

Compagnie du Congo pour le Commerce et l'Industrie

(SOCIÉTÉ ANONYME)



THE

CONGO-RAILWAY

FROM MATADI TO THE STANLEY-POOL



RESULTS OF SURVEY



FIRST DRAFT

CONCLUSIONS

With 24 schedules

MAPS. — PLANS. — ESTIMATES. — SEVERAL NOTES.



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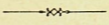
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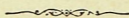
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THE CONGO-RAILWAY

From Matadi tot the Stanley-Pool

RESULTS OF SURVEY

FIRST DRAFT

CONCLUSIONS

The survey of the railway intended to connect the lower Congo with the Stanley-Pool is now entirely completed; the first draft and the estimates have been laid down according to the plans drawn up by the engineers.

We here intend to make known the results of this work in order that every one may be acquainted with the circumstances under which the railway can be laid and worked, and be able to judge with a thorough knowledge of the matter, whether capital employed in the laying of the railway has a chance of proving remunerative.

Let it be said at once that the time seems to have come, when capital should resolutely make the conquest of this new field of equatorial Africa, hitherto virgin, — at least in its central regions — of any commercial or industrial enterprise.

The interior political situation of the independent State of Congo has, in a few years, affirmed itself with a wholly unprecedented surety and rapidity. A simple legislation inspired by the most liberal ideas has been created at one cast, so as to ensure the

respect of individual rights, and to afford to real estate that stability which it wants to have in a constituted State. The authority of the State has been established without any shock to the most distant regions attainable by the steamers ploughing the waters of the Upper Congo; we dare to affirm that to day security is absolute in the cataract region.

In this summary we content ourselves with indicating the results of the works in which we have been engaged — details will be annexed in the form of notes. Those desirous of more completely studying the question will, we believe discover in those schedules the numerous elements pertaining to the Congo-Railway undertaking.

Accordingly the schedule n° 1 will be found to contain a brief historical summary of the question. N° 2 will acquaint the reader with the instructions issued to the engineers entrusted with the actual survey on the ground. This survey carried out by 14 engineers resulted after a 16 months labour on the Congo (see Schedule n° 3) in the drawing up of a plan to the scale of $1/2500$ and figuring the ground with equidistant curves of five metres.

The plans drawn up during the first campaign were brought home to Europe in March 1888. The studies of calculation begun at once comprising successively the drawing up of longitudinal and lateral sections, the calculation of cuttings and embankments and the constructive works.

We annex two complet extracts of the said survey, the first relating to a portion surveyed on difficult ground (see schedule n° 4); the second, comprising the studies of section surveyed in easy ground (see schedule n° 5).

The estimate of expenses was then drawn up (see schedule n° 6). — The schedule n° 7 contains the

justification with various notes of the figures adopted for those estimates : price of lineal metre of railway, of cubic metre of masonry, lineal metre of aqueducts, etc.

Finally the general estimate of the whole undertaking could be made up (see schedule n° 8).

The latter came to the conclusion that a capital of TWENTY-FIVE MILLIONS OF FRANCS would be sufficient to lay the line, to purchase the rolling stock, to cover the general expenses in Europe as well as in Africa, to pay the intercalary interests during the period of laying, estimated at 4 years.

After all the railway which is proposed to be laid in the cataract region according to the above survey, plans and estimates will have a rail-gauge of 75 centimetres, with steel rails weighing 23 kilos, steel sleepers at equal distances of 80 centimeters and weighing 23 kilos, the whole of the line weighing 75 tons per kilometer.

The total length of the line will be 435 kilometers ; the laying of the first 26 kilometres only will offer some important difficulties, while the remainder of the line will be laid under exceptionally easy circumstances either in plains by straight lines, or along the hill sides by means of curves of great radius.

The earth-work of the first twenty six kilometers not only will be much more considerable, but a great deal of it will have to be done by excavating the rock, while farther the cuttings can be proceeded with in argillous ground and nearly always in sandy and friable earth.

In consequence, though the earth works of the first part will necessitate an expense of 57,741 francs per kilometer, those on the remainder of the line will only cost 4,472 francs per kilometer. Likewise, on the first portion the masonry of the retainingwalls will cost 9,106 francs per kilometer, while farther

the cost per kilometer will be reduced to 24 francs.

During the first 26 kilometers, where special precautions will have to be taken in order to facilitate the draining of waters, the cost of establishing aqueducts of pressed beton, will amount to 4,620 francs per kilometer, and that of building bridges and culverts with metallic superstructure to 11,302 francs per kilometer, while beyond Palaballa those expenses will be reduced respectively to 1,519 francs and 4,575 francs per kilometer.

On the other hand, the expenses to be incurred by the laying of the line will naturally increase with the distance, in consequence of the higher rate of transport along the line; from 18,500 francs per kilometer during the 26 first kilometers, they will increase for the latter section of 60 kilometers towards the Pool, to 21,770 francs per kilometer.

If we except the first part there will be few constructive works, the most important of them being a bridge of 100 meters across the Inkissi, two bridges of 80 meters across the Mpozo and the Quillou and six bridges ranging between 40 and 60 meters; the others will have a length of from five to twenty metres only in the clear.

The construction of the abutments of bridges will be everywhere very easy as firm soil is to be met with at no great depth from the surface of the ground.

Nearly everywhere, except on the first section, the nature of the soil will admit of bricks being made, and in the valleys of the Luima, of the Unionzo, Quillou and Inkissi, lime stone is to be found in abundance. Fragments of quartzite and sand, everywhere to be met with, will supply the ballast.

The maximum of incline will be 46 m m. per meter and will be reached three times during the first portion, where as a rule steep inclines will be met with.

Nevertheless it has been possible to combine the slopes and horizontalness so as to render traction as easy as possible, and during the last 400 kilometers the slopes and inclines are very unfrequent and generally insignificant.

Likewise in the first section curves are rather numerous and of short radius, although the latter will never be less than 50 meters.

Thus all the difficulties of laying and working accumulate at the starting point, a most fortunate circumstance as the first section also offers greater facilities for laying, and on the other hand by establishing a twofold traction for the 26 first kilometers and reorganizing the trains beyond Palaballa, it will be possible to work the whole of the line under far greater economical conditions, than if the working difficulties had to be dealt with at some distance from the starting point.

The locomotives when loaded will weigh 30 tons and drag with the speed of eighteen kilometers per hour an average useful load of 50 tons. The capacity of transport is superior to any traffic to be foreseen for a long period; as one train per diem in each direction represents a total movement of 36,000 tons along the line and, if necessary, a service of eight daily trains might be organized without difficulty.

The starting-point of the railway on the lower Congo will be at Matadi, a point which is easily reached by sea-going steamers (see the note, schedule n° 9) and where unexpensive works will easily allow of those steamers to unload their cargo on waggons.

The terminus of the railway at the Stanley-Pool will be at Ndolo at a little distance above Kinchassa, and also above all the rapids which hinder navigation in the cataract region. Beyond this point light draught

vessels can ascend the Congo and its affluents for an uninterrupted length of 11,500 kilometers. Ndolo is admirably situated for the building of spacious quays.

Matadi and Ndolo will be the two principal stations; a second class station will be erected in the district of Kimpésé, where travellers will stop, as two days will be required to pass the distance between Matadi and Stanley-Pool, the trains will not run by night. Three other stations shall be established along the line, one at the Loufou, another at the Inkissi and a third at Ntampa, thus dividing the total distance between the lower Congo and the Stanley-Pool into five sections of an average length of 85 kilometers each, and each section being itself divided into 4 sub-sections by 3 halting-places, with water-tank and crossing-way.

Under such conditions the working expenses of the line, supposing two trains per week in every direction, will amount, according to calculations (see schedule 10) to about 1,200,000 francs.

Adding to this 1,250,000 francs for the payment of interest at the rate of 5 % on the building capital, receipts to the amount of 2,450,000 francs would suffice to enable the railway to prove remunerative from the first year of working. Now the Independent State of Congo, the tradinghouses, the missionaries, in short all who must actually operate transports between Matadi and Stanley-Pool, would realise considerable savings by making use of the railway even by devoting the same sums to their transports. We need hardly point out that the actual mode of transport in the cataract region offers no guarantee either as concerns safety or dispatch. Many goods arrive in a damaged state and sometimes loads are several months on the way before reaching the Pool. Besides the consequent loss of interest, commercial transactions are constantly crossed by the

want of necessary stock owing to the insufficient means of transport.

We may add that transport by means of carriers necessitates the weight of loads being limited to 65 pounds (english weight) and that the numerous precautions which must be taken, in order to avoid as much as possible any damage of contents involve costly package, which transport by rail would of course greatly simplify. Likewise transport of passengers being carried on by rail, would also greatly diminish the expenses, supposing even that the actual fares were maintained.

The agent would then reach the Pool in two days, while now the journey necessitates a month, during which period he renders no services — which means a dead loss for the State, or the trading house who employs him — and after which he arrives to the end of its journey exhausted and very often ill.

This simple reasoning proves that the sums actually spent for transport in the cataract region may be considered as representing the absolute minimum of receipts, which the first years's working will enable the railway to yield. The schedule n° 11 shows that the said sums are at any rate superior to 2,500,000 francs, and consequently sufficient to insure interest at five per cent on the capital employed in the laying.

It must also be remembered that between the period which will elapse from this day, to the achievement of the line, transports will surely have assumed extensive proportions, as is proved more than enough by the increasing progress for the last eight years (see schedule n° 12 : history of transports by means of carriers in the cataract region).

This is all the more true as up till now the number of loads transported has been limited only by the requisite number of carriers. Consequently, when

the laying of the railway will have penetrated a certain distance inland, it will be possible to carry on transports by rail over all that part of the line already laid, thus accumulating on a shorter distance the available carriers, so that when for instance the line will have reached half-way to the Pool, that portion of the country, where transport will have to be carried on by natives, being reduced by half, the number of loads available for transport will be doubled. Besides there is no doubt that the aliments of transport will immensely increase with the opening of the railway. The Upper Congo and its navigable tributaries constitute an immense system of natural communicationways, affording 23,000 kilometers of banks (see schedule n° 13) and bathing the enormous area of 1 million of square kilometers, inhabited by a numerous population which Stanley estimates at 29 millions.

All these native tribes are thirsting for goods of European manufacture, and their very fertile soil enables them to offer us in return raw materials very valuable for the industry of the old world.

At the present time ivory alone can reach the coast. Six years ago scarcely some single tusks found their way from the Pool towards the sea. Since the opening of the caravan's road, the progress of the ivory-trade has been amazing.

The capital represented by the ivory actually transported certainly exceeds 2,500,000 francs per annum. Before long all the ivory of Central Africa will come down by the Congo, an evident proof of the oft-repeated saying that " rivers are marching roads ".

Rubber has likewise made its appearance on the trade roads, but the value of this produce is insufficient to cover the 1,000 francs per ton, representing the actual cost of transport.

Now the railway will reduce this freight to 250 francs per ton, for instance, and enable the immense quantities of rubber found in Central Africa to be shipped to Europe or America. At Luébo, a station founded only five years ago, a factory of the Belgian Society for the Upper-Congo-Trade have purchased in three months 20 tons of rubber, the prices paid being about twenty centimes (two pence) a pound. The sole reason for stopping purchasing was the running short of goods for exchange. Central Africa can besides offer various other produces — see schedule n^o 14.

Considering that this varied natural produce can be harvested on such an immense extent of country as the Upper Congo, and its affluents, the conviction remains that the Congo railway, intended to transport them thro the coast, will soon prove a potent factor for goods.

The objection has been raised that in a country such as the Congo, void of all means of communication, the laying of a railroad would be a matter destined to utter failure from its very rise, as being out of proportion comparatively to the commercial development of the regions it was intended to work.

The objection is simply worthless; in fact, at the navigable terminus of the railway the Congo and its tributaries form an immense road of natural communications, at once cheaper and more adapted to commercial development than any other. Thus the railway will find at its terminus the working facilities, which laterally would fail. Besides one would be wrong to suppose the cataract region totally destitute of produce. It has long been thought that the Congo railway would have a trans-saharian character and be compelled to search for transport only at its extremity. Moreover the cataract region has been painted in very dark colours by most of the travellers, while

the whole country, in opposition to some unfertile districts, contains entire regions of remarkable fertility which certainly will contribute their share of produce for the traffic of the railway.

We do not consider it advisable to discuss here the question of the railway rates. This would be premature. The rates will depend on the commercial situation existing at the time of their application. No one can foresee to what extent commerce will have prospered on the Upper Congo four years from hence.

We have endeavoured in this brief summary to remain calm and uninfluenced, and not to dazzle the reader by the figures which would be those of transports if each of the 23,000 kilometers of the Upper Congo and its navigable affluents were to bring some tons only of their produces to the Pool. Let it be remembered that an uninterrupted line representing the banks of the Congo and its affluents, would be equal in length to the coast line of Europe from the Cape North to Constantinople, following the borders of the Frozen Sea, the Baltic, the North Sea, the Channel, the Atlantic and the Mediterranean.

Anyhow the rates will be differential at all events for the coast bound produce, so as to tax each produce proportionately to its value on European markets, and to enable also produce of less value to enter rapidly the commercial movement. Thus a very large figure of business will soon be reached by a scale of rates, considered carefully, reexamined frequently and intended to lead rapidly to cheap rates.

Moreover the receipts for transport will not be the only ones which the capital employed in the railway can expect. In fact the Congo State has bound themselves from now under the terms of an agreement passed with the Compagnie du Congo — see schedule n° 15) — to grant to the building Company as a sub-

sidy 20 % on all sums realised by export duties, as well as the gratuitous concession of 1,500 hectares of land for every kilometer of railway laid and opened. Of course export duties have been hitherto very moderate; nevertheless their produce has been constantly increasing (1).

The total concession of land for the 426 kilometers of railway, independently of a zone of 200 metres to the right and 200 to the left of the line, will amount to 655,400 hectares of land with faculty of option anywhere within the limits of the State. There can be no doubt that these concessions will some day acquire considerable value.

We cannot here examine in a detailed manner the question of climate. Experiences of the late years have proved that Europeans can inhabit the Congo for some years and attend their occupations without any serious danger for their health. Mortality decreases every year as comfort and luxuries begin finding their way to the inland.

Is it possible to entertain the hope that some day the white man will be able to inhabit the Congo and multiply? the question is highly debated. We may say however that those who have travelled in the regions of the Upper Loualaba and Katanga — easy of access owing to the recently discovered navigability of the Lomami — (see schedule n° 16) state that the climate of these regions which possess great mineral richness and where even the existence of gold has been stated, is extremely healthy, temperature never falling under

(1) The Compagnie du Congo which meantime enjoy the same subsidy in consideration of the survey of the railway has received 12,000 francs for the survey of the first year, 20,000 for that of the second year, and doubtless these figures will be increased to 28,000 for the third year.

5° C. and that they are convinced that Europeans will be able to acclimatize there and prosper.

Questions allowing of positive answers have often been asked us concerning the railway undertaking. We give them below as well as our exact answers, of which developments will be found in the schedules.

Shall you find among the negroes a sufficient number of workmen to build the railway?

Without any difficulty (see schedule 17). Moreover no doubt can subsist on the subject, since southwards from the Congo, between Saint-Paul de Loanda and Ambaca, the Portugueses have constructed a railway for which only negroes were employed for the earth-works.

Has large cattle been introduced to the Congo, and how does it prosper?

The experiments of the last ten years show that good results are to be expected from the breeding of cattle in the Congo (see schedule 18).

Must one not expect bloody wars with the natives? No, as the social and political state of the negroes — see schedule 19 — is a great warranty of security and the story of the last ten years shows that no serious trouble is to be feared in the Congo.

Do negroes possess commercial aptitudes? Yes, to a very high degree. See schedule n° 20.

Will the use of coin be easily introduced to the Congo? The schedule 21 shows that everywhere real monetary units have been adopted by the negroes; so there is no doubt that they will easily adopt coined money, as it is much easier to be conveyed and kept than the hoes, brass-rods, copper-crosses, which in the several regions are admitted as monetary standards.

Are not land-slips, imperilling the railroad, to be feared during the rainy-seasons?

Yes, more or less on the first portion of the line,

but this has been especially taken into account in the working estimates. No, as concerns the latter 400 kilometers of railroad.

Finally we have been asked sometimes if not another large communication can be established to compete with the railway from Matadi to Ndolo.

It is obvious that this would be impossible by water, as there is no possibility of canalizing the Congo, neither of digging a lateral channel.

Moreover a single glance cast upon the map, shows that the railway from Matadi to the Pool crosses a region half as deep on the straight line than would do any railroad to be laid across the Niadi Quillou, and on the other side, the navigable lower Congo forms an immense natural road, capacious to shelter the largest fleets of the world, while on the whole shore from the Gabon to the Congo, there is not a single place suitable for establishing an harbour. We think, however, that we must limite ourselves to set forth here the considerations able to prove that the affair we propose to the public is a good affair. If some day any other similar enterprise were to be undertaken, the sole fact would be a proof of our anticipations being true in the prediction of an immense commercial future of the Congo. That will be the time for those who will then set forth the project of an other railroad than ours, to maintain it and to prove its financial possibility; as for ourselves, we think that it would be useless to discredit in advance any effort made with a view of favouring the commercial development of the Congo.

The conditions of contract are actually under discussion. They grant to the Company the greatest latitude as for the laying as well as for the working, principally with reference to tariffs.

It has been our endeavour to lay before the reader

with scrupulous sincerity the railway undertaking in the Congo cataract region. Now it is for the capital to conclude. The question however does not interest capitalists alone.

We appeal to philanthropists and humanitarians desirous of putting an end to the slave trade and its horrors. We appeal to the patrons of science avid of discovering the scientific richesses which central Afrika has hitherto kept hidden, and finally to the religious and faithful people who see with pain the wretched Africans given over to the practise of idolatrous fetishes.

All those friends of humanity will understand that the Congo railway is the best and surest way of allowing civilization to penetrate in the hidden regions of Africa.

Moreover the laying of the railway is only one episode of the gigantic work conceived and carried on by Leopold II. Like the entire work of the King, it will answer not only a powerful utilitarian interest, but also the noblest feelings of humanity.

Agreed to at the sitting of the general board held on 15th may 1889.

FOR THE BOARD :

The permanent committee :

The Vice-president,
J. URBAN.

The President,
G. SABATIER.

The Deputy-directors,
ALB. THYS, A. DE ROUBAIX.

SCHEDULES

SCHEDULE N° I.

The Congo-Railway question. — An historical notice.

It might almost be said of the Congo railway that it is a railway of geographical interest, we would almost venture to call it a natural railway.

For it is impossible to study the regions of Central Africa without coming to the conclusion that a railway connecting the admirable system of navigable water-courses of the Upper Congo, with the sea-coast is an absolute necessity. This is all the more true, as after carefully studying the map of the Congo, the mind is intuitively led to span the cataract region by means of a railway, and admit the important evidence of the decisive elements pertaining to the question, viz.: the immense expanse of fertile regions of the Upper Congo, and the comparatively short development of railway making produce to reach the coast.

Thus, when Stanley after his memorable journey across Africa, made known to the civilized world that a space of only 300 kilometres separated the sea-coast from the magnificent river he had just descended from Stanley Falls to Stanley-Pool, the question of the Congo railway was naturally and at once brought into evidence. It has been ever since so intimately connected with the question of the Congo itself, that the original idea of this railway is to be met with in everything that has been attempted on the Congo for the last dozen years.

The object pursued by the " Comité d'Études du haut Congo ", the formation of which was the stepping-

stone to the founding of the Independent State of Congo, was in a great measure the laying of a railway intended to span the cataract region.

Readers of M. Stanley's admirable book ⁽¹⁾ might even be led to believe that the eventual laying of this railway, was the sole object held in view by the promoters of this great work, the political end simultaneously pursued being brought about by the necessity of ensuring to the Congo regions previously stability of institutions and rights of property. " To create, " says M. Stanley stating the hesitations of the promoters of the " Comité d'études du Haut Congo " in determining exactly the plan of the enterprise to be created by them, " a railway for over 200 miles through a little known country would require a preliminary survey of the land through which it was proposed the line should run. An exact knowledge would have to be gained of the laws which govern the natives, of proprietary rights along its proposed course; and of the protections if any, which could be guaranteed by the native chiefs to such a road. "

The whole of Mr Stanley's work giving an account of the labours of the expedition of the Comité d'Études, converges towards the same object, and the admirable chapter headed: " The kernel of the argument " is the most eloquent possible appeal in favour of the railway :

" Of the 325,000,000 people in civilized Europe — exclaims Mr Stanley — there must be some surely intelligent enough to be convinced by the gospel of trade, initiative, activity preached in this chapter. I am encouraged in this belief by the rapid absorption of several ideas which have been promulgated during

(1) *Five years on the Congo*, 1879-1884. Brussels, 1 vol. in-8°, 696 pages.

the last few years respecting the Dark Continent. There are enormous riches expecting the railway intended to gather them. I apply to the trading class and I am sure that my advertisement will not be lost. "

The great explorer's appeal was heard. In November 1885, a syndicate of English capitalists was constituted with a view of obtaining from the Congo State the concession of the railway from the lower Congo to the Stanley-Pool.

The time however had not yet come for great enterprises on the Congo. Stability was not yet sufficiently secured. The political work was not sufficiently advanced, so that capital in order to insure its security, was obliged to demand powers which the Congo was unable to grant, so that at the last, the negotiations fell through and the English syndicate was dissolved.

Shortly after, the affair was taken in hand on a more modest scale by the "*Compagnie du Congo pour le commerce et l'industrie* ", constituted with a capital of 1 million francs, which sum was afterwards raised to 1,225,000 francs with the immediate object of studying in a practical and definitive fashion the possibility of laying the railway. The statutes were drawn up however in order to allow the Company to become, by simply increasing its capital, the Company for laying and working the railway.

The "*Compagnie du Congo pour le commerce et l'industrie* " was definitely constituted on the 9th of February 1887. The board of the Company decided on the immediate organisation and departure of two expeditions, one of which would be instructed to draw up the survey of a railway between Matadi and Leopoldville, and choose the best road adapted for the purpose, and the other entrusted with the drawing up of a report on the commercial future of the Upper

Congo. Captain Cambier, who had already twice travelled in Africa, went in command of the engineers entrusted with the survey. M. Delcommune, who had during twelve years been at the head of important trading establishments at the Congo, took the direction of the commercial reconnoitring. Captain Thys, orderly officer to the King and delegate director of the Company, left at the same time in order to assume the direction of the two enterprises and represent the board in Africa.

SCHEDULE N° 2.

Instructions for the Director of survey of a railway from the lower Congo to Stanley-Pool.

The " Compagnie du Congo pour le Commerce et l'Industrie " has undertaken towards the Independent State of Congo to carry out the complete survey of a railway connecting under the most favourable circumstances the lower Congo with the Stanley-Pool.

The railway to be entirely within the limits of the territory of the Independent State of Congo; it may be laid in two sections connected by a navigable portion of the river.

Serious inconveniences militate against the railway being laid in two sections, the latter plan would only be adopted in the event of a continuous line being found to be impracticable or too costly.

At all events, the undivided the line must be situated on the left bank, in order to remain within the limits of the Independant State of Congo. The survey of this inferior part will thus have to be carried on, on the left bank ; survey on the right bank will be carried on, only in the event of a line between the lower Congo and Manyanga being found to be impracticable, and on this subject no apprehensions are entertained.

The starting-point of the line must be on the left bank and accessible to sea-going vessels, besides it must be situated so as to allow afterwards maritime establishments to be created. This point will have to be sought for in the neighbourhood of Matadi.

The terminus of the railway must be situated beyond the rapids and cataracts in the vicinity of Leopoldville, and also at a point of the bank where establishments can be created suitable for the requirements of the Upper Congo navigation.

The general direction of the railway will thus be determined by the geographical positions of Matadi and Leopoldville. Precise informations will first have to be obtained on the subject, and those relating to the situation of Matadi, must be minutely verified and ascertained before the survey begins.

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In order to conduct the survey in a practical manner, the conditions under which the proposed railway can be laid must first of all be arrived at.

Means of communication for the transport of workshops, supplying for same, for transport of materials, are completely wanting. Neither roads, nor beasts of burden are to be relied upon.

Consequently, during the period of laying, the railway will have to provide for itself; hence the absolute necessity of proceeding by stages, and of pushing forward operations only as the line in the rear becomes practicable.

Hence likewise the necessity of attempting no work the completion of which would necessitate any considerable length of time; difficulties will have to be turned, however much the line will have to be lengthened accordingly.

The line must comprise no tunnels, nor trenches cut in the rock, nor any important trenches even in soft soil, nor any considerable displacement of soil.

Constructive works must have for sole object the crossing of streams, and the protection of the line from the action of the waters during the rainy season.

It must always be remembered that whatever may

be the line, the first expenses of laying will be considerable, in consequence of the length of railway compared to the results of traffic during the first years, consequently it will be necessary to diminish those expenses by every possible means even should difficulties of working issue therefrom.

No first expense must be made with a view of diminishing the cost of working.

The railway must at first be accessible only to produce commanding a high rate of transport; later on as traffic gradually will develop, owing to the first railway laid, the line may be modified and improved; important works may be undertaken in order to rectify and improve it, to diminish the costs of working, and to allow the tariffs to be lowered.

In order to keep within those general conditions, the line will have completely to conform to the nature of the ground, only those earthworks, which will be necessary to correct the profile must be admitted, or else along mountain-sides for the establishment of the surface of formation.

Constructive works must be provided with iron superstructures on iron piers, requiring only fitting up and little or no works of masonry, according to the nature of the soils to be met with.

The halting-places will at first be determined with the exclusive object of supplying water to the engines. Supplies of fuel will however also have to be considered as well as, under circumstances which will no doubt at first be of rare occurrence, the storage of goods for transport, especially where affluents of the Congo are to be met with, navigable for ships and for rafts.

The actual studies are only to comprise the centralisation of information respecting the tribes to be met with at certain distances from the line. The plans of

buildings for stations, halts, workshops, stores, will be dealt with later on.

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The proposed railway is intended to have a rail-gauge of 75 centimetres, sufficient for the construction of relatively powerful engines, and possessing in many other ways indisputable advantages while having a capacity of traffic superior to any wants which are likely to occur.

The surface of formation will have a width of 3^m20; the line will easily admit of slopes of 30 millimetres per metre.

Slopes of this incline superior in length to 1,000 metres will have to be sectioned every 100, or 150 metres.

If needs be, slopes of a superior incline to 30 millimetres can be adopted, but only exceptionally and on short distances; under these conditions slopes of 48 millimetres can be admitted, but on a maximum length of 500 metres, with horizontalnesses of from 100 to 150 meters.

Should slopes of a steeper incline be found to be indispensable, exceptional means of working will have to be resorted to, funicular traction, rack, etc., etc., and in this case the steepest inclines will have to be boldly adopted, in order to concentrate on the shortest possible distances these exceptional working difficulties.

The straight parts of the line will be joined by circular or parabolic curves.

The radius of these curves can descend to 50 metres on condition of the latter being established on slopes the incline of which shall not exceed 5 millimetres per metre.

The operations will include a rapid reconnoitring between Matadi and Stanley-Pool, the centralisation

of all details thus acquired, and the choice of the line to be adopted for the return journey;

The return by the chosen line with plan of trajectory, and survey of sufficient details to determine the line and bevelling of the railway, necessary embankments, position and importance of bridges and aqueducts, with all the necessary details for the drawing up of the final design, position of halting-places for water-supplies and conditions of erection of same;

All details concerning nature of the soil, hardness of rocks, importance of water-courses, swelling of same, etc., etc.;

Finally experiments which should be esteemed necessary for appreciating the probable cost of works, and drawing up an estimate of same.

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The plans presenting a general view of the survey will be drawn up to the scale of 1/5,000; plans to the scale of 1/1,000 will be drawn up for the particularly difficult parts, approaches to bridges or aqueducts.

The slopes surveyed must allow of curves of level being traced dividing the trajectory once in every five metres on easy ground; in difficult ground the equidistance to be two metres, or even one metre. The zones of survey to the right and to the left will extend from 50 to 200 metres according to circumstances.

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Where water-courses have to be crossed, the ground must be most carefully surveyed, the high-water marks must be noted, the nature of the soil composing the banks and bottom must be examined, as well as the strength of current, in order to establish in the drawing-up of the lengthwise profile, the position and dimensions of constructive works, and the best mode of construction to be adopted.

The rear-guard brigade will besides be instructed to note all details, of whatsoever nature concerning the ground gone over, the water-courses, whether of a permanent or temporary nature, points to be chosen for water-supplies, in a word a descriptive memorandum, day after day, of the entire plan.

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During the preliminary reconnoitings, as well as the survey on the return, the actual surveying operations must be completed by calculations and day by day drawn up and added to the plans.

All sketches, information concerning the nature of the soil, crossing of water-courses, and details of whatsoever nature, must be every day put in order and completed so as to be easily understood and made use of by others than those by whom the information has been acquired. They must every day be entered in a separate book.

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The director and chiefs of brigades will keep diaries, in which they will enter the principal events of the day's work, length of actual surveys, astronomical observations, atmospheric and climatic conditions, distances covered, etc., in fact anything which may allow of the general progress of the work to be estimated.

The chiefs of brigades will, whenever possible forward daily copies of their diaries to the director of survey.

The director of survey will forward to Europe copy of his own diary, and those of his subordinates, every time he will have an opportunity of doing so.

SCHEDULE N^o 3.

The engineers' expeditions. — Work on the ground.

On the 8th May 1887, the first expedition of engineers left for the Congo; on the 10th June same year, a second group sailed from Antwerp; at the end of July the gangs, assembled at Matadi, were composed of one director of survey, twelve engineers and one physician.

Those, who had arrived first determined the geographical position of Matadi, made some soundings to satisfy themselves of vessels of a large draught being able to land without considerable works, and reconnoitred the environs.

From the first days of August, work begun seriously; one studey-gang walked in advance, reconnoitring the country and determining rapidly, by means of the levelling compass, the zone of the ground to be surveyed. Three gangs, each composed of three engineers followed and drew with the tacheometer the plan of the reconnoitred zone. Haoussas, negroes of the Gold-Coast, were employed as staffholders. The zone on which the operations with the tacheometer were performed, varied, according to circumstances from 50 to 200 meters on both sides of the likely axis of the way. The progress of the work, which at the very beginning of the operations was only from 300 to 500 meters per brigade and per day, on the difficult grounds of Matadi and Palaballa, soon increased to 1 or 2 kilometers, after the expedition having passed the mountainous region, and by way of exception was raised to 4 and even to 5 kilometers per day, the

maximum space between the stations of the instrument being 300 meters.

The operations on the ground continued in 1887 up to December, when the studey had been carried on as far as Lukunga. The work then suffered an interruption of four months on account of the rainy season; nevertheless a special gang continued working during January and February 1888 in order to execute near Matadi the survey of an alteration made in that region to the first direction-line.

In May 1888, the staff having again their full complement, works were resumed. While the chiefs of the gangs went to reconnoitre previously the region which extends between the Lukunga and the Stanley-Pool, the other engineers completed the works around Matadi.

At the beginning of July, the whole staff resumed the operations with the tacheometer. On the 4th November 1888, the level was set up for the last time at the Stanley-Pool and the engineers went back to Europe.

SCHEDULE N° 4.

TYPE OF SURVEY

ON DIFFICULT GROUND

between kilometers 6 and 7 ⁽¹⁾

SUMMARY :

- A.* Calculation of earthwork.
- B.* Removal of ground.
- C.* Estimate of construction.
- D.* Ground-Plot.
- E.* Longitudinal section.
- F.* Lateral section.

(1) The ground-plot and the longitudinal section are given for a distance of 2,250 meters, from kilometer 6,000 to kilometer 8,250.

SCHEDULE N^o 4.

A

Estimate of earthwork between the kilometers 6 and 7.

NUMBERS of HECTOMETERS.	SECTIONS.	SLOPE OF THE SOIL.	DIMENSIONS.	BANK OR DUG.	SURFACES		DISTANCES BETWEEN THE SECTIONS.	CUBES	
					partial.	mean.		partial.	TOTALS. Dug. Bank.
6000	Two ditches.	0	9.00×0.60 <hr/> 2	D	2.90	1.55	36.00	45.800	
6036	—	0	0	D	0.20				
6036			0	B	0				
6054		1/6	$7.20 \times 0.40 + 4.00 \times 1.20$ <hr/> 2	B	3.84	1.92	18.00	34.560	
6086			0	B	0	1.92	32.00	61.440	96.000

6086	Two ditches		0	D	0.20	3.09	17.00	52.530
6103	—	1/3	$\frac{8.80 \times 0.40 + 4.60 \times 1.75}{2}$	D	5.98	9.88	7.00	69.160
6110	—	1/2.6	$\frac{9.80 \times 1.40 + 5.60 \times 2.40}{2}$	D	13.78	11.62	10.00	116.200
6120	—	1/2.2	$\frac{9.60 \times 1.20 + 5.40 \times 1.30}{2}$	D	9.47	5.75	30.00	172.500
6150	One ditch	1/2.2	$\frac{1.05 \times 1.85}{2}$	D	2.04	1.07	15.00	16.050
6165	—		0	D	0.10			426.440
6140			0	B	0	0.67	10.00	6.700
6150		1/2.2	$\frac{1.85 \times 1.45}{2}$	B	1.34	3.59	30.00	107.700
6180		1/2.8	$\frac{7.20 \times 0.40 + 4.00 \times 2.20}{2}$	B	5.84	9.27	20.00	185.400
6200		1/3	$\frac{8.80 \times 1.20 + 5.60 \times 2.65}{2}$	B	12.70	6.35	24.00	152.400
6224			0	B	0			452.200
								472.240
							Over.	548.200

NUMBERS of HECTOMETERS.	SECTIONS.	SLOPE OF THE SOIL.	DIMENSIONS.	BANK OR DUG.	SURFACES		DISTANCES BETWEEN THE SECTIONS.	CUBES	
					partial.	mean.		partial.	TOTALS.
								Dug.	Bank.
6228	One ditch		0	D	0.10		Brought forward.	472.240	548.200
6242	Two ditches	1/2.8	$9.50 \times 1.10 + 5.30 \times 3.50$ 2	D	14.70	7.40	14.00	103.600	
6265	—	1/2.6	$10.55 \times 2.15 + 6.35 \times 3.10$ 2	D	21.38	18.04	23.00	414.920	
6278	—	1/	$9.85 \times 1.45 + 5.65 \times 2.25$ 2	D	13.69	17.53	13.00	227.890	
6286	One ditch		0	D	0.10	6.89	8.00	55.120	801.530
6286			0	B	0	6.02	9.00	54.180	
6295		1/4	$9.10 \times 1.35 + 5.90 \times 2.00$ 2	B	12.04	6.02	9.00	54.180	
6304			0	B	0				108.360

6304	One ditch		0	D	0.10	4.20	16.00	67.20	
6320	Two ditches	1/3.6	$9.25 \times 0.85 + 5.05 \times 1.65$ <u>2</u>	D	8.30	7.25	35.00	253.750	
6355	One ditch	1/3.2	3.25×1.85 <u>2</u>	D	6.21	4.57	20.00	91.400	
6375	Two ditches	1/3.6	4.20×1.30 <u>2</u>	D	2.93	2.36	10.00	23.600	
6385	One ditch	1/3.6	3.10×1.10 <u>2</u>	D	1.80	0.95	5.00	4.750	
6390	One ditch		0	D	0.10			440.700	
6385			0	B	0	6.28	15.00	94.200	
6400		1/3	$8.80 \times 1.20 + 5.60 \times 2.60$ <u>2</u>	B	12.56	7.54	40.00	301.600	
6440		1/1.6	1.80×2.80 <u>2</u>	B	2.52	2.22	40.00	88.800	
6480		1/1.8	1.80×2.15 <u>2</u>	B	1.93	4.20	20.00	80.400	
6500		1/1.8	3.70×3.50 <u>2</u>	B	6.47	4.02	20.00	80.400	
6520		1/2	1.80×1.75 <u>2</u>	B	1.57	0.78	10.00	7.800	
6530			0	B	0				
								Over.	1714.470
									656.800
									1313.360

NUMBERS of HECTOMETERS.	SECTIONS.	SLOPE OF THE SOIL.	DIMENSIONS.	BANK OR DUG.	SURFACES		DISTANCES BETWEEN THE SECTIONS.	CUBES	
					partial.	mean.		partial.	TOTALS. Dug. Bank.
6426	One ditch		0	D	0.10		Brought forward.	1714.170	1313.360
6440	—	1/1.6	$\frac{1.60 \times 1.90}{2}$	D	1.62	0.86	14.00	12.040	
6480	—	1/1.8	$\frac{1.40 \times 1.90}{2}$	D	1.43	1.52	40.00	60.800	
6500	—	1/1.8	$\frac{0.75 \times 1.00}{2}$	D	0.47	0.95	20.00	19.000	
6520	—	1/2	$\frac{1.25 \times 1.90}{2}$	D	1.29	0.88	20.00	17.000	
6550	Two ditches	1/2	$\frac{9.05 \times 0.75 + 4.95 \times 4.95}{2}$	D	15.84	8.56	30.00	256.800	
6562	One ditch		0	D	0.10	7.97	12.00	95.640	461.880
6562			0	B	0	9.63	20.00	192.600	
6582		1/2.4	$\frac{9.10 \times 1.35 + 5.90 \times 4.45}{2}$	B	19.27	41.19	16.00	659.040	

