnel* is trained to make the fullest use of the improved *matériel*.

"E."

RIVISTA DI ARTIGLIERIA E GENIO.

November, 1912.

SOME REFLECTIONS ON SIEGE WARFARE.

An article by Colonel Rouquerol in the *Journal des Sciences Militaires* (15th September to 1st October) is well worthy of attention, the author being famous on account of several important publications on the employment of field artillery.

The author commences by distinguishing the differences that exist between the fronts of the attacking and defending forces. The assailant being master of the external ground can select the method of approach best adapted to the particular case. Moreover he can remedy his errors, abandoning an attack that is badly conceived or does not prove successful, in order to seek a better issue at another point. For example, the Japanese at Port Arthur, finding their efforts against Dragon Hill useless, turned their attacks against 203-Metre Hill. The defenders, however, are not able to refuse the conditions of strife offered by their adversaries. The defending troops in a regular siege are numerically inferior to those of the attack, and would have few mobile batteries, owing to the difficulty of feeding the horses. Besides this, artillery would not have the facilities for manœuvring, and it is on such facilities that the advantages of modern artillery so greatly depend. The assailants on the other hand would possess a strong proportion of the best field artillery.

The material of the artillery of the place will not always be of the most recent pattern, or that best adapted for the conditions of defence; the place should be able to sustain the siege with the material that it possessed previous to the commencement of the attack. The assailants, however, can prepare the material necessary for the proposed attack a few weeks before the commencement of operations.

If errors in the preparation of the park arise, owing to an inexact appreciation of the means of resistance of the place, these can be corrected before the siege operations are begun. For instance at Port Arthur, at the commencement, the siege park did not possess shells of large calibre, and the Japanese had not cannon of this kind. But the want of heavy

shells was soon felt for the purpose of destroying the cemented covered ways, and such shells were brought to the batteries from the coast armaments. During a war of a certain duration the assailants can procure guns of a new pattern, while the defenders of a besieged place are not able to reinforce their armaments. The same applies to ammunition. The assailants can always replace that which is expended, incurring only the risk of lessening their fire. But the defenders after a long siege are restricted from a day's exceptional consumption of ammunition, by the reflection that they will not be able to continue the fire on the following days.

Between two adversaries having such unequal conditions, the strife cannot be long without the assistance that the defenders obtain from fortifications. These conditions have always been found to hold good, and they are more marked by the power of modern artillery, which makes it more than ever necessary for a place to have a means of defence adequate to that of the attack. While in the past it was possible to organize an efficacious defence with improvised means, to-day only permanent fortifications can resist the projectiles of siege artillery.

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To form a correct idea of what is required for the defence of a modern place, it is first necessary to take account of the means and the power of the attack.

All the great European Powers possess not only organized siege parks, but also light parks which are able to follow the troops in the field. Germany can dispose of three principal centres, Metz, Cologne, and Thorn, with siege parks ready to be placed on the railways, and she has besides 120 batteries of foot artillery with guns of 15 to 20 c.m. The mobilization of these batteries require five or six days, so that a mass of artillery of medium calibre can march behind an army intended for the investment of a fortified place. It would be absurd to suppose that improvised works or antiquated walls would be able to resist the shells thrown from these guns.

Those who would attempt to remedy an initial error by substituting earth, wood, or rails for cement and armour, show that they are ignorant of the effects of modern artillery. In case of necessity it is possible to profit by such occasional means, but in front of an energetic attack such resistance cannot be relied upon.

The long resistance made by the Visokaya Redoubt (on 203-Metre Hill), may be cited, but it must be remembered that the guns which were brought to bear upon this position were put out of action before their fire had given any useful result, and that in the end the material resistance of the work would have been of small value without the constant intervention of reinforcements, and especially without the action of vigorous counter-attacks. Actually the redoubt fell long before the capture of one of the permanent forts.

This experience shows that valour and expenditure of life will be of little service in correcting errors in the construction of permanent fortifications. The engineers at Port Arthur, after having multiplied the cemented works on Dragon Hill, had trusted to 203-Metre Hill as an active

defence to assist the semi-permanent fortifications. It is impossible to say what would have happened if the Japanese had attacked Visokaya by mining, and had employed means for destroying the scarps and the flanking defences; perhaps the besieging army would not have been able to take part in the Battle of Mukden. In fact, from the conditions to which we have referred, it would seem that the investment of a strong fortress should proceed much more rapidly than in the past.

Local fortifications, fieldworks, all the obstacles for a weak resistance which form objectives for artillery fire, have lost their importance in the siege warfare of to-day. Against a walled fort wanting in flanking defences and more or less in a ruined state, an assaulting column can seek to overcome the scarp by means of scaling ladders and by crossing the ditch by flying bridges. But the assailants, who wish in this manner to capture a strongly cemented fort provided with flanking caponiers, well arranged, would certainly be stopped by the fire of quick-firing weapons of small calibre placed in action by the defenders.

It is not necessary for the forts to have an armament of medium calibre nor a numerous garrison, to compel the assailants to an attack step by step. They should be so constructed as to render the defenders absolutely secure from bombardment, and to allow for the action of arms of small calibre from sheltered positions. Under such conditions the assailants can only have recourse to the old system of mining to attack the cemented masses which cannot be ruined by artillery fire. The assailants can, however, try to penetrate into the interior of the place by passing between two forts. Such an undertaking should essentially constitute an attack *de vive force*, as its success depends upon special circumstances, such as mist or the negligence of the defenders. But it would be rash to organize an attack of long duration advancing as a wedge between two forts. When the mists disappear the defenders would be masters of their defences and the assailants would find themselves exposed to disaster.

The assailants have at their disposal guns having a range of from 12 to 15 k.m. with which they can bombard and damage the besieged city, depressing the *morale* of the population and continually disturbing the repose of the garrison. The defenders, who wish to make sorties from the place in order to confront the enemy in the open, would, even with the assistance of the works, find themselves in such inferior force that they would certainly be beaten, perhaps compromising the possession of the place. In a siege conducted by enterprising assailants and sufficiently provided with artillery, the probable result of the occupation of an advanced position by the defenders would be its abandonment with material losses, and grave and important moral consequences.

An advanced position, organized after the commencement of the war and distant from 2 to 3 k.m. from the lines of forts, constitutes a trap which the defenders prepare for themselves. The active defence should be undertaken in quite another manner, and according to Rouquerol should take the form of a continued series of counter-attacks. These should commence as soon as the siege enters into the region of small operations, and should be continued up to the last day of the siege. Surprise and rapidity are the principal conditions of their success.

The endeavours of counter-attacks should be to destroy any detachments pushed forward in advance of the besiegers; to cause panic in a cantonment or encampment; to ruin the earthworks and material. In counter-attacks, more important results can be obtained with small detachments than with larger masses, which are less manageable.

The author holds that the force to be employed in a counter-attack should not exceed one battalion, and should not comprise artillery if there is any danger of the carriages impeding the operations. It is desirable for the defence to have detachments of pickets always allotted to the counter-attack, and ready to move at the first signal so as to seize upon all occasions of injuring the enemy. It is of the greatest importance that the defence should have perfectly organized systems of obtaining information, by means of which it can be informed with security of all the enemy's movements; the same *personnel* should guide the counter-attacks and perform the service of exploration. Inhabitants of the country, having practical knowledge of the locality, would be useful for this purpose.

It is strongly recommended that, for a garrison consisting of one army corps, the force allotted for the reserve should consist, approximately, of a brigade. The garrison of a place is necessarily composed of elements drawn to a great extent from the reserves. These troops are at their best when they have a certain cohesion and are well in the hands of their leaders. But if these troops are employed as workmen they cannot be formed into a solid unit. In the case in which the enemy does not leave time to complete the works and to prepare for combat, the resistance of the place, notwithstanding a considerable garrison, should be passive. The defenders would be wrong if they desired to give up all active manœuvres by the whole of the garrison, while the fortress is not placed in a complete state of defence. By doing so they would possibly have abundance of defensive works; but they would not have soldiers, and these being wanting the place would remain inert.

The author holds that it is preferable that the works required to put the place into a state of defence should remain incomplete, rather than that the services of a well-instructed general reserve should be lost in completing them.

E. T. Thackeray.

RECENT PUBLICATIONS OF MILITARY INTEREST.

REVIEW OF BOOKS.

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HISTORY.

RUSSIAN OFFICIAL HISTORY OF THE RUSSO-JAPANESE WAR, VOL. II.,* PART I. (Guerre Russo-Japonaise 1904–5. Historique rédigé à l'état-major général de l'armée russe). 759 pp., with 17 maps. 8vo. Paris, 1912. Chapelot. £1.

Vol. II. comprises the first period of the campaign, and its Part I. deals with events from the commencement of operations to the Battle of Wafangkou (Te-li-ssu) exclusive. It therefore covers the period dealt with in Vol. II., Part I. of the Russian original, the text of which is rendered almost word for word.

The Official History of the Russo-Japanese War, prepared by the Historical Section of the Committee of Imperial Defence, is quoted as the authority for much of the information regarding the movements and operations of the Japanese troops.

The Introductory Note (*Note concernant la Traduction*) contains useful information regarding the spelling and meaning of names and terms, Russian and Chinese, and the organization of the Russian Staffs and units.

The table of contents, which is to be found at the end of the volume, gives the following chapter headings:—

Chapter I.—Military geographical survey of the theatre of operations.

Chapter II.—Review of the general situation in the theatre of war at the commencement of operations.

Chapter III.—First period of operations up to the date when General Kuropatkin joined the Army, March 28.†

Chapter IV.—Second period of operations, from the date when General Kuropatkin joined the Army till the Japanese were on the point of crossing the Ya-lu.

Chapter V.—The Russian "Eastern Force." The crossing of the Ya-lu by the Japanese. The Battle of Chiu-lien-cheng (the Ya-lu).

Chapter VI.—Events from the Battle of Chiu-lien-cheng (the Ya-lu) till the date when communication with Port Arthur was cut off, May 14.

Chapter VII.—Events from the time Port Arthur was cut off until the Russians took the offensive southward to relieve that fortress, May 30.

Chapter VIII.—Events in the theatre of war during the first half of June, 1904, up to Battle of Wafangkou (Te-li-ssu), exclusive.

Appendices and Notes to Vol. II.

In Chapter I., the description of the sea coasts and the points likely to be selected by the Japanese for the landing of their Armies is of interest. Fusan in Southern Korea is mentioned as the easiest and safest point for a Japanese disembarkation. Admiral Alexeiev, however, considered that a Japanese landing might be effected as far up the coast as Chemulpo. North

* Vol. I., Part 2, was reviewed in *The Army Review* of July, 1911, p. 189.

† All the dates in the French translation are given in the old and new style, thus:—March 15/28.

of that port the landing of any important force in the presence of the Russian fleet was, in his opinion, impossible.

These opinions were based on the assumption that the Russian Fleet would display due activity at the outset of the war, whereas its complete inactivity permitted the Japanese to make Chemulpo their principal landing place at first and to change it later on to Tsinampo when the ice melted.

The chapter also contains a description of the roads and resources of the theatre and concludes with the admission that, though the Russian troops had occupied Southern Manchuria since 1898 and, in the Boxer insurrection of 1900–1, had traversed it in all directions, they had not succeeded, to the same extent as had the Japanese, in appreciating its possibilities and drawbacks from the point of view of military operations.

Chapter II. commences with a list of the Russian units in Siberia—from the Trans-Baikal to the Pacific—and their stations on February 10, when mobilization was ordered. The arrangements for the selection and the despatch of reinforcements from European Russia are then described.

As the Russians had taken no steps, previously to the outbreak of war, to organize an intelligence service in Japan and Korea, the Staffs both of the Viceroy and of the Army of Manchuria were dependent, for information regarding the Japanese, mainly on popular rumours.

The conclusions of the chapter are :—

(i.). The Russian forces in Siberia were small and reinforcements could be sent only in driblets.

(ii.). The disasters to the Fleet at the opening of hostilities complicated the task of the land forces.

(iii.). China's attitude being doubtful, it was necessary to keep a sharp lookout towards the west.

(iv.). The complete absence of information regarding the enemy further increased the difficulties of the Russian commanders.

Chapter III. begins with a statement of the dates of the arrival of Russian reinforcements in South Manchuria.

The next few pages, 46–52, are devoted to that part of the information regarding the enemy which seemed worthy of credence. The first such information was brought by the Russian attachés from Tokyo, who landed at Shanghai on February 17. Their information is compared with the facts as ascertained later, and is characterized as being far from the truth.

Other information from various sources is then given at some length, with the concluding remark that, at the end of March, the enemy's future plan of operations was for the Russians a complete enigma.

Pages 54–76 set forth the exchange of views between the Viceroy, General Kuropatkin and General Linevich on the proposed plans of operations, the result of which was that, after due provision had been made for the defence of Port Arthur, the Littoral Province, Vladivostok and Nikolaevsk, the Army of Manchuria was grouped in the following manner : the main body in the vicinity of Liao-yang, the Southern Advanced Guard watching the west coast of the Liao-tung peninsula from Ying-Kou to Hsiung-yao-cheng* with its reserve at Hai-cheng, the Eastern Advanced Guard (afterwards known as the Eastern Force) pushed forward to the Ya-lu and covered by General Mishchenko's cavalry in Korea.

After a description of the composition, condition and tasks of the Southern Advanced Guard and the Eastern Force, there follows an account of General Mishchenko's cavalry operations in Korea, and the information collected by him regarding the Japanese advance towards the Ya-lu.

The chapter concludes with a reference to a telegram despatched to the Minister of War on March 19 by the Viceroy's Chief of the Staff, who expressed the opinion that by April 14 the situation would be altogether favourable, and that it would then be possible for the Russian forces, acting on interior lines, to develop a decided superiority at any selected point. The comment on this view is that as the Army of Manchuria, owing to the state of its administrative

* The spelling of the names of places and individuals adopted in this review is in accordance with the Official History of the Russo-Japanese War, prepared by the Committee of Imperial Defence, and not with the French translation of the Russian Official History.

services, was dependent on local resources and its far-away base in European Russia, it could not be considered capable of operating on interior lines, where the principal chance of success lies in the mobility of the troops.

The opening pages of Chapter IV. (pp. 117—139) are of special interest. They depict the difficulties of the commander of an Army which has to watch a long line of coast on which there are to be found many points suitable for an enemy, possessing command of the sea, to disembark his forces. These difficulties were intensified by the utter absence of reliable information regarding the movements and intentions of the Japanese, and by the divergence of views held by General Kuropatkin and the Viceroy, which had to be settled by a reference to the Emperor.

After April 24, the date of the arrival from Europe of the last of the 3rd battalions destined for the East Siberian Rifle Regiments, the influx of troops into the zone of concentration in Southern Manchuria practically ceased till the middle of May.

This was the result of the Viceroy's fears that a Japanese force of 36—48 battalions with mountain artillery and pack transport might land in the neighbourhood of Possiet Bay and operate thence towards Kirin or Ninguta—Harbin.

To meet this possibility, it was decided, in spite of General Kuropatkin's protests, but with the sanction of the Emperor, to retain at Harbin the 1st Siberian Infantry Division, which was the next reinforcement on its way to the Army of Manchuria.

This chapter also contains General Kuropatkin's report to the Emperor on his inspection of the troops which he completed by April 19. He drew attention to the numerical weakness of certain units and to the unsuitability of the vehicles of the trains, since the majority of troops coming from Europe had brought with them heavy four-wheeled vehicles useless in the mountains and during the rains.

On April 16, the question of the general plan of action was submitted to a committee consisting of the heads of the various departments of the Staff. This committee formulated six plans of operations which they conceived that the Japanese might adopt. None of the plans suggested had much resemblance to that which the Japanese actually followed.

Further disasters to the Russian fleet and the Viceroy's visit to Port Arthur had by this time called attention to the fact that the fortress itself with the remnants of the fleet in its harbour might become the object of a Japanese attack. The Viceroy, therefore, urged that the Army of Manchuria should be ready to lend its aid to the fortress. The result was that, by the end of April, Kuropatkin found himself charged with a triple mission, firstly to hold back the Japanese on the Ya-lu and the Fen-shui Ling range; secondly to guard the coasts of the Gulf of Liao-tung; and thirdly in case of necessity to come to the aid of Port Arthur.

His relief was great when he heard later on (April 28), that the Japanese were moving to cross the Ya-lu, since he accepted this fact as an important indication that their main forces would follow from the same quarter. The fears for the safety of Port Arthur and Vladivostok would thus be lessened, and the necessity for the extreme dispersion of the troops would cease, not in South Manchuria only, but in the whole theatre of operations.

It was not only on the question of the troops to be sent to succour the fortress that there was a divergence of views between the Viceroy and Kuropatkin. While the latter attached but little importance to the defensive value of the Ya-lu, and suggested the advisability of retiring the Army on Liao-yang, the Viceroy was in favour of offering a solid resistance to any attempt of the Japanese to cross the above-named river. This disagreement led to the Viceroy's request to be relieved, which however was not acceded to by the Emperor.

Pages 138—180 deal with the composition, distribution, tasks and operations of the three main portions of the Field Army of Manchuria, as already defined in pages 54—76.

On April 24 General Kuropatkin impressed on General Zasulitch, who commanded the Eastern Force, that his mission was to oppose the enemy with firmness but also with prudence, bearing in mind that he was not posted on the Ya-lu for the purpose of engaging in a decisive battle with an enemy of superior strength.

Chapter V. describes the events of the week preceding the Battle of Chiu-lien-cheng (the Ya-lu), and the battle itself.

The general conclusions (page 260) are as follows:—At first the accounts derived from Russian sources tended to attribute the Russian defeat to the turning movement of the 12th Japanese Division and to the insufficient resistance offered by the 22nd East Siberian Rifle Regiment. Information from other (foreign) sources, which became available at a later date, throws a different light on the affair. The turning movement of the 12th Japanese Division

had in fact no decisive influence, as it was the operations of the Japanese Guard and 2nd Divisions which caused the Russians to evacuate the river banks from Chin-lien-cheng to Po-te-tien-tzu. Similarly it was the attacks of fractions of the Guard and the Reserve and, to a limited extent only, those of the 12th Division which broke the Russian resistance on the rearguard position. With regard to the 22nd East Siberian Rifle Regiment, that corps did not evacuate the Po-te-tien-tzu position till after the 12th East Siberian Rifle Regiment had already abandoned that of Chin-lien-cheng. By that time the 22nd was already hard pressed by the enemy in greatly superior force. In its retirement from Po-te-tien-tzu on Ching-kou it drew away after it the whole of the 12th Japanese Division and thus greatly delayed the completion of the latter's turning movement, which was to bring them on the Russian rear. Though there was an excellent field of fire for the Russian infantry, and the enemy presented a good target while crossing the sands and fords of the Ai Ho, the losses sustained by the Japanese were less than was expected by themselves and by the Russians. The poor marksmanship of the Russian riflemen, which let the Japanese off so easily, is attributed to the faulty construction of the fire trenches, which were deficient of head cover and offered a good mark for the Japanese guns.

Chapter VI.—In this and the two remaining chapters of the volume, the following general plan of treatment is followed. Firstly, the increase of the Russian Field Army by reinforcements is traced. The information regarding the enemy is then given, and lastly the views, plans and operations of the Russian commanders. The sequence indicates how completely the initiative lay with the Japanese.

In pp. 273—280 we have the exchange of views between the Emperor, the Viceroy and General Kuropatkin on the subject of plans to meet the new situation resulting from the Battle of Chiu-lien-cheng (the Ya-lu).

This exchange of views and the news of the disembarkation of the 2nd Japanese Army near Pi-tzu-wo led to the decision to concentrate the Russian Field Army with the least possible delay and to the withdrawal of the 1st Siberian Corps to the zone Hai-cheng—Liao-yang.

The history of events in this chapter commences with the narrative of the landing of the 2nd Japanese Army south-west of Pi-tzu-wo, the occupation of Pu-lan-tien on the railway by the Japanese on May 12, and the consequent cessation of Russian communication with Port Arthur.

Pages 308—330 deal with the Eastern Force and its withdrawal behind the Fen-shui Ling range. The opinion is expressed that if the Japanese First Army had decided or been able to undertake a rapid and energetic offensive it is probable that the Eastern Force would have failed to effect its retreat with all its transport and that the Japanese might have reached the cols close on its heels.

The remainder of the chapter deals mainly with the reconnaissance work of the Russian cavalry detachments.

Chapter VII. also is of special interest to British officers as illustrating the manner in which the Japanese command of the sea influenced the strategy of the Russian Commander-in-Chief and affected the land operations.

Pages 370 to 398 give the correspondence between the Emperor, the Viceroy and General Kuropatkin regarding the situation and plans to meet it.

General Kuropatkin was chiefly concerned with the consideration that the Japanese command of the sea enabled their forces to threaten his communications in the neighbourhood of Kai-ping or Ying-kou. Moreover he had formed the opinion that his Army needed additional reinforcements owing to the disasters which had overtaken the Russian fleet, to the ill-success of his troops on the Ya-lu river, and to the inferiority of his reserve units in respect of officers, artillery and train. Accordingly, on May 16, he asked the War Minister to send him two additional Army Corps provided with artillery of the latest pattern. Meanwhile he set his Staff to work out a scheme for assuming the offensive, not by an advance to the aid of Port Arthur, but by a movement to meet the enemy in case they should disembark in the neighbourhood of Kai-ping and Ying-kou.

The possibilities of Japanese sea power presented themselves to the Viceroy and his Staff in another light. They considered that the departure of the 3rd* Army from Japan and the possibility of a new disembarkation on the portion of the coast between Ta-ku-shan and Pi-tzu-wo which was not watched by the Russians, admitted of the supposition that the

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enemy's principal effort would be directed against Port Arthur. On this account they favoured an expedition into the Kwan-tung, *i.e.*, towards Port Arthur.

With this end in view the Viceroy formulated in a letter to Kuropatkin, dated May 21, two alternative plans.

General Kuropatkin commented on these plans as follows in his journal, dated May 24 :—"The Viceroy considers that the moment has arrived for the Army to advance either towards the Ya-lu or to the aid of Port Arthur This advice is given when it is not yet known where the Japanese 3rd* Army will disembark. Truly our strategy is rash : we have already compromised the Fleet, now it is the turn of the Army." His Staff reminded him that the rainy season would commence at the beginning of July and would render uncertain the movement of field artillery and wheeled transport, while they had not sufficient pack animals to assure supplies for the Army and only possessed seven mountain guns.

At this juncture also General Mishchenko reported, on May 22, the commencement of a Japanese disembarkation at Ta-ku-shan, which General Kuropatkin held to indicate the enemy's intention to choose the direction of Hsiu-yen—Hai-cheng for his main operations.

On May 27 General Kuropatkin wrote to the Viceroy to the effect that he was opposed to both his plans as entailing a hazardous dispersion of the Russian forces, and gave his reasons.

On the same day, the Viceroy and General Kuropatkin met at Mukden and agreed to refer to the Emperor for a decision as to whether an advance should be made to aid Port Arthur. News of the capture of the Chin-chou position by the Japanese was received on May 29 and strengthened the Viceroy's conviction that the enemy's principal effort would be directed against Port Arthur. He brought out this point in his telegram to the Emperor of the 29th, while, on the other hand, General Kuropatkin telegraphed his objections to the War Minister for submission to the Emperor. That the War Minister's views were not in accordance with those of General Kuropatkin is evident from the notes made by him later on, after the Battle of Wafangkou (Tel-li-ssu), on the copy which had been forwarded him of Kuropatkin's letter of May 27 to the Viceroy (*vide* Annexe 29).

On May 30, the Emperor telegraphed to the Viceroy :—"I share your views, as set out in your telegram of May 29." The Viceroy apparently read this sentence as a formal approval of the assumption of the offensive towards Port Arthur, as he at once telegraphed to General Kuropatkin to that effect, urging immediate action and the despatch if possible of a force of four divisions.

The remainder of the chapter (pp. 398—436) deals with the disposition of the Russian forces on May 16, the measures taken towards the end of May to reinforce the Southern Advanced Guard against a possible Japanese disembarkation about Kai-ping and the steps taken later on to stiffen both the Eastern Force on the Fen-shui Ling range and the Southern Advanced Guard with a view to a possible advance towards Port Arthur. The cavalry reconnaissances which were taking place meanwhile are also described.

Chapter VIII.—At pages 449 to 453 will be found the text of the War Minister's telegram to the Army Commander, dated June 1, and the despatches, dated Port Arthur, May 26 and 28, from General Stessel, which reached General Kuropatkin on May 31. The former document, after a review of the situation, urged the necessity for energetic measures to resist the Japanese and succour Port Arthur, provided that operations undertaken to these ends were conducted so that the Russian forces at the decisive point were sufficient to ensure success without exposing the troops to local defeats. It was further pointed out that the decision as to the direction and time of the effort and the allotment of troops must be with the commander on the spot. General Stessel's despatches, which were to become an important factor in the decision, reported the action at Chin-chou and the subsequent evacuation of Dalny and Ta-lien-wan. Port Arthur held an "extremely limited" quantity of projectiles and meat for at most three months. General Stessel was of opinion that it was against Port Arthur that the enemy's principal effort was being directed and urged that once his force was completely shut up in Port Arthur he would no longer be able to act in concert with a relieving force by attacking the position of Chin-chou. The relieving force must therefore be despatched immediately and be a strong one, at least three infantry and one cavalry divisions.

In his reply to Stessel, General Kuropatkin promised to do his best to aid Port Arthur, but added, "What you require is assistance and not that the Army of Manchuria should be defeated in detail."

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The Viceroy's opinion as to the critical situation of Port Arthur and the urgency of an immediate advance to its succour was confirmed by General Stessel's despatches, and he addressed a communication in that sense to the Emperor, dated June 4.

Meanwhile, the 1st East Siberian Division was being moved forward by rail from Kai-ping, and by June 6 was assembled at Wafangkou (Tel-li-ssu).

On June 4 the Viceroy received a despatch from the Emperor to the effect that the fate of Port Arthur caused him much concern, and that it was necessary to take more decisive measures to draw the Japanese troops away from it. General Kuropatkin was to be made to understand that the Emperor held him responsible for the fate of Port Arthur.

This despatch the Viceroy repeated word for word to General Kuropatkin "for information and action," and on June 6 he sent him in addition formal instructions in his capacity of "Commander-in-Chief of the Armies" to assume the offensive at once to relieve Port Arthur.

On the same day and in accordance with the Viceroy's instructions as given above, General Kuropatkin warned General Stakelberg that an energetic and prompt assumption of the offensive in the direction of Port Arthur by the 1st Siberian Corps, reinforced by the 2nd Brigade of the 35th Infantry Division, had been definitely decided upon. The defence of the sea-coast from Hsiung-yao-cheng to Ying-kou and the guarding of the routes from Hsiu-yen towards Hai-cheng—Kai-ping were allotted to Levestam's detachment and the 3rd Division of Siberian Infantry which was arriving by successive echelons. These troops were grouped under the command of General Zarubaiev.

On the 7th General Kuropatkin notified these arrangements to the Viceroy, adding the strength of each of the forces.

The Viceroy on June 10 objected that the forces detailed were insufficient for the task.

This evoked from General Kuropatkin two letters in reply giving his views generally on the course of operations so far, and calling special attention to the recent radical change in the Viceroy's views regarding Port Arthur's powers of resistance; and to the fact that owing to the early misfortunes of their Fleet and Army the Russian authorities had passed from an exaggerated contempt for Japan to an excessive estimate of her forces and their value. He also pointed out the bad moral effect that would result if the fears of its chief regarding Port Arthur were communicated to his troops. To operate towards Port Arthur with 48 battalions and to leave only 62 to defend the Fen-shui Ling range would not be acting in accordance with the general plan of operations approved by the Emperor.

In acknowledging these letters the Viceroy intimated his opinion that it was inopportune in time of war to continue correspondence of a polemical character, and stated that he would again refer to the Emperor.

On June 10, news arrived that Hsiu-yen had been occupied by the Japanese. This movement was held by Kuropatkin and his Staff to indicate an effort of the 1st Japanese Army against the communications of any Russian force that might advance southwards.

Three days later—on June 13—news was received that a considerable Japanese force was advancing northwards from Pu-lan-tien. At that moment 20 battalions, 19 squadrons, and numerous artillery of the 1st Siberian Corps were at Wafangkou (Te-li-ssu) and Wa-fang-tien. Simonov's advanced guard at the latter place was ordered to avoid a serious engagement, and, if necessary, to retire on Te-li-ssu where a defensive position was being prepared. Also the 34th and 35th East Siberian Regiments were ordered by rail to Te-li-ssu.

Thus the 2nd Japanese Army anticipated General Stakelberg's force in the assumption of the offensive with the result that a battle was fought at Wafangkou (Te-li-ssu), the account of which will be found in Part II. of this volume.

Pages 477—501 give an account of the operations which took place on the southern front between May 29 and June 12. Among the most important were General Akiyama's reconnaissance and the resulting combats at Te-li-ssu on May 30 and June 3. This reconnaissance was intended by General Oku to cover his movement on Chin-chou with a view to securing Ta-lien-wan and Dalny as bases for his Army and that destined for the Siege of Port Arthur. When it became evident to the Japanese General Staff, about June 6, that a Russian advance South towards Port Arthur was actually intended, they issued orders to the 10th Division and the 1st Army to assume the offensive so as to force the enemy to abandon his intention of reinforcing the 1st Siberian Corps. The fleet also co-operated, by a feint of disembarking troops near Hsiung-yao-cheng on June 7 and 8.

Pages 501 to 517 describe the operations of Mishchenko's detachment and the Japanese

offensive towards Hsiu-yen, which took place while Stakelberg's force was being moved southwards. The information about the Japanese movements and intentions gained by the Russian cavalry was meagre and misleading, and General Kuropatkin made the following note on one of Mishchenko's reports: "It is useless for our cavalry to engage in encounter combats with their infantry." On June 8 the Japanese under General Asada drove Mishchenko's force out of Hsiu-yen and occupied it.

On June 11 General Kuropatkin instructed General Mishchenko to move slightly southward to discover whether any Japanese movement was in progress from Hsiu-yen in the direction of Kai-ping, through which were moving the troops destined for the southern advance.

Pages 517 to 567 deal with the Eastern Force and the various cavalry detachments holding the line of the Fen-shui Ling and guarding the approaches to Mukden, and the operations in the direction of Hsi-mu-cheng (Saimatsu). The first expedition to Hsi-mu-cheng which reached that town on June 1 showed how little prepared as yet were the Russian troops for operations in the mountain districts even with small detachments with their trains reduced to a minimum. It became evident that more energetic measures and some reinforcements were needed in this quarter and General Keller, by order of the Commander-in-Chief, prepared a plan for the assumption of the offensive towards Feng-huang-cheng by the Eastern Force as soon as reinforcements arrived.

The volume concludes with an interesting letter, dated June 13, from General Sakharov, the War Minister, to General Kuropatkin. The former considered that events in the theatre of operations during the first half of June had not justified the opinions of the Commander-in-Chief regarding the possible attack of his Army by two Japanese Armies totalling about 100 battalions. On the contrary Kuroki, after his success on the Ya-lu and advance to Feng-huang-cheng, had stopped at the latter point, which argued his comparative numerical weakness. It seemed that Kuroki was trying to attract Kuropatkin's attention so that the other Japanese forces destined to act against Port Arthur might disembark unhindered. With this end in view Kuroki had undertaken a series of small and by no means serious operations with success, as the Army of Manchuria had maintained a waiting attitude in the face of an inferior force, while other Japanese Armies had disembarked on the Liao-tung Peninsula, gained an important success at Chin-chou and cut off Port Arthur. It was to be hoped that the latter place could hold out till relieved in some way or other.

Further the Emperor was unable to understand why the Russian cavalry, though superior in numbers, had achieved nothing, not even information more or less positive as to the distribution of the enemy's forces.

As regards the additional two Army Corps asked for by the Commander-in-Chief on May 16, the War Minister gave his reasons for considering the moment had not arrived for their despatch. The letter concluded with a reminder that the Emperor regarded the situation with some alarm since the possible fall of Port Arthur would shake Russian prestige. Consequently if, as the Commander-in-Chief surmised, the war was going to last 18 months, it was most necessary that the Japanese successes of the last four months should come to an end, and the rest of the war should be characterized by successes of the Russian forces, which were now strong enough to show their activity in a decisive form.

The English reader will encounter some difficulty in using the maps accompanying the volume, partly because of the French spelling of the place-names, partly because the spelling of the latter is not always similar to that in the text, and partly because the blocks and lines representing troops and their movements often obscure the detail of the map.

The notes in the French translation, each referred to by a number in the text, are not identical with those in the Russian original. Those in the French translation are apparently more up to date.

Notes for Officers Proceeding to India.

By Major A. T. MOORE, R.E., 1904.

REVISED

By Major E. C. OGILVIE, R.E., 1912.

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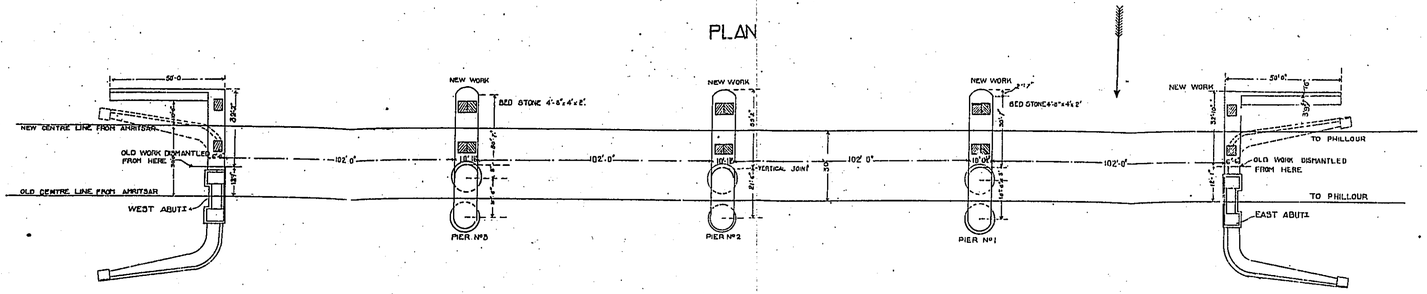
4	697·01	10	3	1¼
4A	705·82	10	4	1⅛
5	699·42	10	3	¼
6	702·42	10	4	⅞
7	701·48	10	4	⅜
8	700·42	5	4	7/16
9	701·90	10	4	1⅛
10	699·22	10	4	1½
11	698·47	5	4	½
12	703·05	8	4	⅞
13	701·62	10	4	⅜
14	701·20	5	4	⅞
15	703·71	10	4	5⅛
16	701·56	10	4	1⅜
17	698·69	5	3	1¼
17A	702·74	10	3	1½
18	698·96	10	4	1⅜
18A	703·77	10	4	1½
19	701·48	10	4	½

PLAN



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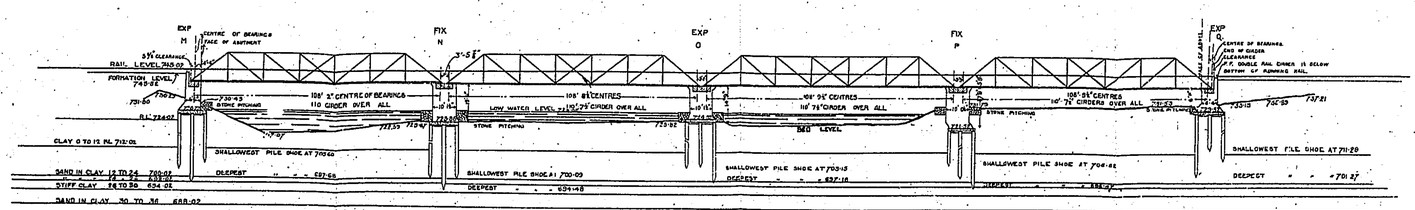

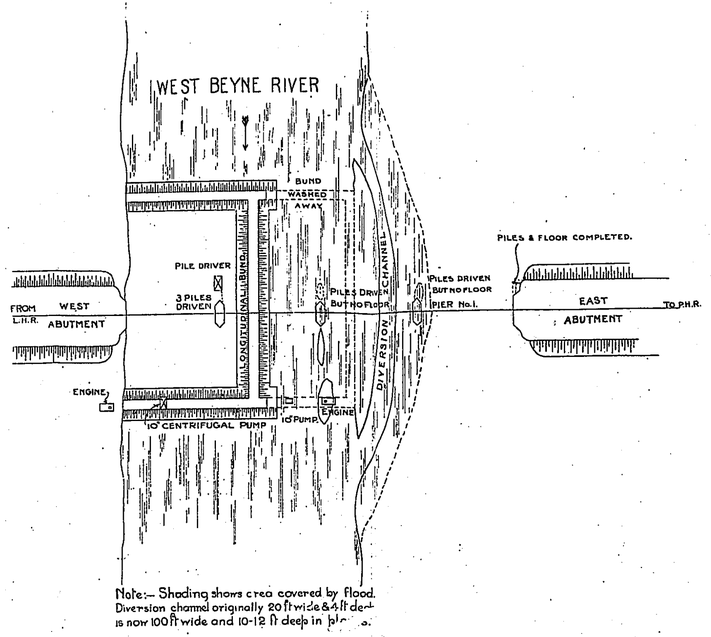

Note:— Shading shows area covered by flood. Diversion channel originally 20 ft wide & 4 ft deep is now 100 ft wide and 10-12 ft deep in places.

The above shows the damage done by flood of 12—14 March, 1911.

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