

REPORT
ON THE
ENGINEER OPERATIONS
OF THE
TIBET MISSION ESCORT,
1903-04.



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General.

The main features of the country traversed by this expedition, and which necessarily affected the engineering works, were the extremely high, steep, and densely wooded hills of the Himalayas, with an enormous rainfall during the monsoon months, all the way from the base at Siliguri until Phari was reached at an elevation of 14,300 feet above sea-level, a distance of 150 miles by the Gangtok route.

From Phari on, the road lay over the so-called table land of Tibet, in reality a series of more or less narrow, tortuous, valleys at a height of never less than 12,000 feet above sea-level, shut in by hills several thousand feet higher.

By far the greater part of this was absolutely destitute of trees, agriculture, or any growing thing except saxifrage.

Throughout this portion the winter is extremely rigorous; 50° of frost at night is common.

Down each valley invariably flows a stream, varying in size from a trickle to the mighty Brahmaputra: these generally provided excellent drinking water, and but little work was required in connection with water-supply.

The very heavy rainfall in Sikkim necessitated a large amount of hutting for men and animals on the line of communications.

From this brief description it is obvious that the construction and maintenance of serviceable roads were of immense importance, while the rigors of the climate necessitated huts for men and animals employed on them.

The crossing of the Brahmaputra with a certain amount of minor bridging, was vital to the success of the expedition, while the stubborn opposition shown by the Tibetans in their defence of Gyantse Jong and neighbourhood necessitated a considerable amount of engineering attack and defence.

This report is accordingly divided into the five sub-heads:—

Road-making.
Hutting.
Water-supply.
Crossing the Brahmaputra and Bridging.
Siege operations.

Road-making.

The roads may be roughly divided into the following sections:—

- (a) Siliguri—Teesta Bridge.
- (b) Teesta Bridge—Rangpo.
- (c) Rangpo—Gangtok.
- (d) Ghoom—Pashok—Teesta Bridge.
- (e) Gangtok—*via* Nathu La to Phema.
- (f) Rungpo—*via* Jalap La to Chumbi.
- (g) Chumbi—Phari.
- (h) Phari—Kangma.

(a) *Siliguri—Teesta Bridge. (Cart road, 30 miles.)*—This is a cart road at easy gradients along the right bank of the Teesta river, and has been in existence for years in charge of the Public Works Department, Bengal.

It was, however, in poor condition and required a heavy amount of maintenance in order to keep it practicable for the heavy cart traffic now for the first time put upon it.

This it failed to receive at the hands of the Public Works Department, and its good condition being of vital necessity to the success and safety of the expedition, it was accordingly transferred to the expedition under Brigadier-General J. R. L. Macdonald, C.B.

A special road division was then formed to maintain it along with the cart road as far as Gangtok.

This division, which came into being on 1st July 1904, was under Mr. H. H. Green, Executive Engineer, Public Works Department; it did heavy work during July, August and September, the three wettest months of the year, in keeping the road free from slips, metalling, etc.

This road was hardly ever closed to traffic after the formation of this division.

(b) *Teesta Bridge—Rangpo. (Cart road, 14 miles.)*—This had been in existence for years and was in charge of the Executive Engineer, Sikkim.

When the special division "Siliguri-Gangtok Road" just mentioned, was formed, it was transferred to the charge of the Executive Engineer of that division, and its maintenance then formed a charge against the expedition.

(c) *Rangpo—Gangtok. (Cart road, 24 miles.)*—Most of this had been constructed in 1903, or earlier, prior to the despatch of the expedition.

Amongst other labor employed, the 12th Company 2nd Queen's Own Sappers and Miners were employed on this from 4th April 1903 to 6th May 1903.

In addition to road-making and small bridges, they constructed a suspension bridge of 110 feet span at Singtam and a frame bridge of 54 feet span between Singtam and Gangtok.

The work was greatly impeded by incessant rain, landslips and frost.

The 3rd Company 1st Sappers were also employed on this for the first 3 weeks in December 1903.

Part of the 32nd Pioneers worked on this road during some months of 1903, prior to the expedition.

This section, which consists of a 12-foot cart road, at an average gradient of 1 in 15, although open throughout, was in an unfinished condition: drainage was not complete and it was unmetalled.

When heavy traffic came on to it, it naturally was unable to stand it, got into bad order, and on the formation of the Siliguri-Gangtok road division mentioned above was transferred to it.

It was then metalled throughout and other improvements made.

After the Siliguri-Gangtok road division was formed on 1st July 1904, up to the end of September, 62 out of 68 miles of road from Siliguri to Gangtok were completely soled and metalled and 13 miles partially so; 12 miles of masonry drains were constructed and many retaining walls built.

Except in the Teesta valley, where rollers were available, the metalling was rough but served the purpose for which put down.

The expenditure on these 68 miles of road amounted to approximately Rs. 1,22,000, or nearly Rs. 2,000 per mile.

(d) *Ghoom—Pashok—Teesta Bridge (21 miles.)*—The upper portion of this is a cart road, the lower a mule path.

It was in charge of Mr. Searight, the Executive Engineer, Darjeeling Division, Public Works Department, and remained so throughout.

A wire ropeway was constructed by him across a large slip at Siticollah, 2 miles from Ghoom, to facilitate the despatch of stores when the road was carried away, at a cost of Rs. 850 for two ropeways of 1½ inch steel wire rope.

(e) *Gangtok—vid Nathu La—Phema road—48 miles (new trace.)*—At the commencement of the expedition this road hardly existed.

From Gangtok to the Laggap La, a distance of 15 miles, there was a cooly track, often not more than 2 feet wide, the last 5 miles of which was along a very precipitous hill side.

From the Laggap La, past Changu, over the Tuni La and Sibul La to Yewkontong, 10 miles, the cooly track continued, over and through boulders, at any and every grade, extremely narrow and rough.

From Yewkontong over the Nathu La and down to Phema in the Chumbi valley, there was practically not even a cooly track; an ill-defined foot path could be seen in places, nothing more.

During December 1903, work was started on this at the Gangtok end, under the direction of Mr. White, Political Officer, Sikkim, assisted by military labour.

Under his direction by the end of February 1904, a cart road, 10 feet wide, at a grade of 1 in 12 had been cut for 5 miles, the labor employed on this consisting of the 3rd Company 1st Sappers, half of 12th Company 2nd Sappers, and about 1,100 coolies.

On 8th February 1904, the Military Member of Council, in his wire No. 452, enquired the expenditure on this road from 1st November 1903, and on 15th February he conveyed the sanction of Government to the construction of a mule path over the Nathu La, at the same time asking for an estimate of cost.

On 4th March, a reply was sent that the expenditure to end of February was Rs. 78,000. These were the figures given by the Political Officer, Sikkim, but subsequently turned out to be incorrect, as there were outstanding charges, some of which were not paid till October 1904, and brought the total up to approximately Rs. 81,000 after deducting the value of dynamite handed over to the Public Works Department, approximately Rs. 16,000.

On 1st March 1904, the charge of the road was transferred to Mr. H. H. Green, Executive Engineer, Public Works Department, Sikkim.

A fresh set of accounts was now started. Mr. Green's estimate for the construction of the mule path amounted to Rs. 1,75,000.

On 20th March, Mr. Green reported that he had arranged to import 1,300 coolies, but was immediately warned by the General Officer Commanding Tibet Mission Escort to go easy, as Government had not yet accepted his estimate.

On 23rd March, the Quartermaster General in India, in his wire No. 590-M., conveyed the orders of Government that no work was to be undertaken or expenditure incurred until the estimate was sanctioned, thus cancelling the sanction already given.

Accordingly all work was immediately stopped, coolies paid up and disbanded.

On the same day, Mr. Green's estimate amounting to Rs. 1,74,210 was despatched to the Quartermaster General.

The work done then stood as follows:—

The 5 miles of cart road, cut under Mr. White's direction, existed, but in an unfinished state; it was not metalled and the drainage arrangements were incomplete.

From the 5th to the 10th mile the old track had been widened and improved, while the 3rd Company 1st Sappers had maintained the 10th to 13th miles, kept them clear of snow, and widened them in places with the assistance of a company of 32nd Pioneers.

They had also commenced a new trace from the 13th to 15th mile at grades not flatter than 1 in 12; (this was widened to 6 feet and completely paved with rough stone paving by 20th April, by which date they had also cut a new trace from the 15th mile to the borders of the Changu lake; this was paved later on by the Public Works Department).

On 26th March, Brigadier-General Macdonald, C.B., in his No. B-4, to the Quartermaster General (in reply to his No. 803-M., dated 25th March 1904), stated that all the troops he could spare would be quite insufficient to construct this road, that it would take a month or more to reassemble the disbanded coolies, and recommended that Government should at least sanction Rs. 10,000 a month to improve the road and keep it open for coolies.

On 26th March, the Quartermaster General conveyed the orders of Government to the effect that when sanction was originally given to the construction of a mule path, Government understood that one already existed, and that it could be improved and kept open for a small outlay; that there was no intention of constructing a permanent road; that economy was the first consideration; that work was not to be entrusted to the Public Works Department; that arrangements were to be made to construct it by military labor; and that the total expenditure was to be limited to Rs. 20,000.

On 28th March, he further conveyed the orders of Government in his No. 814 M. C., to the effect that the road was to be fit for mules only and not a cart road in any sense.

On 29th March, Brigadier-General Macdonald, C.B., replied that by reducing the mule path to $6\frac{1}{2}$ feet wide, the estimate could be reduced to Rs. 1,20,000, that nothing short of a pucca mule path would stand during the rains, and that if this sum was thought too high, he adhered to his recommendation for a cooly track: he also asked that the order regarding non-employment of the Public Works Department should be reconsidered, as troops would suffer much from sickness if employed.

On 5th April, the Quartermaster General in his No. 685-M., conveyed the sanction of Government to an expenditure of Rs. 10,000 a month, for 3 months from 31st March, and that all available military labor was to be employed on the Nathu La road.

On 8th April, in his No. 728-M., he further conveyed the instructions of Government to the effect that, as labor had been disbanded, Government now understood that a $6\frac{1}{2}$ -foot path could not now be constructed before the rains, that work should be confined to improving and maintaining cooly track, and that they had no objection to the employment of the Public Works Department if the Local Government did not object.

On 19th April, in his No. 854-M., he again conveyed the instructions of Government to the effect that as it appears that assuming the section Changu to the Nathu La be maintained as a cooly track, a practicable mule track might be maintained from Gangtok to Changu and again from the foot of the Nathu La to Phema for Rs. 25,000 additional to the Rs. 30,000 already sanctioned, and accordingly sanctioned a total of Rs. 55,000 for expenditure from 1st April to 30th June.

On 1st May, a conference was held between Brigadier-General Macdonald, Captain Sheppard, D.S.O., R.E., and Mr. Green.

It was found that prior to the receipt of Quartermaster General's wire No. 590-M. of 23rd March stopping all work, the Public Works Department had incurred an expenditure of Rs. 20,618, and during the last eight days of March an expenditure of Rs 7,171: the first of these amounts having been incurred in the last financial year, was not charged against the present allotment; the second amount was.

They then allotted the sanctioned Rs. 55,000 as follows:—

	Rs.
Already spent by Public Works Department	7,171
For the road Champitang to Phema by military labor	6,000
For road Gangtok-Changu by Public Works Department agency	19,829
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	33,000
For maintenance during May, June, July, August, and September	22,000
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TOTAL	55,000
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For the military labor, the 3rd Company 1st Sappers, and two companies of 32nd Pioneers were available, while Mr. Green undertook to send 200 coolies for one month to assist them.

Work was accordingly put in hand on these lines.

From 22nd April to 12th May, the 3rd Company 1st Sappers and two companies, 32nd Pioneers, were at or near Champitang. They found the road from Champitang to Rinchengong almost impassable from mud and in 3 weeks paved or corduroyed with logs the worst parts for 4 miles.

Half of the Sappers and all the Pioneers then left for Gyantse.

The remaining half company of the Sappers stayed on and worked first at paving and later on from 17th June 1904 to 5th August 1904 at cutting a new trace of 1 in 15 from Champitang to Phema for 4 miles, 4 feet wide. One mile of this was widened to 8 feet.

On 15th May, the Quartermaster General informed the General Officer Commanding that Government was considering the advisability of placing the Nathu La route directly under him, and enquired what field engineers he would require.

Captain R. St. J. Gillespie, R.E., was then appointed field engineer in charge of this route, with a staff of 2 sergeants from the Military Works Services,

four native sub-overseers and clerks : he reached Gangtok on 9th June and took over charge on 18th June.

On 4th June, the Quartermaster General in his No. 1695-M., asked the General Officer Commanding whether any more money could be usefully spent on the road, having in view the possibility of prolonged operations.

On 16th June, the General Officer Commanding replied that the present grant was entirely devoted to completion of cooly track. A mule path on ekka road alignment, would now cost the sum originally estimated of Rs. 1,75,000 plus 50 per cent. due to sickness during the rains, or a total of Rs. 2,60,000.

On 28th June, the Quartermaster General in his No. 2136-M., conveyed the sanction of Government to this amount, Rs. 2,60,000, for the construction of an 8-foot mule road on ekka road alignment.

Great difficulty was then experienced in raising sufficient coolies for the work locally, as not more than 1,000 coolies could be obtained.

Sanction was applied for to raise 2,000 Hazara coolies (Quartermaster General's No. 2175, dated 29th June 1904).

Hazara coolies do not appear to have been obtainable, but by the 15th August, two cooly corps, each of 1,000 men, had reached Gangtok. These consisted of :—

The Mussooree cooly corps of 400 Garhwalis and 600 Pathans from round Quetta under Lieutenant Malan, R.E.

The Peshawar cooly corps under Lieutenant Hill, R.E., mostly Pathans from the neighbourhood of Peshawar and some Punjabi Mahomedans.

All of these were found to be quite ignorant of road work, and their head men, who should have been of the "mate" class, were equally ignorant.

On 8th July, Lieutenant Hodgson, R.E., reached Gangtok as Assistant Field Engineer.

For a short time previously Lieutenant Haswell, R.E., had been assisting Captain Gillespie ; he now returned to his company (3rd Company 1st Sappers).

On 12th August, the Quartermaster General in his No. 2908-M., enquired if the Rs. 2,60,000 allotted would suffice.

The Officer Commanding Lines of Communications replied that the estimate was not yet ready, but that the amount was certain to be largely exceeded.

On 24th August, the Quartermaster General wired for estimate and specification, and ordered every effort to be made to keep down expenditure.

On 27th August, an estimate for an 8-foot road at 1 in 15 was despatched (amount, Rs. 5,15,250) to the Quartermaster General : this included the Rs. 2,60,000 already sanctioned, but none of the expenditure previous to that sanction. It was also pointed out that raising and railing the cooly corps had cost Rs. 1,30,000, and three more officers were asked for.

On 5th September, the Quartermaster General in his No. 4272-M., directed that Mr. Green, who has great experience of Sikkim roads, should be placed in communication with Captain Gillespie ; also that the grade of 1 in 15 need not be adhered to, considering the large expenditure involved and the possible construction of the Ammo Chu-Di Chu route.

Mr. Green gave his opinion that considering the labor obtained and the cost of raising it, the estimate was not too large ; he estimated it to cost —

	Rs.
48 miles road, at Rs. 10,000	4,80,000
Contingencies, at 15 per cent.	72,000
TOTAL	5,52,000

This opinion was forwarded to Government by the Officer Commanding Communications in his No. 9 C., dated 7th September 1904.

On 7th October the Quartermaster General in his No. 4832, in reply to an enquiry from the Officer Commanding Communications, conveyed the sanction of Government to work being continued under existing arrangements until 31st October, by which date it was understood, it would be fit for traffic throughout.

On 31st October, the work done was roughly as follows :—

From the Supply and Transport Godowns at Gangtok, a new short cut mule path had been made to join up with the cart road and save the long round it made.

From this on the 5 miles of cart road, were metalled, drained and improved.

The 5th to 10th miles were also more or less metalled and kept fit for traffic.

From the 10th to 15th mile (Laggap La) the old track was partially metalled and kept fit for traffic, while a new trace at a good grade had been cut and parts of it commenced.

From the 15th to 20th mile (Changu) a new path was constructed, roughly paved and metalled.

From Changu to the Nathu La and down to Phema, a new path had been constructed throughout, but was narrow in parts, unpaved, unmetalled, very muddy when wet and generally unfinished; the grades of all this are very good and the new alignment avoids the double ascents of the Tuni La and Sibu La.

The expenditure on this road stands roughly as follows:—

	Rs.
(1) While in Mr. White's charge up to 1st March 1904	81,000
(2) While in Public Works Department charge, 1st March 1904 to 18th June 1904	47,531
(3) While in Captain Gillespie's charge, 18th June 1904 to 31st October 1904—	
Construction	4,15,000
Maintenance	20,000
(4) Working pay of Troops, roughly	5,000
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TOTAL	5,68,531
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or a total of roughly six lakhs including the raising and disbanding of the cooly corps.

(f) *Rungpo-Chumbi—via Jalap La (57 miles)*.—The first 11 miles of this, as far as Rongli, was a newly made hill track, fit for mules.

The 23rd Pioneers worked here from 15th to 23rd October 1903.

A new 84 feet span bridge was erected in this section by the 12th Company, 2nd Queen's Own Sappers, prior to the start of the expedition.

From Rongli on to Gnatong ran the old Tibetan trade route, a very steep, roughly paved, and stepped track, just practicable for animals.

A considerable amount of work was done here by the Public Works Department in maintaining the old track, while 2 companies of 23rd Pioneers were also employed here about the end of October 1903.

From Gnatong to the Jalap La was comparatively easy and required but little maintenance.

From the Jalap La to Langram was extremely bad, very steep, very narrow, very crooked, over and round boulders of every size and description, while the next section from Langram to Yatung was even more deadly to pack animals owing to the frequent sheets of ice which covered the road.

Three companies of 23rd Pioneers were employed on this from 13th to 16th December 1903.

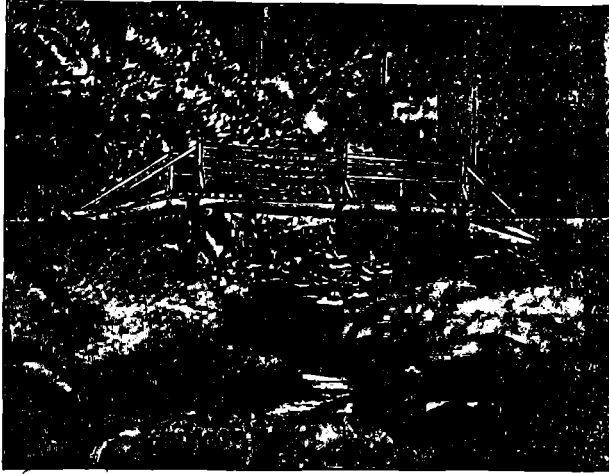
From then on till the end of May, one company was kept constantly busy in keeping this road open, corduroying, draining, etc.

The 12th Company, 2nd Queen's Own Sappers, were also employed here from 21st February till the end of that month.

From Yatung to Rinchengong, the track followed the left bank of the stream, was very narrow and not easily capable of improvement.

A new track was accordingly made on the right bank by one company of 23rd Pioneers who also bridged the stream, while a section of the 12th Company, 2nd Queen's Own Sappers, made another bridge across the stream near Yatung.

A photo of the Pioneer's bridge is attached.



From Rinchengong to Chumbi the grades were easy, except for one spot, but the track itself was narrow.

It was worked at by various troops (mostly 1 Company, 23rd Pioneers, and half of 12th Company, 2nd Queen's Own Sappers) at different times between January and May 1904.

The one steep spot just mentioned was where the track ran over a rock spur about 30 feet high, which projected into the river. It was built up here to get the height and was very steep and rough.

One company, 23rd Pioneers, commenced blasting a road round it out of solid rock. This was completed by the 3rd Company 1st Sappers and was a great improvement.

The Chumbi bridge which was kindly left standing by the Tibetans (as were all their bridges) was a cantilever bridge of the usual type.

This was repaired by the 12th Company 2nd Sappers who also put railings to it. A photo of it is attached.



(g) *Chumbi-Phari—(29 miles).*—(The first 17 miles of this road, from Chumbi to Lingmatang plain (there was a mile of level across the plain), past Gantsa as far as Dotha Tang were very steep, narrow, irregular, through and over boulders.

From Dotha Tang to Kamparat bridge, 3 miles along the side of a bare hill, at fairly easy grades, and then 9 miles across the undulating Phari plain, grades easy, but ground hummocky with several small streams.

Much work was done by the troops on improving this.

Four companies of 23rd Pioneers were employed between Lingmatang and Gantsa from 26th December 1903 till 4th January 1904, and 2 companies of

the same regiment on the Gantsa-Dotha section from 4th January till 23rd March.

A half company from 12th Company 2nd Sappers also were employed at the same time in the vicinity of Gantsa.

Four companies of 32nd Pioneers were employed from early in January until 21st March on the Gantsa-Kamparat section.

The garrison of Phari, 3 companies, 8th Gurkhas, made the road across Phari plain fit for ekkas, cutting a new trace along the side of the hill, thereby avoiding most of the streams which cross the plain.

All the above work was rendered difficult by the severity of the winter, the ground being in a frozen state throughout.

On the Gantsa portion, much blasting was done to remove boulders, and a great portion of the track was built up from boulder to boulder.

When the first advance to Gyantse took place at the end of March, all the troops mentioned above moved on except the following:—12th Company 2nd Sappers; about $\frac{2}{3}$ of their strength remained at Gantsa and continued work until their return to India in September. Two companies, 23rd Pioneers, remained till the middle of May; they cut a path on a new alignment near Dotha saving a very stiff climb over one of the worst bits of the road.

Early in June, Government sanctioned Rs. 40,000 for the construction of a mule path on ekka road alignment, throughout this section; the work to be done by troops and local labor.

In addition to the company of Madras Sappers, 2 $\frac{1}{2}$ companies of 19th Punjabis were employed on this road during September and part of October.

Four companies of 23rd Pioneers were employed between Gantsa and Kamparat from 5th August to 20th September.

Half of 3rd Company 1st Sappers worked just above Lingmatang plain from 8th August to 11th October and constructed 1 mile through hard rock avoiding a steep rise and fall which previously existed.

Local labor was scarce, but as much as could be procured was used.

Roughly only Rs. 8,500 were expended out of the Rs. 40,000 allotted.

When work was stopped on this section about the end of September, owing to the withdrawal of the troops, about half the length of the road had been widened and improved, but much work still remained to be done.

(h) *Phari to Kangma, 75 miles.*—This was the easiest road making met with. Only one portion presented any difficulty, about 4 miles in length, up the gorge connecting the Bam Tso and Kala Tso lakes. The remainder was mostly practically level and only needed the removal of hummocks, stones filling holes and minor petty jobs.

The following troops worked on this:—

The garrison of Phari (3 companies, 8th Gurkhas) during January and February as far as the Tang La.

Three companies of 23rd Pioneers, in various places on the occasion of the first advance to Gyantse.

One company of them was left behind at Chalu and made the 4 miles of ekka road up the gorge mentioned above in 15 days, besides improving the old Tibetan causeway across the stream and making it fit for ekkas.

On the return of the column in April, one company was left to form a post at Kangma and commenced the Kangma-Menza section of the ekka road.

On 17th May, two more companies of this regiment arrived at Menza and by the 16th June the ekka road from Kala Tso to Kangma was ready.

During September, two companies of 19th Punjabis worked for a fortnight on improving and repairing the road up the gorge between the Bam Tso and Kala Tso lakes.

Hutting.

As a general rule, the huts constructed were of four kinds.

At Siliguri, the base, and up the Teesta valley as far as Rangpo they were of Sál bullah frameworks with thatched roofs.

From Rangpo up the Rongli Chu valley as far as Sidonchen, and up the Rongni Chu valley as far as Karpoonang (10th mile beyond Gangtok) they were entirely of bamboo.

From both of these spots on into the Chambi valley, bamboo ceases to exist and the huts were of sawn or split pine planks on pine posts and framework.

In the Chumbi valley itself a large quantity of the local shingle was available; this was of split pine about 5½ feet long, and 5 or 6 inches wide, and was very easily used as either weather boarding or roofing for huts.

The actual construction of the huts calls for but little remark.

Those at Siliguri-Swoki-Riang were constructed by the Executive Engineer, Darjeeling Division, Public Works Department.

Nearly all those in Sikkim were constructed by the Executive Engineer, Sikkim Division, Public Works Department, except at the commencement and latter end of the expedition when the Political Officer, Sikkim, and Field Engineer, Nathu La road, respectively, held charge of the Nathu La road and carried out any hutting required along it.

Those at Chumbi were constructed by Sappers and Miners and Engineer Field Park.

The accommodation provided was as small as possible,—2' x 6' being usually all the floor space allowed for a man, while for the animals 5' x 7' was generally given; nearly all the animals' huts were in a hot damp climate.

Most of the labor actually employed in the construction of the bamboo huts was Nepalese or Sikkim coolies, both very handy at this class of construction.

In addition to the above hutting, a detailed list of the main items of which is attached with approximate cost, a few huts were constructed at various places by the troops.

The 12th Company 2nd Sappers constructed two (2) small log huts at Gautsa, the logs used being laid horizontally and notched into one another at the corners.

The 3rd Company 1st Sappers constructed a similar hut at Champitang. Roofs were of shingle. These huts proved very warm and weather-proof.

Huts were also constructed with stone or sod walls, by both regiments of Pioneers at Chumbi, Kala Tso, etc.; old sacks, tarpaulins, shingle, etc., being used for the roofs.

A house was constructed for the Political Officer, Chumbi valley, at Chumbi by the Engineer Field Park. This was superior in description to the huts. Walls of stone in mud, plastered with a clay which is found locally in some nullahs and which gives a plaster nearly equal to lime plaster. Shingle roof on pine collar beam trusses, boarded floors, and glazed doors and windows.

The Chumbi pine timber is very easily worked, but very soft and weak.

Main Items of Hutting for the Tibet Mission Escort.

Locality and description of hut.	Purpose for which required.	Approximate cost.
Siliguri. Thatched roofs, split cane walls, cane machan floors 2 feet above ground for men's huts, sāl bullah posts.	<i>Supply and Transport Corps—</i> 3 huts for 350 followers	Rs. 18,000 4,000
	10 huts for cart train animals	
	3 " " " drivers	
	3 Supply godowns each 100' x 20'	
	<i>Ordnance Department—</i> Huts for 1 tindal, 12 lascars, 2 followers	
	Store 16' x 50'	
	<i>Hospital for 46 sick—</i> Huts for hospital assistant, store-keeper, packstore, 40 followers and latrines	
	<i>Post Office including quarters</i>	
	<i>Supply and Transport Corps—</i> Huts for drivers, 30' x 14'	
	" " animals 40' x 14'	
" " 200 bullocks	3,850	
" " 120 men		
Store shed		
<i>Hospital for 26 sick</i>		
Huts for hospital assistant and 27 followers		
Carried over		25,850

Main Items of Hutting for the Tibet Mission Escort—contd.

Locality and description of hut.	Purpose for which required.	Approximate cost.
	Brought forward	Rs. 25,850
Riang. As at Siliguri.	As at Swoki	3,850
Teesta bridge. As at Siliguri	Sheds for transport animals " " drivers	} 4,790
Tarkollah. Cane huts, thatched roof, machan floors in huts for men.	<i>Supply and Transport Corps—</i> Sheds for 200 bullocks " " 120 men " " stores <i>Hospital for 26 sick</i> Hospital assistant's quarters and 2 followers Hut for dooly bearers	1,200 270 90 } 400
Rangpo. As above.	<i>Supply and Transport Corps—</i> Huts for 500 bullocks " " drivers " " followers Store godown Coolies' shelter <i>Guard shed</i> <i>Hospital for 30 sick</i> Hospital assistant and 2 followers' quarters Dooly bearers' hut Store and sweepers' quarters Latrine <i>Post office and outhouses</i> <i>Telegraph office</i> 10 signallers' quarters Followers' quarters	} 4,600 150 } 860 689 720 1,014 56
These were of sawn planks.		
Middle Camp. Bamboo huts	<i>Supply and Transport Corps—</i> Store shed Huts for 370 animals Huts for 275 drivers <i>Hospital for 26 sick</i> Hospital assistant and 2 followers' quarters Dooly bearers' hut <i>Postal Dāk runners' huts</i>	90 } 2,400 1,350 300 40 54 120
At 4th, 8th, 12th and 16th miles from Rangpo to Gangtok.		
Adamtang. Bamboo huts	<i>Supply and Transport Corps—</i> Store shed Drivers' huts for 275 men Huts for 250 animals	90 1,350 1,600
Gangtok. Plank hut Bamboo huts	Officers' quarters <i>Supply and Transport Corps—</i> Store godowns 210 ekka ponies' sheds 250 drivers' huts	268 } 8,000 1,575 500
	Carried over	62,276

Main Items of Hutting for the Tibet Mission Escort—contd.

Locality and description of hut.	Purpose for which required.	Approximate cost.
	Brought forward	Rs. 62,276
	Shed for sick ponies	200
	Latrines	952
	Store godowns	1,200
Plank huts	Officers' huts and warrant officers' quarters	2,242
Bamboo huts	Additional accommodation for animals	1,350
	Post office	361
5th mile.	<i>Supply and Transport Corps—</i>	
Bamboo huts	Huts for 500 bullocks	3,000
	" 180 drivers	405
	Paving bullock huts	700
Plank hut	Godown 60' x 12'	720
Ditto	Officers' hut	650
Ditto	" " outhouses	60
Bamboo huts.	Guard shed 15' x 12'	34
	" Cook shed	20
	Postal—Dāk runners' hut 15' x 12'	34
Karpoonang.	<i>Supply and Transport Corps—</i>	
Bamboo huts	Huts for 680 coolies	1,785
Plank hut	Godown 60' x 12'	720
Bamboo huts	Guard hut 15' x 12'	34
	" Cook shed	20
	Post office	200
	Postal—Dāk runners' hut 15' x 12'	34
	<i>Telegraph—</i>	
Plank hut	Signallers' quarters	180
Bamboo hut	Followers' quarters	75
Plank hut	Officers' hut	300
	" outhouses	60
Bamboo hut	Hospital for 26 sick	300
	Hospital assistant and 2 followers	50
	" dooly bearers' hut	54
15th mile Camp.	<i>Supply and Transport Corps—</i>	
Plank huts	Huts for 850 coolies	7,000
	Godown 60' x 12'	720
	Guard shed 15' x 12'	135
	" Cook shed	50
	Postal—Dāk runners' hut	135
Changu.	Hut for 2 officers	400
Plank huts	" " " outhouses	150
	Hospital for 52 sick	2,091
	Hospital assistant's quarters and 2 followers'	150
	" dooly bearers' huts	216
	<i>Telegraph Department—</i>	
	Hut for 2 signallers	240
	" " 5 followers	225
	<i>Supply and Transport Corps—</i>	
	Huts for 850 coolies	7,000
	Godown 60' x 12'	720
	Postal Dāk runners' hut	135
	Post office	200
	Guard shed 15' x 12'	135
	" Cook shed	50
	Carried over	97,768

Main Items of Hutting for the Tibet Mission Escort—contd.

Locality and description of hut.	Purpose for which required.	Approximate cost.
	Brought forward	Rs. 97,768
Yewkonting.	<i>Supply and Transport Corps—</i>	
Plank huts	Godown 60' x 12'	720
	Hospital for 26 sick	1,191
	Hospital assistant's and followers' quarters	150
	dooly bearers' hut	216
	Guard shed	135
	Cook shed	50
	Postal—Dāk runners' hut	135
Champitang.	Hut for 2 officers	1,300
Plank huts	Hospital for 26 sick	794
	Hospital assistant's quarters and followers'	100
	dooly bearers' hut	144
	<i>Supply and Transport Corps—</i>	
	Huts for 980 coolies	9,000
	Godown 60' x 12'	720
	Guard shed, 15' x 12'	135
	Cook shed	50
	Postal—Dāk runners' hut	135
	Post Office	300
Phema	<i>Supply and Transport Corps—</i>	
	Bullock sheds	1,200
	<i>Engineer Field Park—</i>	
Chumbi	Store	80
Shingle huts	Gun cotton shed	150
	<i>Supply and Transport Corps—</i>	
	Godowns 2 x 100' x 20'	1,600
	Bakery	75
	Meat shed	45
	Water mill	300
	Hospital for 40 sick	1,350
	Hospital for British troops	600
	nurses' quarters	80
(Description given above.)	Political Officers' quarters and outhouses	10,000
	<i>Postal—</i>	
	Post Office	250
	Dāk runners' hut	75
	Telegraph Office 20' x 18'	140
	Ordnance store hut	300
	<i>Supply and Transport Corps—</i>	
Gautsa	Godown 100' x 16'	400
Plank huts	Postal—Dāk runners' hut	75
Dotha.		
Timber frame,	<i>Supply and Transport Corps—</i>	
Rukroid roof	Godown 100' x 16'	1,200
and walls.	Postal—Dāk runners' hut	75
Phari.		
Sod wall		230
	Enclosure for animals	
Kala Tso.		
Sod walls, flat	Post Office	100
roof.		
Roratang.	<i>Supply and Transport Corps—</i>	
	Officers' hut	70
Bamboo huts,	Three sheds for 250 bullocks, hut for 100 coolies*	6,000
thatch roof,	Store godown	94
machan floors.	Hospital for 16 sick	190
	Hut for hospital assistant and followers	50
	Carried over	1,37,768

* This includes Supply and Transport huts at Lingtam, Sedenchen and Jegluk, marked †.

Main Items of Hutting for the Tibet Mission Escort—concl'd.

Locality and description of hut.	Purpose for which required.	Approximate cost.
	Brought forward	Rs. 1,37,768
Rongll	<i>Supply and Transport Corps—</i>	
	Officers' hut	100
	Sheds for 500 bullocks	
	Godown " " 120 men	
	Hut for store-keeper and establishment	3,500
		}
Lingtam.	<i>Supply and Transport Corps—</i>	
	Huts for 700 cooliest . . . . .	...
Bamboo huts	" " 230 animalst . . . . .	...
	<i>Telegraph Department—</i>	
Plank hut	Hut for signallers	100
	" " followers	50
Jeglük.	<i>Supply and Transport Corps—</i>	
Bamboo huts	Huts for 400 cooliest . . . . .	...
	" " 200 coolies	350
	Hospital for 16 sick	250
	Hospital assistant and followers	50
Sedonchen.	<i>Supply and Transport Corps—</i>	
Bamboo huts	Huts for 250 cooliest . . . . .	...
	" " 410 coolies	690
Shalambi.	<i>Supply and Transport Corps—</i>	
Plank huts	Mule sheds	4,000
Gnatong	Two officers' quarters	250
Plank huts	Repairs to old barracks	5,000
	One new barrack, 100' x 16'	1,200
	<i>Supply and Transport Corps—</i>	
	Huts for 460 men	3,220
	" " 330 animals	1,050
Kupup.	<i>Supply and Transport Corps—</i>	
Plank huts	Huts for 660 coolies	5,500
Jalap La pass	Refuge hut	500
Langram.	<i>Supply and Transport Corps—</i>	
Plank huts	Huts for 660 coolies	3,300
	Total approximate cost of main items of hutting	1,67,482

Water Supply.

As a general rule, the streams which flow down every valley in Sikkim and Tibet afford an ample supply of excellent drinking water.

The only water supply works carried out were:—sinking two tube wells at Siliguri, cost Rs. 500. These at first refused to work, being choked with fine sand, so were withdrawn and refixed in existing wells, when they worked perfectly.

Other pumps with reservoirs were also erected in some of the wells at Siliguri at a cost of Rs. 1,848.

Two tanks were erected at Rangpo the water being brought to them from a spring in bamboos.

At Gantok water was brought from a distant spring in a $\frac{1}{2}$ " pipe.

At Chumbi water was brought into the centre of the camp in a channel made from half round pine logs hollowed out.

None of the above call for special comment.

Crossing of the Brahmaputra.

Chaksam Ferry.—The stores available were:—

4 Berthon boats with superstructure for 2 rafts.

- 2 Tibetan ferry boats, shaped like large oblong boxes, capable of carrying 50 armed men or 22 mules at a time. A few Tibetan skin boats capable of carrying 20 maunds of stores or 10 armed men.
- 1—1" steel wire cable—200 yards long.
- 1 traveller for 1" wire cable.

About 8 maunds of 1½" and 2" manilla rope—see attached sketch.

Round rock A, (page 15) owing to the confluence of the two streams, the force of the current was terrific, and large whirlpools suddenly formed; these were a source of great danger to the Berthon boats and it was in one of these that Major Bretherton here lost his life.

The main stream was at this point roughly 140 yards wide, then a sand bank 100 yards in width and then another small branch about 25 yards wide, fordable at a pinch.

The crossing was commenced at midday on 25th July by rowing only, the Berthons being made up into rafts.

This procedure was very slow, as the big ferry boats were occasionally unable to fetch the opposite shore; when this occurred they went down below the island and had to be towed up for 1½ miles.

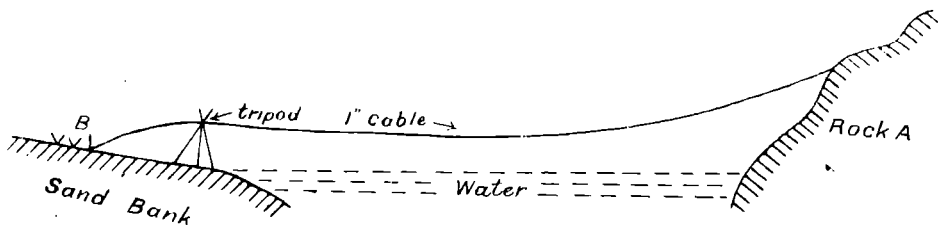
On the 26th, many efforts were made to get a line across, but all failed owing to the tremendous force of the current: the boats were, therefore, rowed as before. The river had risen during the night and many boats were carried down stream. By the end of the day only 14 boatloads had been put over in 14 hours of unremitting work.

After the accident which cost Major Bretherton his life, the Berthon rafts were given up and single Berthons used. These were more economical in time than the rafts and less dangerous.

On the 27th morning, a line was got across in the following manner.

Two Berthon boats were anchored out as far as possible and connected by a line. The other 2 Berthon boats then came out from opposite shores, taking lines, and on approaching the anchored boats, they threw the ends of their lines to the occupants, who joined up with their own connecting line. This was successful at the third attempt.

Having got the line across the 1" cable was hauled over and made fast to the top of the rock A, which was about 20 feet above the water: the other end was fixed to an anchorage at B passing over a tripod 10 feet high.



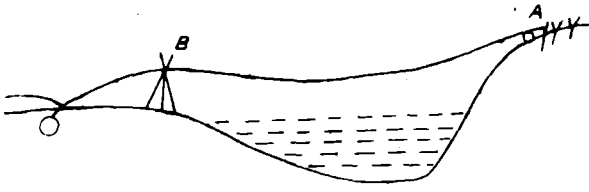
The traveller was slung on the wire, and for every passage of the big boats, one end of a 2" rope was sent across from B to A, the other end being held on the shore at B.

The end at A was then unfastened and fixed to the starting boat, which was then swung and pulled across. The boats were then towed a little upstream and rowed back empty.

The rate of crossing by this contrivance was at once increased to 40 boatloads a day and the crossing was completed in 5½ days.—3,000 men, 3,000 animals, 10,000 maunds of stores.

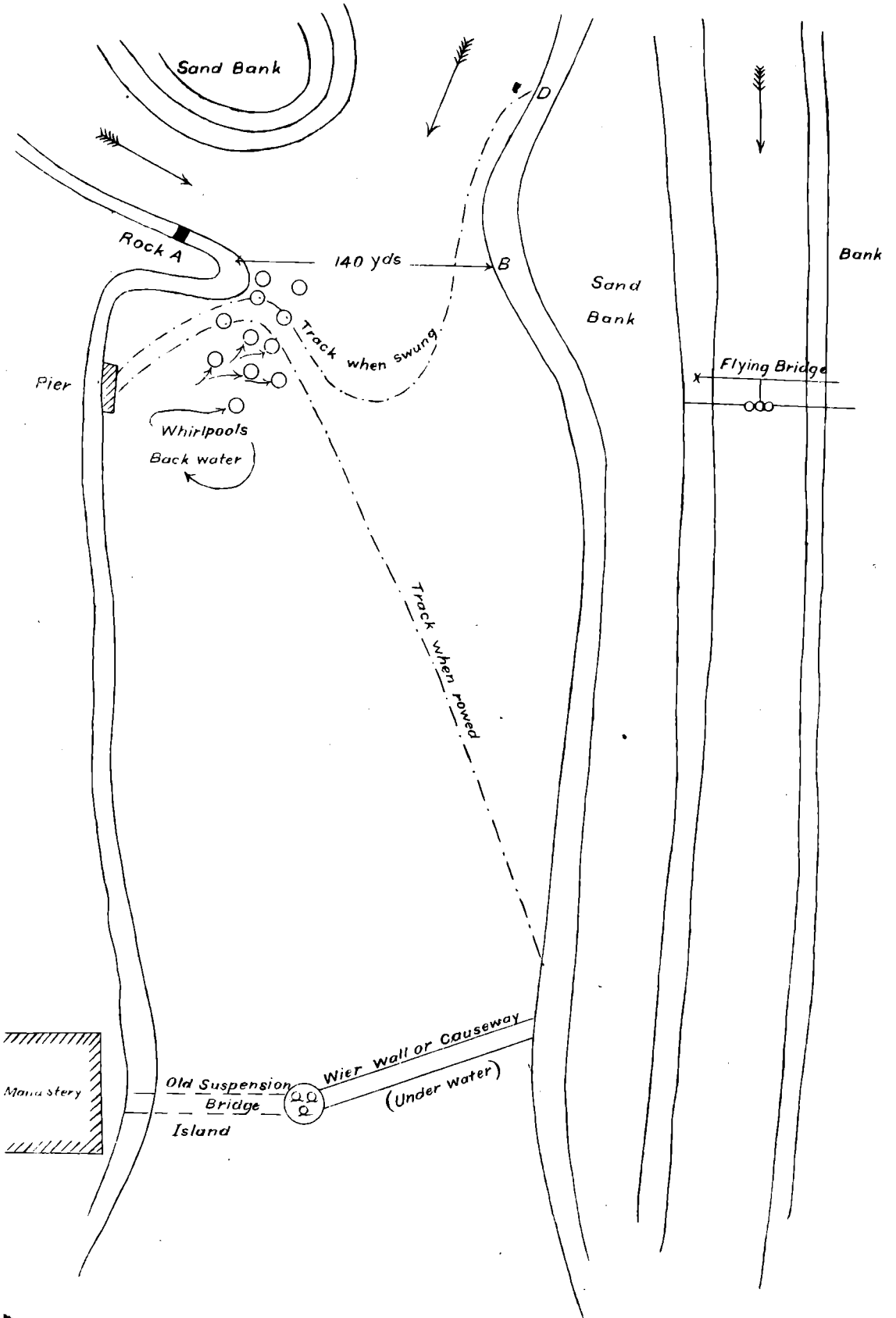
Flying Bridge.—A flying bridge was constructed across the small branch of the stream. This was about 30 yards wide and could be forded at a pinch though deeper than pleasant for men.

A 3" rope was stretched across the stream from the high bank A over a tripod 8 feet high at B. On this ran a pulley to which 3 Tibetan skin boats (like coracles) were attached; these were hauled across direct and back again by 3 men on each side.



Most of the men and a large portion of the stores crossed here. The animals waded.

ROUGH SKETCH OF CHAKSAM FERRY



Return Crossing of the Brahmaputra.—Half of the 3rd Company 1st Sappers left Lassa on 9th September and reached Chaksam ferry on 11th to make preparations for the crossing.

Reports had been received that a better place for crossing existed at Parte, 10 miles higher up, and after inspection it was determined to tow the ferry boats up to this spot.

The river was now some 3 feet higher than when the force first crossed, but was falling steadily at the rate of about 2 inches a day.

In addition to the stores previously in use, the following had since been received :—

A 1½" wire cable, about 150 yards long.

A ½" " " 200 " "

Four maunds of 1½" Manilla rope. "

Two " of 2" " "

Some 20 Tibetan skin boats had also been collected; these were shaped like coracles and consisted of undressed Yak skin over a very flimsy wooden framework.

They were easily damaged, particularly after the leather had been any time in the water and become saturated and soft.

On the 13th the dragging of the big ferry boats to Parte commenced and lasted two and half days.

The towing was done by 200 of Captain Ross' cooly corps, the half company of Sappers and 15 Attock boatmen: it gave a considerable amount of trouble as the river just then was at its most awkward height for the work; several branch streams existed, which were then just not deep enough to allow of the big boats being taken up there; the towers had consequently to wade across them, often breast deep.

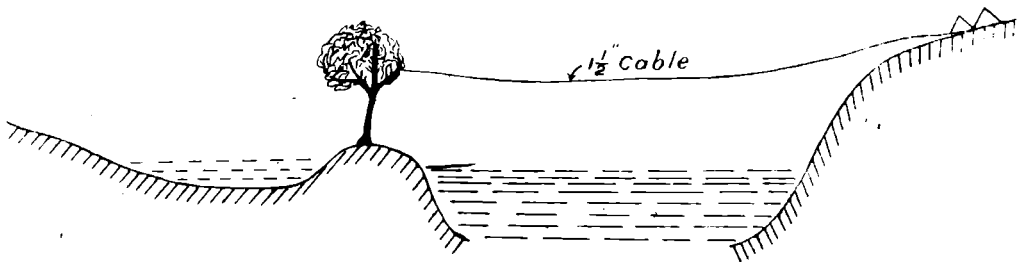
On arrival at Parte, one and a half companies of 8th Gurkhas and 1 company of 40th Pathans also became available and furnished working parties, in addition to usually about 100 coolies, the whole being under the direction of Captain Sheppard, D.S.O., R.E.

It was decided to utilise the material and boats available to form 3 ferries nearly ¼ mile apart.

One of the large ferry boats was allotted to each of the upper and lower ferries, while the skin boats were told off to the centre and Tibetan boatmen hired to row them.

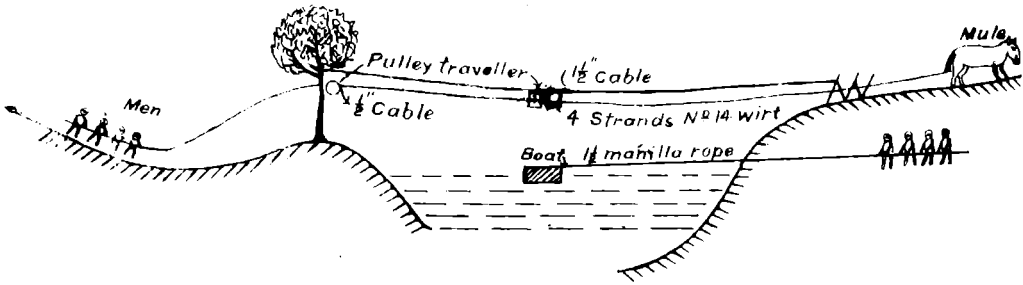
The upper ferry was about 170 yards from bank to bank, the lower 120 yards, the river here being considerably narrower owing to a small island, separated from the right bank by shallow water. A causeway was here made by the 40th Pathans and ½ company of 8th Gurkhas, to connect the island with the bank, but by the time the main body of troops reached the ferry, the river had fallen so that the island had become part of the bank.

At this lower ferry, the 1½" wire cable was stretched across. No particular difficulty was experienced in doing this, a light line being first taken across by a Berthon boat, then a 1½" Manilla rope and then the wire cable.



A stout tree grew on the island; one end of the cable was attached to this, the other to an anchorage on the high left bank of the river.

A traveller was arranged to run along this cable, being hauled towards the high bank by a mule, with 4 strands of No. 14 gauge wire, bound together by fine binding wire, towards the low bank by the $\frac{1}{2}$ " cable, strengthened with a strand of No. 14 wire, pulled by men.



The idea was to use the traveller simply as a means of getting the end of a tow rope backwards and forwards across the river.

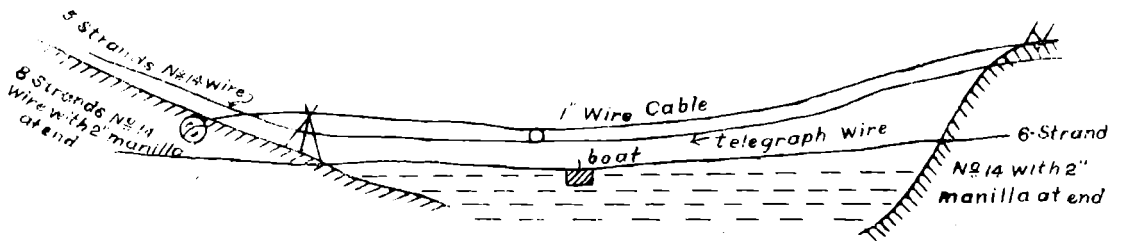
This being sent across was seized by the towing party on the opposite side; the boat pushed off, swung across by the force of the current to near the opposite bank and was then pulled up to the landing stage.

To return the boat, the end of the rope was sent back by the traveller, the boat, being pushed, returned to the original bank.

By this means as many as 30 boatloads would be got across in a day of 11 hours, the rate of loading varying a good deal with the different units.

The arrangements at the upper ferry were similar, but owing to the extra width of the river, more trouble was met with here.

The sketch shows the cable and ropes used.

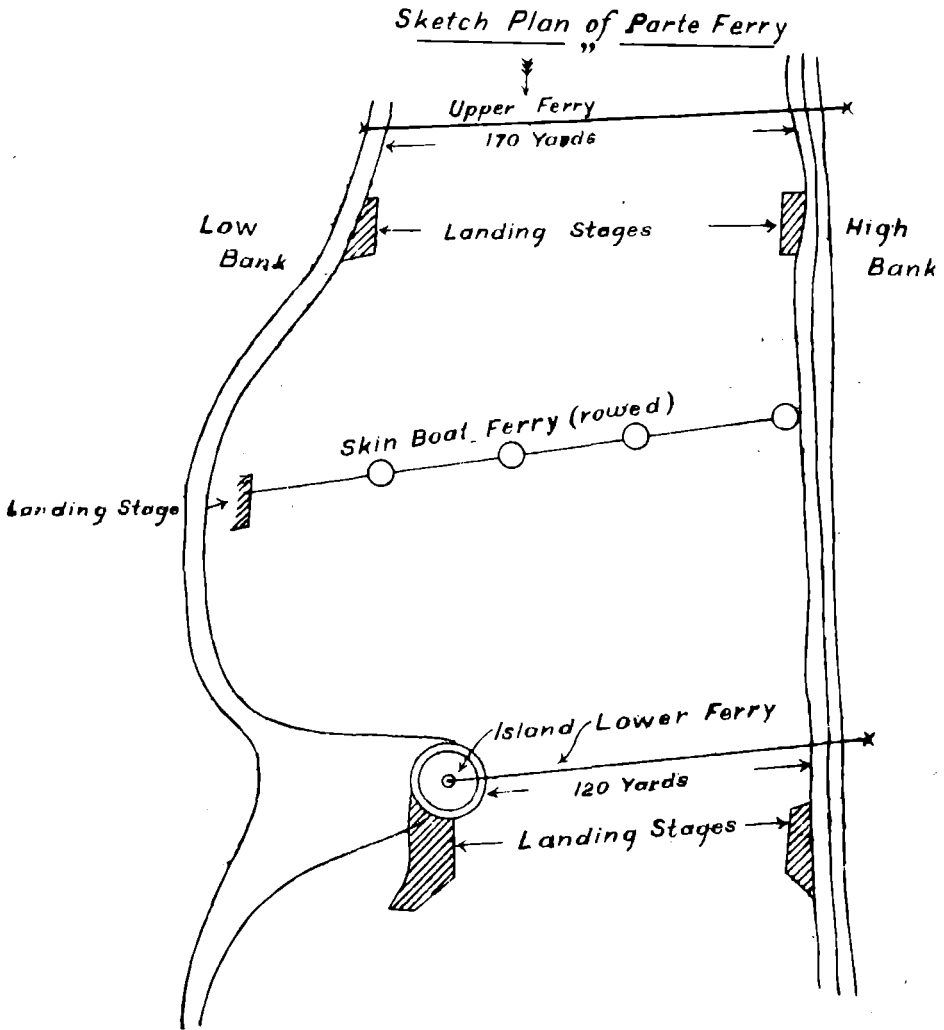


The traveller was an ordinary pulley block in this case. The boat here was provided with 2 tow ropes, the advantage being that the standing end of the one not in use could be undone and sent across while the boat was in transit, thus giving more time for the operation which took a little time owing to the width of the river and force of the current.

Landing places were made at both the upper and lower ferries, of gabions 5 feet high and from 2' to 2½' diameters, of willow withes cut from trees close by. These were made by the 8th Gurkhas.

As the river was falling, these were placed in it with their tops almost flush with the water, filled with stones, tied together and anchored back with wire. The space behind was then filled in with stones.

On 27th September, the force arrived, and was safely across in about 50 hours from the time it reached the ferry. No attempt was made to work in the dark, as there was danger of breaking some of the gears, all of which was only just strong enough for the work it had to perform and required careful handling.

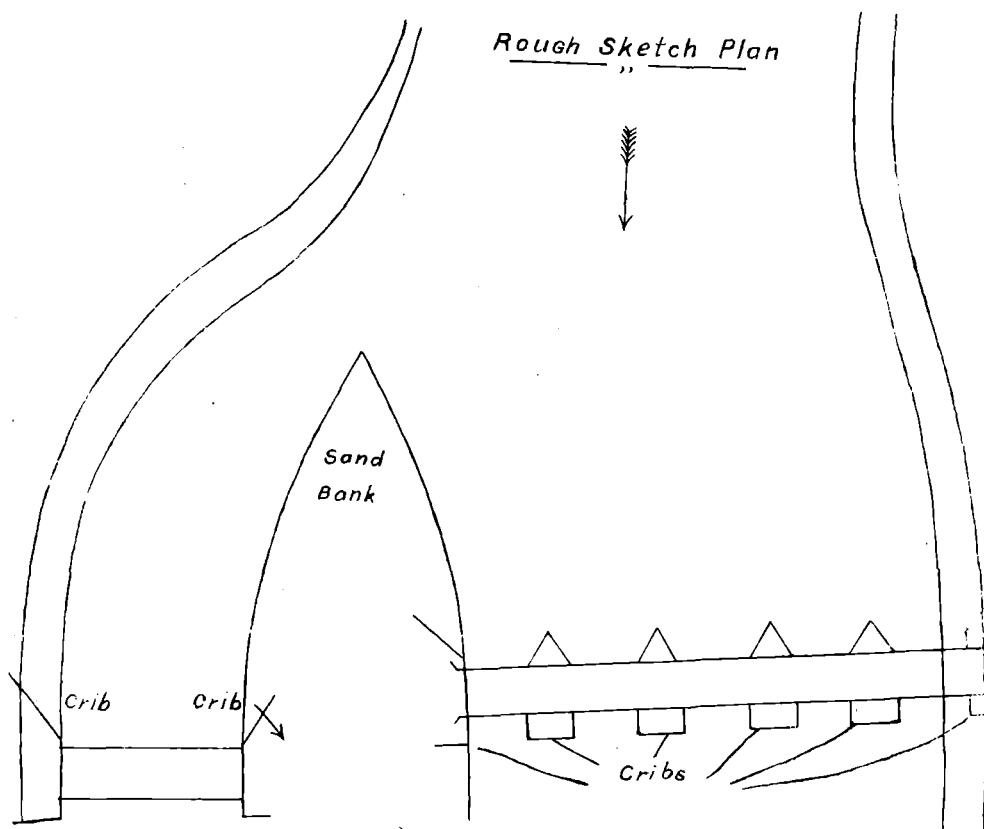


Bridge at Gyantse constructed by 3rd Company 1st Sappers.—After Palla fight, the Tibetan bridge at the Mission Post was rendered unsafe by fire from the Jong: a new one was therefore required.

The span at that time was about 120' and numerous subsidiary streams.

The spot selected was about 600 yards higher up the stream than the Mission Post.

The only timber available was that from houses in the vicinity, never more than 15 feet long, so a bridge of crib piers with numerous small spans had to be made: the whole was constructed in three days with working parties from the garrison.



Spans and cribs were of equal width about 13 feet each.

Bridge below Gyantse, constructed by 3rd Company 1st Sappers.—Between the Tzechen fight and the storming of the Jong, a new bridge was built across the river about 2 miles below the Mission Post.

The volume of water had increased considerably and the river had now a formidable current; a spot was chosen where there were two subsidiary streams, and where the main one was narrow and deep.

The latter had a span of 45' and the longest timber obtainable was only 22'. The current was too swift for a crib pier to stand, so both sides had to be cantilevered out until only a 20' span was left.

This was a work of some difficulty as only 12' timbers were available for the cantilevers, so only about 2½' were gained by each. However by continual anchoring and the use of very large stones, the structure was made very solid, and as a precaution, tension ties were added, passing over a frame 8' high in the clear. The tension ties were each made of 6 strands of No. 14 gauge wire.

Siege Operations.

Palla village : storming of.—Half of 3rd Company 1st Sappers reached Gyantse on 24th May.

The garrison was then subjected to daily bombardment from Gingalls and small cannon mounted in the Jong at about 1,300 yards range; the effect produced by this was small, owing to the defences and traverses constructed by Captain Ryder, R.E. The Gurkha post had been taken by the garrison some little time previously and converted into an excellent outpost, but on all other sides the Tibetans had occupied villages and fortified houses, whence they harassed Dāk patrols and foraging parties.

The most serious menace was the strongly fortified village of Palla, situated about 1,000 yards to the north-east of the Mission Post, strongly loopholed and sangared; also through glasses its garrison could be seen preparing to mount gingals which would have enfiladed many of the defences of the Mission Post.

It was, therefore determined to storm Palla at once.

The attacking column was composed of—

Two storming parties of 1 officer and 4 sappers in 1st line.

Ditto ditto in reserve.

Two assaulting parties, each of 1 officer and 60 men, 32nd Pioneers.

General reserve on Gun Hill of rest of half company of Sappers, two 7-pr. 150 lb. guns; 1 company, 8th Gurkhas; 1 company, 32nd Pioneers.

The side of Palla remote from the Mission Post was the point selected for attack; it was hoped that the defences would be weaker on that side, and the orders were that, the houses A and B (see sketch, page 20) were to be attacked first; that the breaches being made by the storming parties, the assaulting columns should at once enter and capture the houses.

The march was commenced at 2-30 A. M. in the direction shown by the dotted line and was carried out very successfully: the column arrived within 300 yards of their objective before the garrison had any inkling of an attack.

The storming parties approached the village and arrived safely at the courtyard wall marked ⊙; they then separated, No. 1 going round A and blowing in a breach at (1), No. 2 doing the same at (2) in house B: this party also secured the door of house A *en route*.

The storming parties then went back to collect and direct the assaulting columns, but it was found that owing to the darkness and the heavy fire they had gone astray, and only about 20 men in all Sappers and Pioneers, could be found.

With these, it was impossible to assault both houses, so it was determined to take A only for the present.

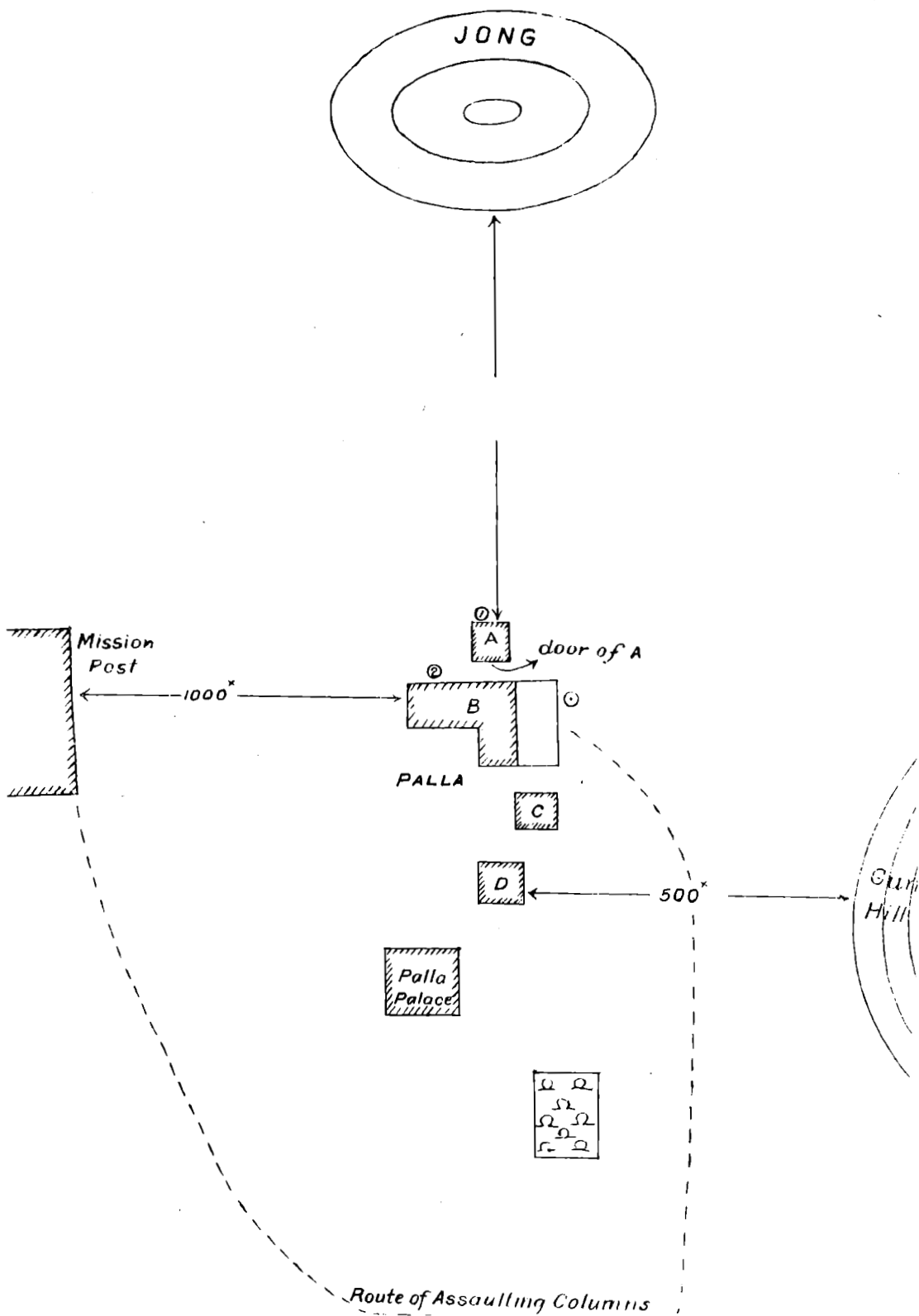
On reconnoitring this, it was found that the garrison (50 or 60 Tibetans) had taken post on the upper floors and roof, carrying the ladders up with them: a box of gun cotton was, therefore, exploded on the ground floor: this killed or buried half the garrison.

A good many casualties occurred during this fight; shortly after gaining possession of A, our garrison consisted of 2 British officers (Captain Sheppard, R.E., and Lieutenant Gurdon, 32nd Pioneers), 8 Sappers and 11 Pioneers, unwounded, while Lieutenant Garstin, R.E., had been mortally, Captain O'Connor, R.A., and Lieutenant Mitchell, 32nd Pioneers, severely, and Lieutenant Walker, R.E., slightly, wounded, while nearly every one had been more or less severely knocked about with stones and bricks.

Under these circumstances, it was only possible to hold A and look out for counter attacks from the Jong.

Meanwhile, Major Peterson, 32nd Pioneers, commenced an attack on Palla Palace and house D, and with the aid of the guns from Gun Hill took both with small loss: B. and C. then surrendered.

ROUGH SKETCH OF PALLA FIGHT



Covered Ways at Gyantse.—After storming Palla, it was converted into an outpost, and it then became necessary to connect it with the Mission Post by a covered way, A in sketch (page 22).

This had to be made through perfectly open ground with no cover of any sort and only 600 yards from the outlying houses and gardens at the foot of the Jong; it consequently could not be constructed by daylight.

Accordingly at dusk, tracing tapes were stretched along the ground in the required direction and just before dark, working parties were extended, the men being at 6 feet intervals: each man then dug a hole 3' × 3' × 3'.

Next morning just before daylight, these holes were occupied by working parties, who joined them up to one another, thus making a continuous trench 3' × 3'.

Another working party in rear then widened and deepened the trench of the day before.

In this manner, the covered way was made in four days with only 1 casualty.

The covered way B was easy as it was fairly well protected by trees, and so could be got out by daylight.

Both A and B were eventually made 6' wide by 4' deep, with crossing places 8' wide.

The 8th Gurkhas had already constructed a covered way consisting of a brick wall to their outpost, but on the Tibetans occupying a house some 400 yards beyond the Gurkha post, this wall became enfiladed and had to be rebuilt in zig-zags.

This (C) was done in one day under a very heavy fire from the Jong during which one sapper was killed by a dropping bullet.

The enemy several times tried to fill in the Palla covered way, and once managed to flood a portion of it, but communication was always quickly restored.

Besides these works:—

Palla was fortified and outlying houses demolished.

Many villages and fortified houses in the neighbourhood were dismantled.

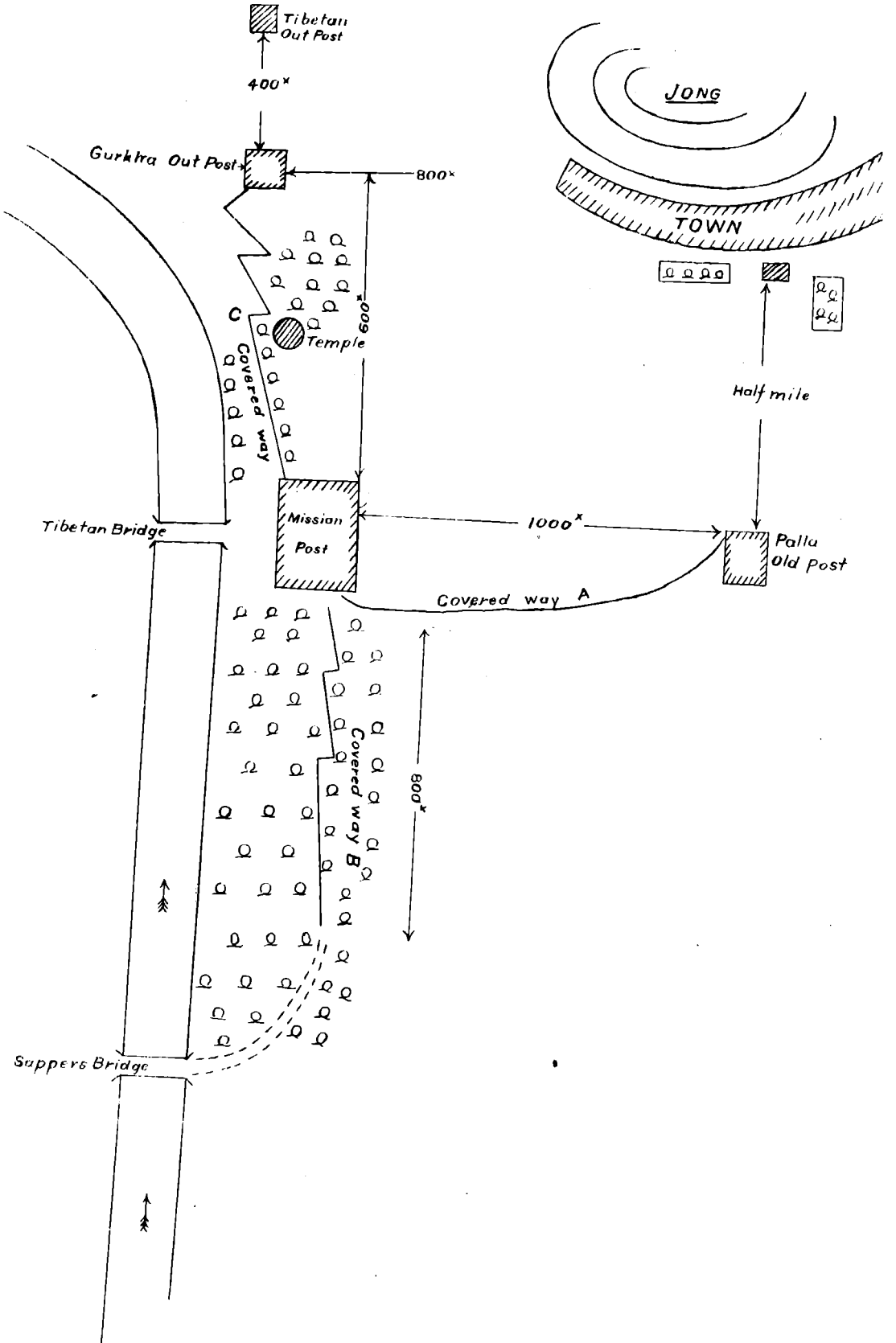
In the Gurkha post, a Machicouli gallery was built under a heavy but erratic fire.

The Mission Post defences were improved and strengthened.

Portions of the enemy's water-supply were cut off.

Trees between the Gurkha and Mission Posts were cleared: this was done after dark, as the trees were only half a mile from the Jong, and once the cutting party was in considerable danger as it returned to the Post only half an hour before the Tibetans made a night attack over the ground where the trees stood.

ROUGH SKETCH SHOWING COVERED WAYS &c GYANTSE



Storming of Tsechen Monastery.—The 8th Gurkhas attacked this from the ridge to the south while the 40th Pathans and Sappers (about $\frac{1}{2}$ of 3rd Company 1st Sappers) made a frontal attack across the plain.

The fire was heavy but very erratic and the monastery and fort on top of the hill were reached with the loss of one officer only, Captain Craster, 40th Pathans, killed.

The large charges of guncotton (whole boxes) used in the Palla fight had apparently inspired the Tibetans with a wholesome terror of the explosive and it was found that they never again stood in a house, after an entrance had been effected by guncotton. In this case they retreated from the monastery into the fort as soon as the doors of the former were blown in, and from the fort into the open as soon as an entrance was made into it.

Defensive Posts.—Many defensive posts and camps were constructed by the troops.

As a rule there was nothing very special about them.

In the Gyantse post, which was perpetually bombarded by the Jong, many traverses were constructed of tree trunks and branches; they proved of great service.

Storming of Gyantse on 6th July.—The portion of Gyantse town round the foot of the Jong, was assaulted just before dawn on 6th July; the assaulting columns were organised as follows:—

<i>Left Column.</i>	<i>Centre Column.</i>	<i>Right Column.</i>	
1 officer, R.E., Lt. Birney, 12 Madras Sappers.	1 officer, R.E., Capt. Sheppard, 12 Bengal Sappers.	1 officer, R.E., Capt. Elliott, 12 Bengal Sappers.	Explosive party.
1 officer, 32nd Pioneers, Lt. Gurdon, 6 men, 32nd Pioneers.	1 officer, 23rd Pioneers, Lt. Turnbull, 6 men, 23rd Pioneers.	1 officer, 23rd Pioneers, Lt. Nicholas, 6 men, 23rd Pioneers.	Reserve Explosive Party.
1 company, 8th Gurkhas.	1 company, 40th Pathans.	1 company, Royal Fusiliers.	
1 company, 32nd Pioneers.	1 company, 23rd Pioneers.	1 company, 23rd Pioneers.	

These 3 columns left the camp on the other side of the river at 1 A.M., marched through the Mission Post, along the covered way to Palla village, whence they started at 3-30 A.M., towards the town.

Their immediate objectives were as follows (page 25):—

Left Column	.	.	.	.	.	Left hand garden.
Centre Column	.	.	.	.	.	Chinese house.
Right Column	.	.	.	.	.	Right hand garden.

The Chinese house was the key of the position and was a large substantial flatroofed house with courtyard.

The right and left columns were, after obtaining possession of their gardens, to assist in its capture if necessary.

The left hand garden was surrounded by a clay brick wall 5 feet high, and the right by a very substantial loopholed one 7' high with a ditch outside. All the 3 objectives were observed to be occupied the day before the assault.

The general idea was that, the explosive parties should breach their objectives, which were then to be rushed by the leading companies of infantry, after which the pioneers, besides supporting the assault, should entrench the positions gained.

Two hundred of Captain Ross' cooly corps with tools were held in readiness behind Palla to construct a covered way from there up to the right hand garden, at dusk.

It was expected that should the night assault succeed in their immediate attack, the Tibetans would still hold adjoining houses and prolonged fighting would ensue before all the houses, up to the foot of the Jong itself, would be in our possession, and until they were captured, no steps could be taken towards actually assaulting the Jong itself.

The explosive parties carried 12lb. charges of guncotton ready made up, and a couple of picks and crowbars, while the troops in rear also carried guncotton and more tools.

The Tibetans were awake, and opened fire when the storming parties were about 200 yards from them.

The left column breached and stormed its garden, and then captured a couple of houses in the direction of the Chinese house.

The right column breached its garden, and both right and centre columns entered that garden which was found to be unoccupied, but was overlooked by the Tibetans on the roof of the Chinese house, and enfiladed by a sangar on the Jong hill from which a heavy fire was kept up.

Just after dawn Captain Sheppard, R.E., went on from the garden and breached the door of the courtyard of the Chinese house; the Tibetans then left the courtyard, and a little later he blew in the door of the house itself; the Tibetans then quitted it, jumping off the roof on to other roofs.

The house was then occupied and shortly afterwards it was found that the enemy had vacated all the houses in that part of the town.

It appears probable that a feint made by General Macdonald the day before against the other side of the town had caused the enemy to withdraw part of their garrison from this portion.

All this locality was now exposed to a heavy fire from the Jong, which completely overlooked it.

The construction of a covered way by the Sappers of right and centre columns from the Chinese house towards the left hand garden was accordingly commenced, holes being knocked in the walls of houses to admit of passage through them.

Before much of this had been done orders were received that the Jong would be stormed that day. The covered way accordingly became unnecessary and was abandoned.

The spot selected by General Macdonald for storming the Jong, was the centre of a curtain wall, some 20 feet high between 2 towers, No. 7 Mountain Battery shelled this spot with common shell at a range of 1,000 yards.

The wall was really a revetment wall, backed up by solid rock cliff and stood a lot of battering. The guns made excellent shooting but could not see what was required quite so well as those in the houses at the foot of the Jong. These being only 100 yards distant could observe perfectly the effect of each shell and see where the next was required; they accordingly signalled back to the Jong how to correct their aim. This proceeding proved very effective. The breach was finally reported practicable and was stormed by fresh troops, the leading company being the 8th Gurkhas.

C. A. ELLIOTT, CAPTAIN, R.E.,

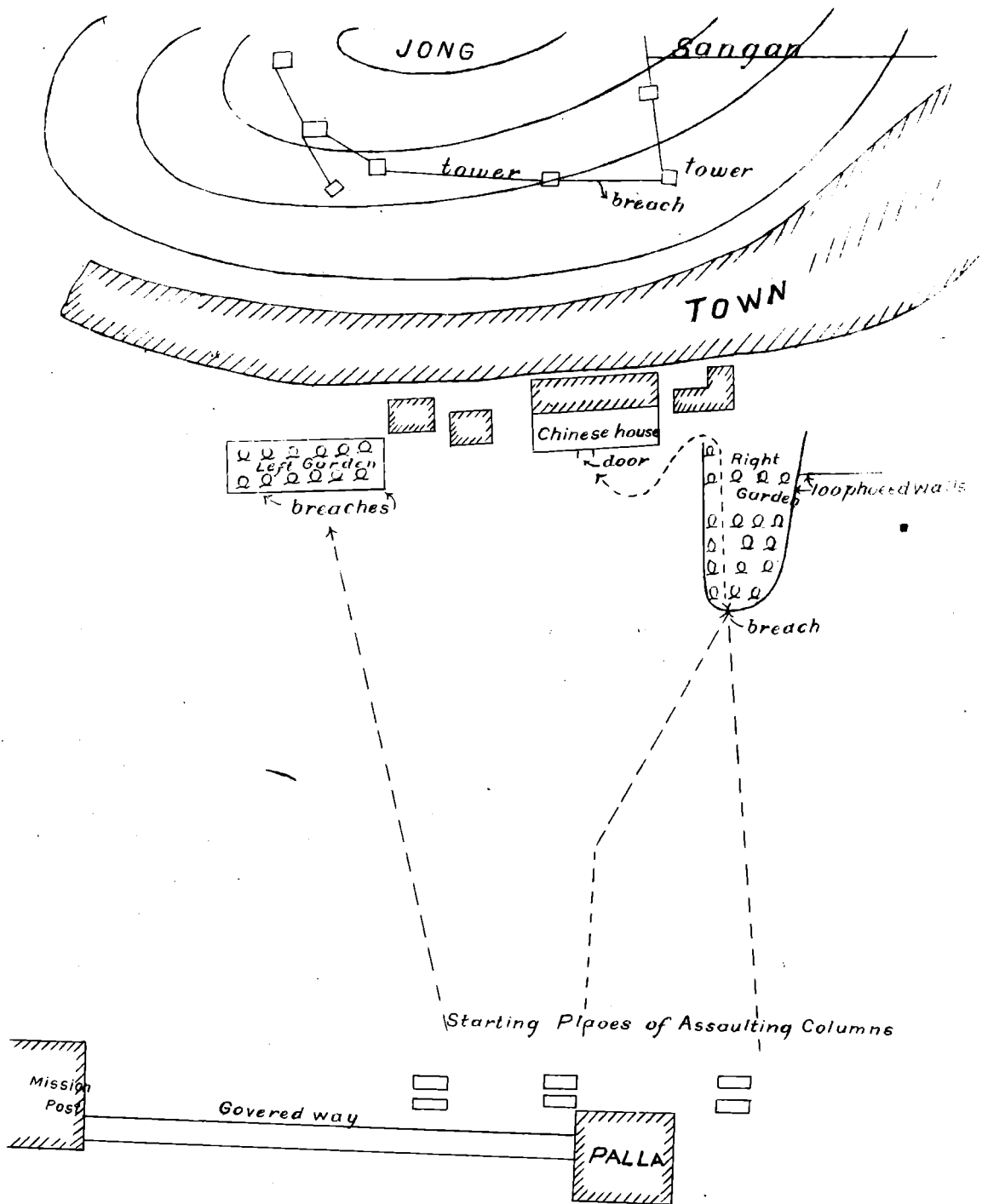
Field Engineer.

The 15th November 1904.

NOTE.—The whole force before Gyantse, except certain necessary guards, etc., was organised in three reliefs, the first fighting, the second in reserve, the third resting in camp. The operations described by Captain Elliott were those of the first relief, the assault on the Jong was carried out by companies of the second relief.

J. R. L. MACDONALD.

ROUGH SKETCH OF ASSAULT ON GYANTSEJONG



NOTE.—The Jong had buildings and sangars all over it. No attempt is made to show them. The houses in the town were a mass of flat-roofed buildings with narrow, tortuous alleys, often blind between them.

C. A. ELLIOTT.

Report on the construction of the Nathu-La road, 1904.

Country.

The country traversed by the Nathu-La route to Tibet is mountainous and rugged throughout.

Gantok, the captial of Sikkim, is situated on the end of a spur which runs out almost at right angles from the main spur of the Himalayas which forms the natural boundary between Sikkim and the Chumbi valley in Tibet. Near the point where the Gantok spur joins the main spur is a depression in the ridge which forms the Nathu-La, or Pass, a little to the west of the pass more generally used as a trade route generally known as the Jelap-La.

The route, roughly speaking, runs along the east side of the spur on which Gantok is situated, crossing by the Nathu-La and descending into the Chumbi valley by a side valley in which is situated the Tibetan frontier village of Yatung. From the Gantok spur three main sub-features project to the eastward and the old route crossed them all at the points where they joined the parent spur, there being natural depressions at these points forming the three passes known as the Lagyap-La, the Tunni-La, and the Sibbu-La, the heights of which are respectively, 10,500', 13,200', and 13,750', the height of the Nathu-La being about 14,300'.

The State of Sikkim near Gantok is entirely hilly, the hills being moderately steep and well covered with vegetation and cultivation.

Above Gantok cultivation ceases and up to a height of 11,000' the hills are covered with exceedingly thick jungle of bamboo out of which rise large trees of many kinds, covered with creepers. The passage of this jungle is only to be effected with the greatest difficulty and danger in many parts. Above 11,000' up to about 12,500' the jungle becomes more open the bamboos disappearing and handsome silver firs taking the place of the former matted jungle growths.

At about 12,500' trees practically disappear but the hills are covered with a thick undergrowth of rhododendron scrub which extends as far as the top of the pass, the bare spaces being covered with a luxuriant low vegetation of extraordinary variety and beauty.

On the Sikkim side of the Pass the ground is generally very steep with great outcrops of rock at intervals forming steep and high cliffs offering formidable obstacles to the roadmaker.

As the altitude increases the depth of soil decreases and bare moraines are encountered, the boulders being often of huge size and generally very hard. The rock on this side of the pass is mostly a schist of varying degrees of hardness. Once the Nathu-La is crossed the character of the country entirely changes. The steep and rugged hillsides give place to comparatively gentle and easy slopes. The tree-limit is also noticeably higher on the Tibet side.

The soil is also generally easier being of a light sandy nature for the most part with much less rock than on the Sikkim side.

The variations of climate met with along the route are very great.

Climate.

Gantok at the height of about 5,500 feet has a climate much like that of any other hill station of similar height, except that it is wetter than most. The annual rainfall is about 150 inches, extending over the greater part of the year. The cold weather is delightful from October to January, and snow appears to be exceptional.

Five miles up the road from Gantok a great increase in the rainfall is met with and from here up to the Nathu-La the annual rainfall appears to be somewhere about 300 inches being greatest at the tenth mile and slightly less close up to the pass. Heavy snow lies all the winter at Changu and as far down as Lagyap and occasionally falls at the tenth mile, but I am informed that, as a rule, work is possible all the year round as far up as Lagyap; but this is not, I think, a reliable statement.

After crossing the Nathu-La, the climate as well as the scenery undergoes a complete change. The rainfall at once becomes less going down to about 60 inches at Chumbi. The climate is also far more bracing and generally more agreeable than that of Sikkim.

The original route to Tibet consisted of a mere jungle track practically unmade in any way. It started at the bazaar at Gantok, dropping down steeply to the bottom of the nullah bed and then climbing painfully up the Lagyap spur joining the line of the present road at the Lagyap-La. From thence it followed the course of the Changu Nullah as far as the Changu Lake, being merely a rough track, worn by the little traffic using it, among the trees and boulders. Old road.

From Changu (12,800) the track rose sharply for about a mile to cross the Tunni-la at a height of 13,200' dipping again for a couple of hundred feet to rise again at a very steep slope to the Sibbu-La, height 13,750'. This was always the most severe obstacle met with on the route. The ascent was up the side of a roaring torrent among loose wet stones and boulders and was with great difficulty made practicable for unladen animals when it was first decided to take the Nathu-La route into use for the Mission.

Before this occurred the lower part of the route was very considerably improved by the Political Officer of Sikkim, Mr. White, under whose orders a mule path was made from Gantok to Lagyap along the present route, avoiding the former steep ascent and descent. The route was further improved in the spring of this year by military labor, the mule path being extended to Changu, the track across the Passes improved enough to allow of ekkas being man-handled across it. A mule path was also constructed from Champitong, on the Tibet side of the pass, down to the Chumbi road at a point near the village of Rinchingong. The first five miles from Gantok up were also widened out to about 14 feet for the first two and a half miles and to about ten feet for the remainder. These first five miles were properly constructed on a gradient of about one in fifteen and although much cut up by the heavy traffic which they had to take during exceedingly wet weather, without having been either metalled or drained, were without difficulty put into order and made into a good road. From the 5th to the 7th mile the grade of the old road was easy and the road averaged about 5 feet wide.

Between the 7th and 10th miles the country becomes more difficult and the easy grades had to be abandoned for economical reasons, the path going up and down at steep slopes to avoid difficulties.

Between the tenth and thirteenth miles was the worst part of the road and still remains so. The country here is of an exceedingly difficult nature, consisting chiefly of a series of high cliffs of very hard rock, covered with a thick growth of trees and shrubs which concealed the precipices without making it at all easier to cross them, the trees being most insecurely rooted in a surface layer of moss and undergrowth which stripped off bodily on the least provocation. The gradients on this part are very steep and the path was very narrow and rough. A very large number of pack and also riding animals have been lost through falling over the khud at this point, hardly a convoy getting past without loss.

The path from the fifteenth mile to Changu Lake was about 4 feet wide, well-graded and for the most part paved or corduroyed.

At Changu there is a lake about a mile long and half as much wide evidently formed by a landslip blocking the course of a small stream. The made path ceased at the natural dam so formed and along the side of the lake there was only a rough and difficult track, almost impassable for pack animals.

From the upper end of the lake the original track over the passes remained almost in its original condition having been merely hastily improved in the spring to enable the ekkas to be taken over it by hand. The distance from Changu to Yokontang, the transport stage was about five miles of exceedingly bad going and thence to the top of the Nathu-La, about two miles more. From the Nathu downwards there was a rough track again for about two miles down the middle of the valley, joining then to a narrow and rough path on a level reaching the post of Champitong in about two miles and a half.

At Champitong the road became better running level for a mile or two and then descending at a steep grade by zig-zags for another four miles to strike the road which runs along the Chumbi valley, about half a mile above Rinchingong.

The upper half of this portion of the road was mostly corduroyed in the early part of the year but the lower part was left with an earth surface which cut up very badly and became almost impassable towards the end of the rains.

Corduroy was used as stone was difficult to get, while wood was plentiful and could be laid down very quickly.

New road.

Orders were received from General Macdonald on the 12th of June to construct an eight foot road on a gradient of one in fifteen, described as a mule road on an ekka gradient.

The estimated cost of this was Rs. 2,60,000, the rate being estimated at Rs. 5,000 per mile with 50% added for difficulties due to climate and the unfavourable time of year. Arrangements were at once made for starting work.

On the existing road at the time it was taken over from the Public Works Department about 500 local coolies were employed and there was a stock of rations for them and also a quantity of tools and explosives.

It was estimated that at least 3,000 men would be required to finish the road by the end of October, and an attempt was made to obtain them locally. It was found however that owing to the large demands already made upon the local labor market by the expedition, it was not probable that more than a thousand could be obtained. The suggestion was then made that a Cooly Corps of 2,000 Hazaras under an R. E. Officer should be raised. This suggestion with modifications was adopted by the Government of India. Hazaras were unfortunately not obtainable and the following arrangements were made.

A Cooly Corps 1,000 strong was raised under the command of Lieutenant L. N. Malan, R.E. It was originally intended that this Corps should be composed of Garhwalis raised at and near Mussoorie but only 400 of these were obtainable. To make up the number 600 coolies were recruited at Quetta, mostly Afghans from Ghazni. The Corps was known as the Mussoorie Cooly Corps. A second Corps of the same strength was raised by Lieutenant A. F. S. Hill, R.E., at Peshawar composed of Pathans recruited locally. These Corps did not arrive on the scene of operations till the beginning of August.

In the meantime preparatory work was started. Huts were run up at various points, planks for tent floors were sawn, tools were ordered from Calcutta, rations were stocked at suitable places, godowns built, and in addition the existing road was repaired all along and kept in order. The work of sloping, draining and metalling the first five miles out of Gantok was put in hand. Local coolies were collected and about 900 were at work by the end of July. Up to this time little work had been actually done on the new road, but the route had been explored throughout and the line decided upon. Trace cutting had been started upon at the most difficult part, *i.e.*, between the 10th and 13th miles and half a company of Bengal Sappers were working at trace cutting below Champitong. The Cooly Corps began to arrive at Gantok in batches of 200 on the 2nd of August, the batches being despatched from Siliguri as they arrived without regard to the Corps to which they belonged.

Unfortunately the Pathans found great difficulty in carrying up the 80-lb. tents with which they were equipped. The men were not accustomed to carrying loads in the first instance. Each man had to carry his own kit which was a heavy one, and in addition had to carry a certain weight of tools. The climate in the Teesta valley at the time was excessively trying being very hot and also very wet and the road was in an appalling condition. The result was that the Peshawar Cooly Corps left the whole of their tents at Rangpo, twenty miles below Gantok, and the Mussoorie Corps left a considerable number behind also. As the weather at Gantok was at that time very bad, being just in the worst of the rains, the inconvenience was very great indeed as it was impossible to send coolies who were not accustomed to wet, to work at a height of 13,000' with no other shelter than that of their waterproof sheets.

Fortunately there were a number of huts ready at Lagyap and Ranglambi and the Peshawar coolies were sidetracked in these the Mussoorie Corps being pushed up through them with all the available tents. The Mussoorie Corps were at work at Yokontang by the middle of August and started making the eight-foot road upwards towards the Nathu-La.

The Peshawar coolies were put on the work of cutting that part of the new road which was close to where they were living. Their tents, which had been handed over to the S. & T. to bring up, arrived in driblets during the next month and at the end of the first week in September it was found possible to

push the Corps up to Changu whence they commenced work along the lake and upwards towards Yokontang.

By the middle of September work was in full swing on the Sikkim side of the Nathu-La. A large gang was at work finishing the existing road between Gantok and the 5th mile. Captain Hodgson with another lot of local coolies was at work near the tenth mile, and the two Cooly Corps were getting on well with the road between Changu and the Nathu.

It had been found possible to get a satisfactory line above the existing road, between the seventh and thirteenth miles and a satisfactory trace had been marked out from Changu upwards, avoiding altogether the difficulties of the Tunni-La and Sibbu-La. For the rest of the line on the Sikkim side, it was intended to follow the existing alignment. On the Tibet side of the Pass no difficulty was found in getting a good and easy line.

Information was now received that the question of stopping the work altogether was under discussion at Head-quarters, and that in any case work would almost certainly be stopped at the end of October.

Modifications in the original project were therefore necessary if anything useful was to be completed in the time.

The width of the road still to be made was reduced to six feet and where it was possible and more economical to do so, the grade was made steeper, the maximum being fixed at one in ten. At this time the only work done on the Tibet side consisted of four miles of trace cut by the Sappers, about half a mile of which had been widened to eight feet. The Sappers had been taken away for other work some time previously.

The Mussoorie Corps were now moved across the Pass, to work downwards while the Peshawar Corps was moved up to Yokontang to complete what the Mussoorie Corps had not had time to finish and to work downwards also.

The work on which Captain Hodgson was engaged was stopped altogether as there was no chance of finishing it in the time and he was sent over the pass to take charge of the whole of the work on the Tibet side and to modify the trace as far as necessary.

The whole of the local gangs were put on the work of improving the existing road from Gantok to Changu, with orders to metal the whole of it first and then to go back on their tracks and do all the widening and improving that could be done in the time.

Definite orders were received on the 7th of October to stop work on the 31st.

By the middle of October the new road was cut to within a couple of miles of the end and the forces at the disposal of the Field Engineer were augmented by the return of the half company of Bengal Sappers who had been previously at work on the road.

The local coolies had by this time completed the metalling of the twenty miles from Gantok to Changu and were put on to the work of widening and improving the worst places as far as possible. A gang of 200 were sent across to Champitong to help Captain Hodgson who was working to a very narrow time limit. The first party of the Lhasa column crossed the Nathu on the 18th of October in a heavy snowstorm which arrived most unseasonably and interfered greatly with the road work besides causing severe suffering to the unfortunate Peshawar coolies, the majority of whom were camped at Yokontang the altitude of which is about 13,200'. Fortunately for the troops, the part of the road round the Tunni and Sibbu Pass was ready for traffic and they were saved considerable hardship.

On the 23rd of October the road was opened right through to Phena in the Chumbi valley and on the 24th General Macdonald and staff left Chumbi and used the road the whole way to Gantok riding practically the whole way although the upper part of the road was in a very heavy state owing to the heavy snow, about 2½ feet on the top of the Nathu.

On the 27th Lieutenant Malan left Champitong for Quetta with the Quetta portion of his Corps followed from Changu on the 30th and 31st by the Peshawar Corps in two parties.

Captain Hodgson remained at Champitong with the Garwhalis for a few days longer finishing up and left with them for Dehra Dun on the 1st of November.

Labor.

The process of clearing up was now commenced and the local coolies were employed for a few days more in getting tools and surplus stores down to Gantok, the whole being collected into store there by the 12th.

The Cooly Corps raised for work on the road were each 1,000 strong. They were each commanded by a Royal Engineer Officer.

The authorised organisation was that each Corps should have two Sirdars of the sub-overseer class in charge of 500 men each, and ten Jemadars of the mistry class each in charge of 100 men. Each gang of 20 men had one mate or head cooly in it. The rates of pay offered were not, however, sufficient to attract men of the sub-overseer and mistry classes and as it proved this was not altogether unfortunate as such men would not have been equal to the task of keeping Pathans in order. The Sirdars and Jemadars ultimately obtained were generally pensioners from the Sappers and Miners and other regiments. One Sirdar was a commissioned Native Officer from the 48th Pioneers and was invaluable.

The Mussoorie Corps consisted of 400 Garhwalis and 600 Pathan coolies from Quetta, mostly Ghilzais.

The Garhwalis were excellent in every way. They were docile, strong and hardworking and able to look after themselves. On the whole they were the most satisfactory coolies employed on the road and turned out very good work all through.

The Quetta coolies were very different. Mostly, as before mentioned, Afghans from Ghazni, they were a very rough and wild lot. Hardly any of them could talk Hindustani and their notions of discipline and cleanliness were of the vaguest and had to be entirely revised. They were generally of good physique but poor workmen. Their strongest point was earthwork, they were of little use in rocky ground. Their work was always untidy and generally had to be finished up by some one else. They did good work on the Tibet side of the Pass in the light soil but required incessant driving and were generally more trouble than they were worth. A further objection to them was that they were very helpless in looking after themselves which was a serious defect under the circumstances. The Peshawar Cooly Corps was principally composed of Pathans of a low class, recruited near Peshawar. Their physique was inferior to that of the Quetta coolies but their intelligence was greater on the whole. They gave a lot of trouble at first but the application of forcible persuasion gradually induced more disciplinary behaviour. They were on the whole good road coolies but required more supervision than it was possible to give them. They did their best work in rocky ground being especially good at tackling the old moraines which formed a serious obstacle on the upper parts of the road. The pay of the Sirdars was Rs. 75 per mensem, of the Jemadars Rs. 50, of the mates Rs. 15 and of the Coolies Rs. 12. All ranks got free warm clothing and rations.

The cost of each cooly including outfit, rations, pay and cost of bringing to Sikkim and returning home worked out to about Rs. 45 per mensem. From an economical point of view they were unprofitable servants, but their employment was fully justified by the circumstances. Without them it would have been quite impossible to finish the work in the time and even if sufficient local labor had been obtainable it would have been almost impossible to induce the local cooly to work in such unpleasant places as Yokontang at that season of the year.

The local coolies were mostly Nepalese and Sikkimese. The former were the best workmen but all were very satisfactory in their way. They require considerable tact in dealing with them and are easily frightened into deserting but when kept contented and well managed give little trouble and work very well. Each cooly got Rs. 12 per mensem with clothing and rations, a baidar at Rs. 15 being allowed for each gang of 20. A fee of 1 rupee a month had to be paid for each cooly to the sirdar who brought him in.

The cost of each local cooly, including rations and clothing worked out to about Rs. 23 per mensem.

Half a company, amounting to 50 of all ranks, of the Sikkim Pioneers were also employed on the road. They are a semi-military organisation maintained by the State.

They were, I believe, intended to be a Corps of skilled workmen, but the standard of skill amongst them was very low. They were not very useful at first, as they had never been taught to carry out orders or to work honestly, and

had no idea of discipline. They improved very greatly latterly and did some excellent work and were also useful to a limited extent in supervision.

The supervising staff to begin with consisted of Captain R. St. J. Gillespie, ^{Supervising} R.E., Field Engineer, two sergeants from the Military Works Services and four ^{Establishment.} sub-overseers to be supplied by the Public Works Department. Of the latter only one was forthcoming and he appeared to be mad and was summarily discharged after a very short experience of his methods.

As soon as it was decided to construct the new road, an Assistant Field Engineer, Captain P. E. Hodgson, was appointed and arrived at Gantok on the 8th of August. He spent most of his time on the since-abandoned work above the tenth mile, having the most dangerous and disagreeable task of tracing the new road over exceedingly difficult country, covered with dense jungle in the worst of a rainfall which amounts to about 300 inches per annum. He latterly was in charge of the work on the Tibet side of the Nathu-La.

The supervision of the work of the Cooly Corps was carried out by their own officers but it was a rather hopeless task. It was, of course, impossible to keep a whole corps working close together, and the administration of a body of 1,000 men added to the supervision of their work when spread out over ten miles of most difficult country was a larger job than even Royal Engineer Officers are generally called upon to do. The two sergeants were principally employed on maintenance and store work, the latter a very serious matter on this occasion. One was employed latterly in charge of the gang of local coolies sent over to Champitong.

Two sub-overseers were obtained from the Military Works Services by special request and were employed in charge of local coolies with very satisfactory results. They were both Sikhs, and I think got on better with the local coolies than did men of the local races. A couple more temporary sub-overseers were picked up locally, and three store-keepers and one head store-keeper were also taken on to deal with the tools and rations.

The health of the Cooly Corps was very bad to begin with. The Pathans, ^{Health.} especially, being inhabitants of a dry climate suffered severely from the wet. It was not possible to hut the Cooly Corps as they had to move frequently but planks were supplied to them to use for flooring their tents, which added greatly to their comfort during the rains. The number of deaths among them was comparatively small under the circumstances, most being due to Pneumonia.

The local coolies suffered largely from fever and were difficult to deal with owing to their objection to going to hospital. A supply of medicines was obtained from the medical officer at Gantok and applied to the satisfaction of the coolies.

The number of accidents was surprisingly small. One Garhwali cooly was killed through an unfortunate excess of zeal. A large rock had been loosened and was being shifted. He proceeded to crawl right under it with a pick and tried to assist in loosening it still further with the result that it settled down on top of him, killing him instantly.

One man blew himself up by tamping a charge of powder with an iron bar, but did not suffer any permanent injury.

Minor accidents from falls down the khud were numerous and the Pathans were addicted to felling trees on top of each other but no serious injuries occurred.

A certain number of tools were handed over with the road, but they were ^{Tools.} of poor quality and mostly unsuitable.

Practically the whole of the tools used were purchased from T. E. Thomson & Co. of Calcutta who proved a most satisfactory firm to deal with. They several times ran their shops day and night in order to comply with urgent orders for jumpers, etc. The quality of the tools supplied by them was excellent and they gave a discount of 15 per cent off their listed prices.

The principal item in the tool bill was jumpers. These were all ordered of the best steel as being the most economical in the end. Various sizes from 1½" downwards were used. It was found that the Pathans worked best with a 1¼" jumper while for the local coolies a much smaller one was necessary, a 7⁄8" one six feet long being about the best.

The local coolies preferred the powrah to picks and shovels. At the start the Field Engineer arranged to have the tools from Calcutta sent through the

Garrison Engineer at Darjeeling which was a satisfactory arrangement but expensive owing to the high cost of carriage. On this account, under instructions from the Officer Commanding Line of communications all stores except those tools which the Cooly Corps were able to bring up were handed over to the Supply and Transport Corps for carriage from Silliguri to Gantok. This arrangement turned out disastrously. The transport were labouring under great difficulties owing to the state of the roads and the prevalence of cholera on the route. The consequence was that most of the tools were indefinitely delayed, some not having yet reached their destination and many not arriving till all need from them was over. The most serious want was that of blacksmiths' tools. These left Calcutta on the 1st of August and did not reach Gantok till well on in October. As the greater part of the work consisted of blasting, this was a most serious matter as jumping holes in hard rock with blunt jumpers is not profitable.

A lot of billhooks and axes were ordered as a great deal of jungle clearing had to be done. Some of these never arrived at all and those that did, came after the work was finished. A number of kukries were fortunately obtainable locally which were most useful in the hands of the Garhwalis.

Explosives.

During the earlier part of the work Dynamite was used for all blasting, but as the weather got colder its use was discontinued above Changu. Gunpowder was obtained from the Ordnance and it was found that for most purposes it was equally satisfactory if not more so. The Pathans especially did very good work with powder, the use of which they thoroughly understood. They also used the large jumpers and made good deep holes habitually. The local coolies however were best with dynamite as they could not manage the big holes necessary for powder. Towards the end a quantity of spare guncotton was obtained from the Field Park and used by the Mussoorie Cooly Corps but they could not be got to use it economically. On the whole powder is the most satisfactory explosive for general use except where actual rock-cutting has to be done. There is also always a lot of risk in the use of high explosives by coolies. Although Dynamite and guncotton are really safer than gunpowder in skilled hands, yet the cooly understands the latter and treats it respectfully while he cannot be got to understand that dynamite requires care in handling. I am informed that at the beginning of the year there were many accidents with dynamite, mostly due to the coolies thawing it before a fire in their fingers.

The fuze supplied by the Ordnance Department was found to be better than the commercial article.

Nobel's No. 6 detonators were used with dynamite and found to be excellent. The service No. 8 detonators were used with the guncotton.

Rations.

The arrangement when work was started was that local coolies were to be fed by the Field Engineer, supplies being obtained at Gantok from a stock accumulated there by the Political Officer. The local coolies are rice-eaters and were given 2 lbs. of rice a day with allowances of Dhall, ghi, chillies and salt. The Cooly Corps were to have been fed by the Supply and Transport Corps but at the beginning of August great difficulties were being experienced with the Transport and the Field Engineer was suddenly called upon to feed the whole of his men.

A contract was made with a local firm for the supply of three months' rations for 2,000 men without difficulty, and the whole contract worked satisfactorily.

Godowns were now required and were built every five miles and a regular supply and transport service organised on the same lines as that run by the Supply and Transport Corps but of course on a much smaller scale. The chief difficulty was that no trained staff was available for the work and the four men who were obtained had to learn their work at the same time that they were doing it. In spite of occasional minor hitches and mistakes at first the work of supplying the 3,000 odd men at work on the road was carried out successfully. The work of carrying the rations alone absorbed about 500 of the local coolies, the average daily output of food from Gantok being about 90 maunds, the greater part of this having to be transported some 25 miles and some of it still further. This number was reduced latterly by the employment of hired transport for the first ten miles but there were never less than 400 at work on carrying all the tools having to be carried up in addition to the food. The Cooly Corps were given the full fighting men's rations consisting of 1 lb. of atta, 8 oz. of rice, 4 oz. of

dhall, 4 oz. of meat with allowances of tea, goor, ghi, turmeric, salt, garlic, and chillies.

The Quetta coolies would not eat dhall which was unfortunate, it being particularly suitable for food in cold climates, but a little difficult to cook at high altitudes. They also did not like tea or chillies.

The storekeeping staff, such as it was, was arranged as follows:—The Head Store-keeper had his head-quarters at Gantok travelling up and down the line as necessary for supervision. He also did all the taking over of stores from Supply and Transport and the contractor and kept the returns of all stores on the road.

A store-keeper was in charge of a transit godown at the 5th mile and did the feeding of the local coolies working near. At the 10th mile was the chief depôt for tools and also the chief dynamite magazine. A large number of local coolies were fed from this store which was in charge of a civilian store-keeper. At the 15th mile was another store-keeper in charge of a transit godown also feeding local coolies.

Changu was the advanced base of supply as far as the Cooly Corps were concerned. They drew their supplies from here in bulk and made their own arrangements for its onward carriage and distribution, being supplied with a number of local coolies for carrying loads. The local coolies carry one maund each which was too much for the Pathans.

The Cooly Corps were fitted out at their equipping stations with warm clothing. Each man was supplied with a waterproof sheet, two blankets, a warm coat, a pair of warm pyjamas, a woollen jersey, a cotton pugri, a pair of boots, a tin water-bottle, a leather belt and a copper disc with his number on it. This outfit was insufficient under the circumstances. Although nominally the summer, the greater part of the work done by these coolies was at a height of over 12,000' and many of them were camped for most of the time at 13,200'. The climate was an exceedingly trying one especially for the Pathans who were not accustomed to rain and suffered accordingly. A third blanket, two pairs of socks and a balaclava cap in addition to the above scale would have saved much sickness. The socks and caps were obtained subsequently, by post but did not arrive in time to be served out all round before the work was stopped. Clothing and tents.

The warm coats supplied were of a pattern unsuitable for wet climates being made of khaki drill lined with blanket. The serge ones of which many were supplied for local coolies were far better in every way.

The boots supplied to the Cooly Corps were exceedingly bad. Many of them were not even hobnailed and most of them were several sizes too large for the men, the idea being apparently that they would allow of two pairs of the socks with which the wearers were not supplied, being worn at once. At the end of three months' wear most of these boots were in pieces. A thousand sets of warm clothing for the local coolies were ordered through the Supply and Transport in June but as they did not arrive till the beginning of October, they were not of much use. The warm coats supplied were of three kinds, one the drill and blanket pattern, another good pattern of khaki serge flannel-lined and a third which was apparently that known as the warm coat British which presumably got into the bundles by mistake and was much approved of by the fortunate coolies who got it.

The Cooly Corps were supplied with General Service 30-lb. tents which, as has been related before, were the cause of much disaster. They are not a convenient pattern for such a purpose being too heavy and requiring more room than is generally available. A certain number of tents were in use for local coolies, etc. The best pattern was found to be that known as the Sowar's pal, supplied by the Elgin Mills of Cawnpore. It is a small two poled tent with a semi-circular end and is very easily pitched in difficult places. It is supposed to accommodate 4 sowars with their kit, but easily takes 5 coolies on a weight of about 30 lbs. Tents.

The greater part of the huts required for the various Transport units at each post had been constructed when the road was taken over but some had to be put up for men and animals at Gantok and the 5th mile. These and all other cooly huts as far as the 10th mile were constructed by local coolies from trees cut near by, roofed and walled with bamboo, the only tools used being kukries and sometimes an axe or two. Buildings.

Huts were built for road coolies at the 13th and 15th miles of fir planks, there being no bamboo at these places. Officer's huts were built at Gantok, 5th mile, 10th mile, 15th mile, Changu, Yokontang, and Champitong. Except the two last they were built of planks with a stone in mud fireplace, the roofs being made of thin sheet-iron usually.

The Yokontang hut was made with thick stone walls lined with planking on account of the severity of the climate here. The hut at Champitong was built by the Bengal Sappers of fir logs plastered with mud, inside and out, with a stone fireplace. This was the warmest and most comfortable but on the line when the weather began to get cold and will probably be the most durable.

Cost. Ruberoid was used very largely for roofing godowns and for covering outer walls. It proved most useful. It is cheap, portable and easy to put on and is absolutely weatherproof. The lightest quality was used except for the roof of the Yokontang hut which required a specially thick roof. If it is only durable it is a most valuable material for many purposes. Very shortly after work was started it was found that the original estimate would be largely exceeded, partly on account of the extra cost of the Cooly Corps labor and partly on account of the distance being greater than was expected.

A new estimate was sent in amounting to Rs. 5,15,000.

If the work had been completed this would have been exceeded by about Rs. 50,000 which represented the losses due to unavoidable causes, such as the non-receipt of the tools and the delay due to the Cooly Corps not carrying up their tents. The total expenditure has not been completely worked out up to date but will not fall far short of $4\frac{1}{2}$ lakhs.

For this sum about 25 miles of new road have been made and 20 miles of old road have been considerably widened and improved and have also been metalled. About one lakh more would be required to complete the road according to the original project and if the road were to be metalled throughout as would certainly be necessary if there was much traffic on it, the additional cost would be not less than a lakh and a half.

The road as constructed is probably one of the highest made roads in the world, crossing, as it does, a pass 14,300 feet above sea-level.

R. ST. J. GILLESPIE, CAPTAIN, R.E.,

Field Engineer, Nathu-La Road, Sikkim-Tibet Mission.

Report on Berthon Boats and superstructure.

SIKKIM-TIBET MISSION.

This was a matter of some difficulty, as no camel transport was available **Carriage.** and the sections were too heavy for mules; however, selected coolies were told off, and given reliefs, and they got the boats along, though very slowly.

The boats were extremely useful for getting a line across the river.

Single use.

As a means of transport, we found each boat would take four armed men besides a rower and steerer, but they had to go carefully, and keep to the smoother water, as the boats have so little free-board.

These were found dangerous and non-economical; a raft of two boats with **As rafts.** one bay only, took 10 armed men, and took double the time to get across that single boats did.

When used as rafts, two extra stiffening beams stretching from outer gunwale to outer gunwale, had to be lashed fore and aft of the superstructure, and the baulks had to be lashed to the saddle beams with wire.

When used as a pontoon bridge, the superstructure left nothing to be desired. **The accident at**

This occurred owing to the bow of the left-hand boat of the raft diving into the middle of a whirlpool; the boat immediately swamped. All on board naturally scrambled over the bay into the other boat, which also swamped but both boats *floated*, and the superstructure stood firm. **Chaksam ferry.**

Those who stuck to the boats were saved; some were taken off by other boats, and some floated down the river till the raft grounded on a sand bank half a mile away, but Major Bretherton and the two sepoy who were drowned, all jumped clear of the raft, and tried to swim to shore—an impossible task in such a fierce current full of eddies and under currents.

I can suggest but little improvement in the boats themselves; they were easy to put together, and stood work well; the only two things I can think of are (a) that the bows should be raised three to four inches by a combing 3' down the gunwale on each side (this would certainly make them far less liable to swamp in waves) and (b) that two beams of sorts be provided, to go from bow to bow, and stern to stern, and thus give the boats the necessary rigidity for use as flying rafts.

The boats stood coolie transport very well, and we found that the Company mochi could easily sew up all small rents that were made either in carriage or on work.

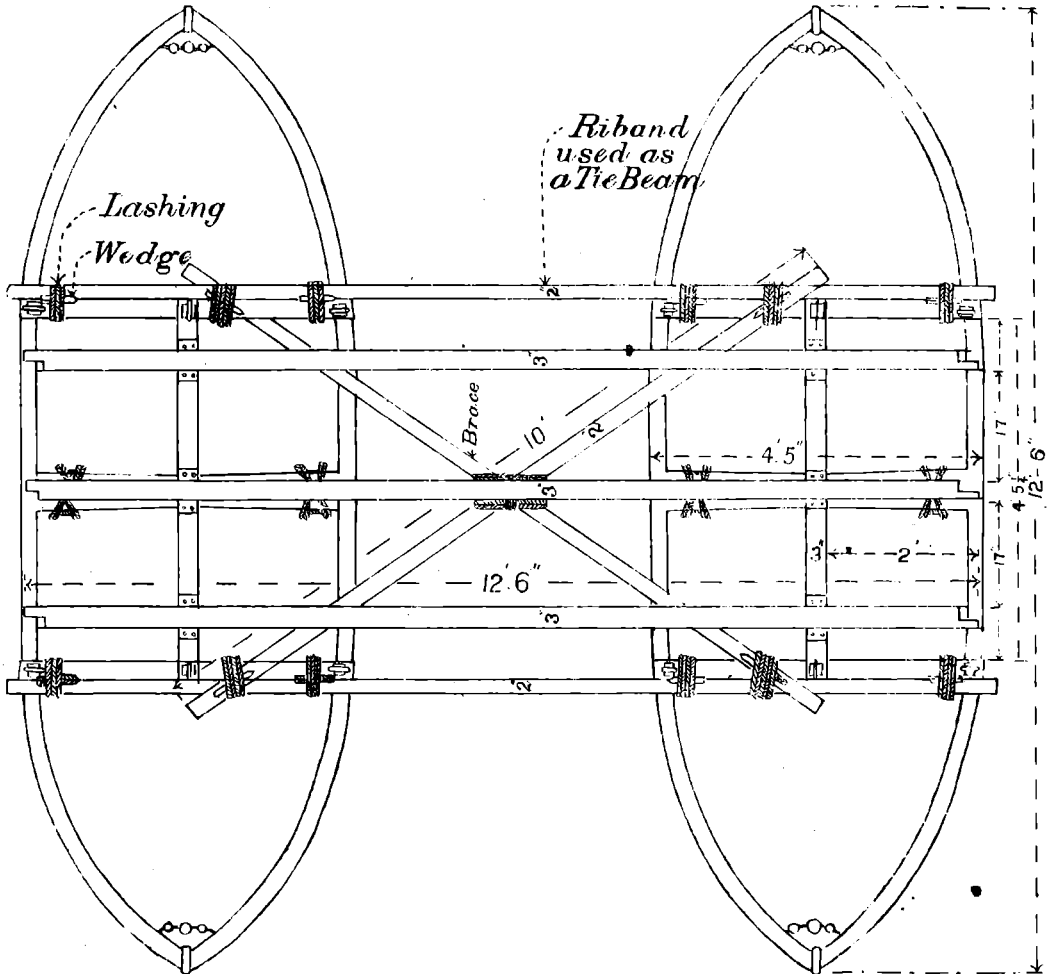
I think a $1\frac{1}{4}$ " steel cable would be the most convenient size for ordinary work; the 1" cable I actually had in Tibet is perhaps a trifle light for the span it was used over (170 yards); while a $1\frac{3}{4}$ " cable, which I had sent up from India, was a bit heavy for mere traveller work.

• The traveller sent worked excellently, and ran equally well on 1" and $1\frac{1}{2}$ " cables.

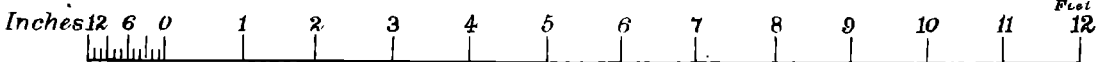
(Sd.) S. H. SHEPPARD, CAPTAIN, R.E.,

O. C. 3rd Company, 1st Sappers and Miners.

Plan of Berthon Boat raft unchessed



Scale 1" = 2'



Remarks by Superintendent of Park.

The equipment can be arranged for cart, camel or coolie transport. If Carriage. carried by coolies the heaviest load is 80 lbs.—a boat section with seat and moveable fittings removed.

Additional claws have now been added to 25 per cent. of the baulks for use Used as rafts. as raft baulks.

This enables the superstructure to be laid from out to out of boats.

Baulk blocks have also been fixed to the saddle-beams, thus doing away with the necessity of lashing the baulks to the saddle beams.

The riband is of a convenient section of scantling to be used as a tie-beam Tie beams. for stiffening the raft. Two tie beams are required to be lashed to each outside cross-piece, as shown in the sketch attached.

Twelve ribands might be added to the equipment for use as tie-beams.

The raft can be further stiffened by bracing, as shown in the sketch; twelve stiff bamboos, 10' x 1½" (diameter) could be added to the equipment for this purpose.

The boats would then not be liable to wobble as at present owing to men shifting position, etc., and the necessity for increased free board would perhaps not arise.

A 1½" cable is the correct article of equipment.

Steel wire cable.

A 1" cable was sent up to Tibet.

James tripartite boats are being tried at home for constructing rafts to carry Tripartite boats. field guns. These might be very useful out here but we had better wait to see result of R. E. Committee report before moving in the matter.

H. J. SHERWOOD, MAJOR, R.E.,

Superintendent of Park.

Copy of Report on Engineer Equipment submitted to G. O. C. Military Escort, Sikkim-Tibet Mission.

1. On going to Chumbi for the first time on February 16th, I looked over the Field Park Stores with Captain Elliott, R.E., and found that the No. 8 detonators sent from Fort William were of dates ranging from '95 to '99, therefore practically useless.

Captain Elliott informed me that when using those of '99 date on road work and at Gyantse, he found 30% missed fire.

I have twice sent in strong reports (after the Mhasud blockade and after the Kabul Khel counter-raids) to the Government of India about these detonators, pointing out how needlessly lives are risked, by detonators of old dates being sent on service. I personally consider that 3 years in this country is the outside safe life of the No. 8 detonator.

2. Suggested that, in the slabs of guncotton pierced for 1 oz. and 2 oz. primers the hole for the latter should be made to fit the 2 oz. primer or that a larger primer, to fit the existing size of hole, should be introduced.

3. On an expedition in a rainy country such as Burma, Assam or Sikkim (and especially where bamboo jungle is met with) I think 2 loads of picks and shovels should be replaced by 2 loads of phauras (mamooties); axes in existing loads to be retained.

4. Some magnesium wire would be most useful for going into dark rooms and cellars in pursuit of an enemy.

5. More electric leads should be useful; mine were quickly used up in Tibet, and I had to borrow plain copper wire from the Telegraph Department; I should like another 400 yards.

6. The No. 13 detonators (electric) should be fitted with "commercial leads"; this would save much time.

7. A megaphone (collapsible if possible) would be of great use; I had to have one made up for use at the passage of the Sanpo.

8. The present red wooden guncotton boxes are most wasteful; out of a maund load one only gets 45 lbs. of guncotton.

I would propose a sealed tin, as at present, but longer; to be carried in a case made of wicker and leather; I think about 60 lbs. of cotton could then be carried in a maund load.

9. The fighting in Tibet made one wish for a return to the old hand grenade in this house-to-house fighting, often storming one dark room after another, something of the nature of anarchist bomb would have been of the greatest service; one of these, thrown into a room, would stun anyone inside.

10. Addendum:—

I would propose that the 4 "Crosscut" saws at present in the equipment be replaced by 4 more lightning saws; these latter are lighter and far more useful.

(Sd.) S. H. SHEPPARD, CAPTAIN, R.E.,
O. C. 3rd Company, 1st Sappers and Miners.

No. 1584-A, dated Camp, Fort William, the 30th November 1904.

From—Brigadier-General J. R. L. MACDONALD, C.B., R.E., Commanding Tibet Mission Escort,

To—The Adjutant General in India.

I have the honour to forward this my report on the tactical and strategical questions affecting future operations in Tibet, with short notes on the working of the different arms, and points brought to notice on which improvements might be effected.

Extracts from Report.

STRATEGY.

If, however, the Tibetans intended to contest the passage they would doubtless remove or destroy their boats, hence any future expeditionary force should have better means of crossing the river than the expedition of 1903-04, which had only four duplex 12-foot Berthon boats. These proved useful and their number might well be increased, but probably the most suitable boats would be 20 to 25 feet whale boats in sections.

Those used in Uganda were of steel, but if made of aluminium doubtless larger sections could equally well be carried by two men each. These whale boats were very handy in the water and in rough water too.

With two such boats and eight Berthon boats mentioned above it should be possible to pass over 100 men a trip independently of any local craft.

The bridging plant should also include steel cables and runners and a fair supply of rope, in all of which items the expedition of 1903-04 proved at first inadequately equipped.

Engineers.

The working of the two companies of Sappers and Miners and field engineering work with the force was most satisfactory.

Every description of field engineering including hutting, bridging, road-making, demolishments, entanglements and field works, was carried out most creditably to all concerned, and under climatic difficulties and hardships it would be difficult to parallel.

The services rendered to the force by the engineers have been invaluable and their aptitude and skill showed a high state of efficiency and training.

The following points have been brought to notice as conducive to increased efficiency :—

One native officer for each section of Sappers and Miners would be an advantage. At present there are four sections to a Company of Sappers and Miners and only three native officers.

The custom of supplying old detonators No. 8 for gun-cotton cannot be too strongly condemned, as the missfires from old detonators are most dangerous to life.

The detonators issued from Fort William were of dates between 1895 and 1899 and were practically useless; those of 1899 averaging 30 per cent. missfires. This matter has, I understand, been represented on previous expeditions and I am of opinion that no detonators should be retained, or issued, after three years in store, as they rapidly deteriorate.

The instantaneous fuze was found quite unreliable and useless.

Wire, plain or barbed, should be kept in readiness at Arsenals carefully coiled on light drums, giving a total gross weight of one maund each.

In gun-cotton pierced for 1" and 2" primers the hole for the latter should be 2" in diameter and a larger primer made to fit the hole.

Magnesium wire should be added to the equipment of Sappers and Miners.

Hand grenades would be very useful for house fighting, and would have been invaluable in the village fighting in Tibet.

Four hundred and forty yards electric leads should be supplied, and commercial leads attached to electric detonators.

A collapsible megaphone should be supplied to companies.

The four hand jumpers be replaced by 4—1" jumpers 2½' long, and 4—1" jumpers 4½' long, as being more efficient and easier worked.

Field Engineering.

Captain Elliott's report gives the engineering operations in considerable detail and needs little comment.

It clearly shows the vicissitudes undergone by the Gungtok-Nathu La road owing to various orders. The estimate for this road was largely exceeded owing to a variety of causes, in part due to these orders.

The work was re-started at the worst time of the year and a new staff unfamiliar with the country put in charge just as I was leaving for Gyantse and Lhasa.

The Communication staff were devoting their whole attention to moving forward supplies and military stores, and the engineering work on this new road was thus handicapped, as the engineers had largely to make their own arrangements for forwarding tents, tools, clothing and supplies. Thus Cooly Corps which were sent up with commendable promptitude could not be usefully employed and money was wasted.

The survey and laying out the track took longer than I should have expected and for economy the Cooly Corps should not have come up until this was nearly completed.

The transfer of the Teesta road to military charge at this time and the great exertions necessary to keep it open for carts took up a number of local coolies, who would otherwise have been available on the new road, and aggravated the scarcity of tools, etc.

The actual Cooly Corps sent up also were not always of the best stamp to stand the exceptional rains of Sikkim. All these various causes combined to make the road cost a good deal more than it need have done.

It would appear well if some permanent arrangements were made at certain centres of labour by which a Cooly Corps could be furnished with a suitable supervising establishment and artificers to make it properly efficient.

This has been proposed on previous occasions, I understand, but when Cooly Corps were wanted for road-making in the present expedition they had to be extemporized as usual, with the result that a proper supervising establishment was not forthcoming and that instead of bringing their tools, etc., with them they had to be equipped at the base.

A very trifling annual expenditure at certain centres, would enable the Military or Public Works to keep up a register of suitable men for supervising and artificer establishment who were prepared to come forward on service, somewhat on the same lines as was proposed for the non-combatants technical branch of the Railway Company. A due reserve of tools might also be maintained at these centres or in arsenals, available for the equipment of the corps.

Suitable tents might also be kept in or made available from the arsenals.

Equipment Tables should be made out so that an officer having to raise a Cooly Corps for road work would know what was wanted instead of having to think out everything *de novo*.

Native troops.

Pioneer Regiments.—A clasp knife should be supplied to all havildars of Pioneer Regiments for cutting fuses, and a variety of other purposes, for which at present no provision is made.

The modern pattern tool-box supplied to Pioneer Regiments is very heavy and should be replaced by the Madras Sappers and Miners pattern. The Madras Sappers and Miners have also a much superior pattern of crowbar crate and their introduction as a universal pattern is recommended.

Twenty lbs. nails and 20 lbs. screws would be a useful addition to the Pioneer Field Equipment, also a set of farriers' tools to enable them to shoe their own equipment mules.

Four mason's trowels and hammers *per company* are recommended for peace training and work.

In order to suit the double company organisation and make each double company complete, the following increases are necessary to Field Service Regulations, N. I., Table XI:—

Boxes, wooden, for detonators,	increase from 2 to 4.
" " " for safety fuze	" " "
Keys, plugs, G. S.	" " "
Spring balances (Salters')	" " "

No extra carriage would be required for above increases.

