Revenue (1897) Department.

PRESS SERIES.

G.O., No. 221-222

DATED 30th March

1897

[Despatch Abstract.]

Forwarding with their Petition in connection
with it is the result to date of the Committee's
Enquiry re Establishment of Middlemen-ships, &
Consignment of Salem dist. Tangal Cultivation
for the purpose of determining, by actual
experiment, the value & cost of manufacture
of Tangal made from Indian & with
Ceylon Cocks.

BACK PAPERS.

G.O.	No.	Department.	Date.	G.O.-	No.	Department.	Date.

FURTHER PAPERS.

G.O.	No.	Department.	Date.	G.O.	No.	Department.
Cw 5338/97. to 846			6.10.97			
Cw 10515/97						

ERRATA.

In G.O. No. 221, dated 30th March 1897.

Page	3	line 27	for "business like"	read	"business-like"
,,	,,	,, 42 ,,	"39"	,,	"3.9"
,,	8	,, 13 ,,	"s d" 6 .6	,,	"s d" 6- 6
,,	,,	,, 18 ,,	"5 .6"	,,	"s d" 5- 6
,,	,,	footnote ,,	"½"	,,	"s d" 1- 2
,,	10	line 36 ,,	"angle-bar"	,,	"angle, bar"
,,	,,	,, 53 ,,	"fiye"	,,	"five"
,,	11	,, 47	"4/"	,,	"4/"
,,	14	,, 12 ,,	"025"	,,	"250"
,,	15	,, 15	"si"	,,	"is"

Ulla 12/6/97

To the Board of Revenue (Land Revenue). Secs. 17-6-97

Note:- With reference to the Under Secy's order contained in the attached to the copy of G.O. 221/30.3.97, it is respectfully submitted the misprints detailed are all in the letter and report by Major R. H. Ma printed with the B.P. No 24/19-1-97 on which our Order was passed. In proof of the G.O. was furnished the mailer of the B.P with its enclosures had been in the Press and all that was done in the office was to examine the ress of the order and the general arrangement of the print The Press alone is responsible for mistakes in all standing matt is humbly submitted that, on examination, the original an of the B.P. No 24/19-1-97 and the original report of Major Ma a few cases) are found to contain the same mistake list is submitted for approval.

Date.

Order

Revenue (1897) Department.

CURRENT No. 1428

CONFIDENTIAL GOVT. MADRAS
16 FEB 97
RECEIVING DEPARTMENT

From Board of Revenue
Land Revenue

No. 24.

Dated 19-1-97

Received 16-2-97

Registered 17-2-97

Enclosures —

Spare copies —

SUBJECT.

Passing orders on G.O. (R.D.) Communicating letter from Govt for-warding for information a letter from Major Mahon R.A on the question of working the Salem Iron ores Success-fully, &c.

BACK PAPERS.

G.O.	No.	Department.	Date.

FURTHER PAPERS.

G.O.	No.	Department.	Date.

BOARD OF REVENUE (LAND REVENUE), No. 24, 19TH JANUARY 1897.

PROCEEDINGS OF THE BOARD OF REVENUE
(LAND REVENUE).

READ—the following Government Order, Mis. No. 127, Revenue, dated 9th January 1897:—

Read—the following letter from the Government of India, Department of Revenue and Agriculture, dated 3rd December 1896, No. 4371/36-9:—

In continuation of my letter, No. 2283, dated 26th August 1896, I am directed to forward, for the information of His Excellency the Governor, a copy of Military Department endorsement, No. 4915-D., dated 5th October 1896 and enclosures, being a report and letter by Major R. H. Mahon, R.A., on the question of working the Salem iron ores successfully. In this connection I am to refer to my letter, No. 2283, dated the 26th August 1896, to which a reply is still awaited.

ENCLOSURE No.1.

Memorandum from Major E. G. BARROW, Officiating Deputy Secretary to the Government of India, Military Department, to the Secretary to the Government of India, dated Simla, 5th October 1896, No. 4915-D.

Transferred * for favour of such action as may be considered necessary.

* From the Director-General of Ordnance in India, No. 2042-E., dated 21st September 1896, and enclosures.

ENCLOSURE No. 2.

From Major-General A. WALKER, Director-General of Ordnance in India, to the Secretary to the Government of India, Military Department, dated Simla, the 21st September 1896, No. 2042-E.

With reference to Military Department Memorandum, No. 4287-D., dated 28th August 1896, forwarding a Despatch from Her Majesty's Secretary of State, No. 75, dated 2nd July 1896, for record, I have the honour to submit a report and letter by Major R. H. Mahon, R. A., Superintendent, Foundry and Shell Factory, Cossipore, on the question of working the Salem iron ores successfully. The report and letter might be sent to the Madras Government and the Secretary of State for India. "The day must come when these Salem ores will be put on the market, and any capitalist who may undertake the manufacture of iron and steel from these ores will, in my opinion, reap a rich harvest.

ENCLOSURE No. 3.

From Major R. H. MAHON, R.A., Superintendent, Foundry and Shell Factory, Cossipore, dated Simla, the 17th September 1896.

I have read with interest the papers enclosed under the Right Honourable the Secretary of State's Revenue Despatch † No. 75, dated 2nd July 1896.

† *F.* 36, *S.* 3.

Mr Head has dealt very effectively with a scheme having for its basis the export of Indian ores to England, but it would not appear that any proposal to export ores having a 200-mile railway lead, *plus* a 7,000-mile sea lead, by way of so expensive a route as the Suez Canal, would have any chance of success against Spanish ores quarried on the coast with 1,000 miles of sea lead, closely competing shipping companies and more suitable ore, or against Swedish ores, with rather greater leads.

It may be added to the statement made by Mr. Head that even should the Spanish Government place an export duty on ores, which is said to be probable as a result of recent events in Cuba, the immediate result would be to bring first other European ores, and then American ores, into competition, and to increase the output of the Cleveland mines. It is not at present within reasonable probabilities that any state of the European markets would enable Indian ore to compete.

It is equally futile to expect an iron industry, in the proper acceptation of the term, to grow from any scheme for using charcoal fuel only. Iron made by such means is adapted for special purposes and commands a special price, but for railway work and ship building, as well as for general trade purposes upon which it is indispensable that a country intending to foster its iron manufactures should rely, such iron would be altogether unsuitable. In no country and under no conceivable circumstances could charcoal fuel form anything but a small adjunct to that required for the iron industry proper.

It may be laid down as an axiom that entry into the iron and steel trade proper, without reference to special irons or steels, necessitates plant of the most modern description worked on an extensive scale. It may be of interest to note that the new blast furnaces of the Edgar-Thomson works are turning out 11,000 tons of pig iron monthly per furnace, while English practice, which has a strong tendency to follow the American, at present is best represented at Dowlais with 1,250 tons per week per furnace. And the question may be asked, would it be possible to compete with such outturns as these, having the reduction in general charges consequent on large business, with any outturn necessarily limited by the small supply of fuel available, 5,000 tons per annum as stated by the author, costing Rs. 24 per ton, as against about Rs. 11 or less, the value of the fuel in England and America. If a demand for tin plates, rolled sheets for pens, steel for cutlery, special steels for tools, and pig iron for special castings were likely to arise in India, the erection of a charcoal furnace might be justified, but to commence with such, leaving the great industries, which absorb $\frac{999}{1000}$ lb. of the iron and steel of the world, untouched, would be the reverse of business like.

Mr Head dismisses the subject of the manufacture of iron with coke fuel in a few lines. But I submit that a further and closer attention on lines of more accurate local knowledge would repay the labour, and on this subject there are already valuable papers contributed by Mr. Gilchrist, F.R.S., and Mr. Mannaberg, a perusal of which, even though not dealing directly with Salem ores, would lead to useful results.

In regard to the detail of Mr. Head's report, I observe, for your information, that the cost of "collecting, mining, quarrying and picking" at Rs. 1¼ per ton (page 8—9 in Board's Proceedings, No. 361, dated 23rd September 1896, table No. 2) is probably too low. In my own paper on the subject I have taken 4*s.* per ton (= Rs. 3-4). I think Mr. Head is misled by the *present* cost of picking *surface* deposits, quarrying must, however, be soon resorted to which will be more costly. My figures are taken from average results at Bilbao mines, the working of which resembles that which will be used at Salem. On the other hand, 1*s.* per ton taken by me is an ample charge for loading, if proper appliances are arranged.

Mr. Head assumes a rate of 3 pies per ton mile, Salem, Madras: this is decidedly too low. At present the rate would be 6¾ pies. But in my paper I have taken 3·9, say, 4 pies per ton mile, this being the coal rate in Bengal. It is not probable that 3 pies (= 22*d.*) could ever be attained.

With proper appliances I think loading at Madras may be reduced to 6*d.*, say, 7 annas per ton.

Probably Government would be content with a smaller seigniorage than 6 annas per ton assumed by Mr. Head. I have neglected this item, and I make the cost of Salem ore f. o. b., Madras 9*s.* 4*d.* per ton against 8*s.* 6¼*d.* I think the higher figure is the more correct.

In the cost of charcoal Mr. Head assumes Rs. 24 per ton which is not below the mark, and one ton as required per ton of iron: in his estimate, however, on page 24—21 in Board's Proceedings, No. 361, dated 23rd September 1896, clauses "*b*" and "*c*" he is certainly wrong in assuming 20 cwt. of Indian coke as sufficient per ton of pig iron. Nor is the cost per ton of Barrakur coke delivered in Madras correct.

In the matter of labour (table 11, page 18—17 in Board's Proceedings, No 361, dated 23rd September 1896), Mr. Head has adopted so high a figure, Rs. 17, that I think he must have followed Mr. Maylor's figures without full consideration. In 1858 the cost in labour appears to have amounted to Rs. 15 per ton (page 12, table No. 6), but if the enterprise is to be successful at all, the method of working would bear so little resemblance to the working in 1858 that the labour expended at that time must be reconsidered.

The most recent statistics (1896) show labour, including everything in connection with the blast furnace from unloading the ores to loading up the pig iron (excluding establishment charges) to be 24 pence per ton as a minimum rising to 30 pence for hematite iron, whilst establishment charges vary from 3 pence to 4 pence extra in England. Rs. 2¾ to Rs. 3½ was the estimate of Mr. Mannaberg at Barrakur (see also page 15, Section IV of my report). Taking the highest figures (for England) we have 2*s.* 10*d.* = Rs. 2-4 against Rs. 21 for wages, salaries and establishment estimated by Mr. Head! I can see no reason why the English price should be *exceeded*.

If the plant is planned on a suitable scale, one might, indeed, expect the reverse. My figures refer to coke-worked furnaces. I have no statistics before me here relating to charcoal iron, but it is impossible to imagine such a difference to exist. Mr. Head's high estimate may, perhaps, be governed by the small scale of the plant he had in view.

Page 18 (17 in Board's Proceedings, No. 361, dated 23rd September 1896).

The item "agent at port" Rs. 1¼ per ton is unnecessary and should be included in establishment charges.

Page 18 (17 in Board's Proceedings, No. 361, dated 23rd September 1896).

The item "stores and renewals" should not exceed 3*s.* (see bottom of page 15, my paper). In the States this item is 2*s.* 10¼*d.* = say, Rs. 2-6.

In several points I observe that Mr. Head's calculations and opinions confirm what I wrote in 1894. In this paper I have made some corrections as I have found the railway lead, Salem to Madras, was wrongly stated at 240 miles. I have also added capital charges (wrongly included at first in general charges) in connection with the freight steamers, thus raising the cost of carriage per ton from Rs. 3 to Rs. 4½, and it may be noted that this rate only takes into consideration a small part of the utility of steamers on the outward voyage.

I append a statement in the form of Mr. Head's table 11, page 18—17 in Board's Proceedings, No. 361, dated 23rd September 1896, applicable to the Calcutta site—

	RS.	A.	P.
Iron ore f. o b., Madras, 1 ton 16 cwt. @ Rs. 8	14	6	5
Madras to Calcutta @ Rs. 4½ per ton	8	1	7
Coke fuel, 25 cwt. @ Rs. 13 per ton	16	4	0
Limestones, 10 cwt. @ Rs. 4-6-4	2	3	2
Stores renewals and sundries	2	9	6
Wages, salaries, establishment	2	6	5
Total ...	45	15	1

or £2-13-6 (see also page 15, Section V, my paper). Suitable hematite pig iron could not, at the present moment, be landed under £3-5-0.

Reviewing my paper again after a lapse of 2½ years. I am unable to find serious flaws in it, and the advantage derived from reading and criticising Mr. Head's report tends to confirm my opinion that, properly conducted and on a suitable scale, an iron work at Calcutta should be able to produce hematite iron suitable for all ordinary steel making at a price between £2-12-0 and £2-16-0 per ton.

The energy and enterprise that would be required in the manager of a concern, mining its own ore, fuel and fluxes, transforming the fuel to coke on approved principles, carrying and transferring with the latest appliances, and finally smelting, converting and rolling the products to rails and sections on a scale suitable to the demand, opens up a prospect to a capable individual which might excite enthusiasm in the least sanguine.

I have only to add that the proposal to send 300 tons of Salem ore to Messrs. Balchow Vaughan & Co. should, I think, have the warmest support. If, after experimenting with the ore, that firm could be induced to take up the question of local manufacture either with or without Government assistance or guarantee, no more competent or enterprising iron-masters could be found, they having wide experience not only in acid steel making but also in the basic processes which would be applicable to the ores of Bengal.

P.S.—If the despatch of 300 tons of ore is approved, I recommend that 600 tons of Bengal coal, of a quality equal to the Sanctoria coal, may also be despatched to Messrs. Balchow Vaughan, to be coked by them on principles most suitable to the coal and used in the reductions of the ore. By such means only can a reliable forecast of the quantity of fuel and flux be made, and further information of value in reference to the suitable size of blast furnace obtained.

A

MANUFACTURE OF IRON AND STEEL IN INDIA.

REPORT BY MAJOR MAHON, R.A.,

SUPERINTENDENT, FOUNDRY AND SHELL FACTORY, COSSIPORE.

DATED COSSIPORE THE 5TH MAY 1894.

		Page as given in the original.	Page as now printed.
SECTION	I.—THE QUESTION OF SITE	1—4	7—10
„	II.—EXTENT AND NATURE OF TRADE	4,5	10
„	III.—NATURE AND COST OF RAW MATERIAL	5—10	10—15
„	IV.—LABOUR AND COST, ALSO TOTAL COST	10	15
„	V.—THE ULTIMATE COST OF PIG IRON	10, 11	15—16
„	VI.—THE CAPITAL REQUIRED	11, 12	16—17

NOTE.—I have selected throughout for general comparison the cost of manufacturing Hematite iron in the West of England, as exponent of the best English practice; and at Pittsburgh, United States of America, as exponent of the best American practice.

NOTE.—The figures representing price are in most cases in shillings and pence, exchange being taken at 1*s.* 2*d.*

ENCLOSURE No. 4.

SECTION I.

THE QUESTION OF SITE.

In this country I regard contiguity to the seaboard practically essential. Not only is it improbable that juxtaposition of ores, fuel and flux is likely to be found in any one place of a suitable nature for Bessemer * work, but it is improbable that any successful works operated on a large scale could work profitably at an inland site in this country, at least until the lapse of a great number of years, when competition between different railways, canals, or other means of transit ensure low freight.

It may be argued that c iage landward may be ultimately necessary, but it must be remembered that in this country no landward position is central to a large area of supply, and when the radius, within which profitable freight is possible, is satisfied, production must be checked by the supplies coming from more favourably situated sources. A seaward site on the contrary is enabled to tap landward communications from many points, as also to open up new communications with other countries.

On the other hand, the fact must not be lost sight of that it takes from 3½ to 5 tons of material to turn out one ton of pig iron, depending on the richness of the material used; and one of the main questions in deciding on site is the cost of conveyance of raw material to the works *versus* the cost of conveying finished material from the works. But this is not the only question; proximity of suitable labour and healthiness is an important point, especially in this country.

Examination of existing instances will help a decision.

In Great Britain the most favourably situated districts—the Black Band Field of Scotland and the Cleveland districts of the east coast of England—are perhaps the most notable instances † of works so situated as to draw all their material from the immediate neighbourhood, but in neither of these is the ore suitable for the production of Bessemer iron, and in both, for this purpose, importation either of ore or fuel is necessary.

The main areas of the occurrence of Bessemer ores are—

The Bilbao District, Northern Spain,
The Island of Elba,
The Cumberland and North Lancashire Districts,
The Lake Superior region in America,
In India, the Salem District.

See also note at the end of Section III.

At Bilbao the small works of Messrs. Ybarra are worked almost entirely from coke imported from the Durham District about 1,000 miles distant, while the greater part of the ore raised is exported to English works there to be worked in greater or less contiguity to the fuel.

In Cumberland and Lancashire the ores are worked entirely with coke brought from the Durham Fields.

In America the greater part of the ores are conveyed distances of 650 to 1,000 miles to the works situated in Pennsylvania and the North Eastern States, and worked with coke from the Connelsville coal.

We have here instances in which ore is brought to fuel and fuel to ore; the site in each case being governed by proximity to one or other, and also very largely by its proximity to a trading centre. It is, however, evidently possible, and is in fact frequently the case, that a work may be situated at a place intermediate between the ore and fuel.

In England the great iron work centres are on the Tyne, Tees, Clyde, Mersey, or at seaports, as Cardiff, Newport, Swansea,—or at the centres of a network of railways as Sheffield. In America the neighbourhood of Pittsburgh and Chicago with their immense convergence of railways are instances of inland situations.

In India the want of a convergent railway site practically reduces the question to a choice of seaboard or at least water approached situations. And in this respect the coast of the Bay of Bengal appears to offer the greatest advantages.

Some statistics on the cost of assembling materials at different centres will be useful.

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* By Bessemer ore or Bessemer iron is meant ore fit for steel making and containing a maximum of ·04 per cent. phosphorous.

† Almost the only instances.

	Pence per ton per mile.
United States, distances of 101=150 miles	·436
Do. distances of 630 miles	·226
United Kingdom, distances of 101=150	·650
India, distances of 240 miles	* ·5
United States, distances of 1,000 miles, partly by rail, partly by water	·128
Europe, Spanish coast to Tyne	·07
India, Madras coast to Calcutta	† ·07
India, Salem to Calcutta	·11

the total distance being about 1,090 miles from Salem to Calcutta.

At Pittsburgh and the West of England, both using hematite ore, the cost of production is as under:—

	Quantity used per ton of pig iron.		s. d.	s. d.
Prime cost of ore at mine	35·8 cwt.	@	6·6	11-7¾
Coke	21·0 „	@	7-9·33	8-2
Limestones	10 „	@	1-4·5	0-8¼
Conveyance of material—				
	to Pittsburgh.			
Ores	@		10-1½ ...	18-2
Coke	@		5-3 ...	5·6
Limestone	@		1-8 ...	0-10
Labour	...		... ...	5-9
Other charges	...		... ...	3-0
				2-13-9

West coast of England—

		£ s. d.
Prime cost of Ore 37-1 cwts. @ 8-0		0 14 10
Coke 21 „ @ 8-11½		0 9 5
Lime 10 „ @ 1-10½		0 1 0
Conveyance Ore @ 1-2		0 2 2
Coke @ 7-3¼		0 7 8
Lime @ 1-0		0 0 6
Labour		0 2 9
Other charges		0 2 0
Total ...		2 0 4

And similarly examined approximately for India (*established near Calcutta*).

		s. d.	£ s. d.
Prime cost	Ore 36 cwts. @ 4-8		0 8 5
„	Coke 25 „ @ 7-8½		0 9 7½
„	Lime 10 „ @ 1-0		0 0 6
Conveyance	Ore @ 12-5		1 2 4
	Coke @ 5-1		0 7 4
	Lime @ 4-1		0 2 0½
	Labour		0 2 0
	Other charges		0 2 6
	Total ...		2 15 9

If the steel works were established at Girideh, the cost might be shown to be considerably higher.

In other words, to establish the works near the fuel and convey the other material thither appears to be more costly than an intermediate site.

These figures show that the cost of conveyance and the distances over which the raw material is brought do not greatly differ in this country and the United States. It also shows that the intermediate position of Calcutta would be more profitable than the immediate neighbourhood of the coal. While a very important item referred to more extensively below renders the neighbourhood of Calcutta preferable to the neighbourhood of the ore, *i.e.*, Salem, Madras. (But see note on Salem.)

* Exchange ½=1 R., calculated from 6·75 pies per ton mile. † See calculation of freight.

The items susceptible of reduction are—

(1) The prime cost of coke.

(2) The conveyance of ore.

The former being reduced by the coking and coal works being within the same ownership as the steel works; and the latter by the vessels, especially built for the trade, being owned by the Company for the *export of coal to Madras* and the import of ore on the return journey. There is little doubt but that the profits on the export of coal to Madras would go far to reduce the cost of bringing up the ores on the return journey. And the advantage of being able to carry an item of such prime necessity on the outward voyage is the deciding factor in the site of the Indian steel works. I cannot suggest any other site from which coal could be cheaply shipped to Madras on the outward voyages.

Taking the foregoing into consideration, I believe the neighbourhood of Calcutta is the most advantageous situation. And it would appear probable that the advantages offered by Port Canning, and the probability that, together with its existing appliances, it would be obtained advantageously, leads me to point to it as the best site.

The only other place on the Bay of Bengal which could apparently compete would be the neighbourhood of Cocanada, working the Singareni Fields, but the want of facilities for transit and the fact that all the district is a century behind the Bengal area leads me to neglect it in favour of Calcutta.

NOTE.—The neighbourhood of Masulipatam on the Madras coast is a site which would have advantages which should certainly be considered.

It has practically the same market as the Calcutta site.

Could be connected by rail with the Singareni Field.

The difficulties and expenses can hardly, however, be calculated, as the east coast ports are closed frequently during monsoon weather. The country is but little opened up, and the coking quality of Singareni coal is doubtful.

The question should, however, be carefully gone into before pitching on the Calcutta site, of which these notes take detailed notice.

NOTE ON THE SALEM SITE.

The cost of the assembled materials appears to be—

	s. d.		£ s. d.
Ore @	4 6	per ton	0 8 1½
Lime @	1 6	„ „	0 0 9
Coke (as under)			1 15 10
		Total ..	2 4 8½

Coke.—25 cwts. at Calcutta	0 16 10
Calcutta to Madras	0 5 0
Madras to Salem	0 12 0
Handling 3 times	0 2 0
Total ..	1 15 10

The resultant cost of the pig at Salem is then—	
Material	2 4 8½
Labour, &c.	0 5 10
Total ..	2 10 6½

But as 90 per cent. of the finished product would require transportation to the coast, an additional 10 shillings must be added before it can be compared with the cost of the pig at the Calcutta site: the result is £3-0-6½ and is unfavourable.

But the question is evidently one of the price of coke, and calculation shows that, if the price can be reduced to a total of 28 shillings per ton of pig iron, the Salem site would not be impossible, although advantage would still lie with Calcutta as a trading centre with facilities for shipment.

To the extent, however, that it remains uncertain whether a coking coal will be ultimately procured in the neighbourhood of Salem, the establishment of the works at Calcutta contains an element of hazard. The point is one regarding which the promoters should well satisfy themselves.

ADDITIONAL NOTE ON SINGARENI.

According to the terms of the scheme put forward for establishing steel works in the neighbourhood of the Singareni Fields, the conveyance cost of the finished product is put at—

	s. d.
From works to Gódávari, 182 miles by rail, say	4 3
Gódávari to Cocanada, 50 miles by boat, say including handling on shipboard in harbour.	4 1

The pig iron being estimated to cost as under:—

		Rs. A. P.
40 cwts. iron stone @ Rs. 3 per ton		6 0 0
40 „ coal @ „ 4 „ „		8 0 0
15 „ limestone @ „ 2 „ „		1 8 0
Labour		2 0 0
Stores		1 4 0
Office		1 4 0
	Total ..	20 0 0

or at 1/2 say £1-3-4
or at coast say £1-11-8

In this scheme it is proposed to work on the anthracitic method—that is, using raw coal of an anthracitic nature instead of coke.

This method has been used with some success in America, in the neighbourhood of the well-known Pennsylvanian anthracite which contains from 87·127 to 90·685 of fixed carbon, but the mechanical difficulties met with have caused a very large reduction of the output of iron made in this way.

In 1880 the output of iron smelted by anthracite was 1,807,651 tons; in 1890 this had fallen to 279,184 tons, and it is also stated that in the Northern States only one furnace continued on this method in 1889 out of 66 formerly at work.

Moreover, it is in the last degree unlikely that the Singareni coal contains anything near the same quantity of fixed carbon that is contained in the anthracite alluded to.

For this reason it may be most reasonably assumed that coke* will have to be brought from Bengal at an all-round rate including conveyance, of not less than 30/ per ton, or for 25 cwts. say 37½, which would bring up the price of the fitished product on the coast to £3–1–6, a price which would not compete with the rates at the proposed site.

SECTION II.

THE EXTENT AND NATURE OF TRADE.

In this country, as in most others, the railways must be the main support of any steel and iron works, and the growing tendency of the Great Indian Railways to be their own manufacturers is a factor in the question that must not be neglected. In England the railway directorate is very largely composed of men interested in the production of manufactured iron and steel, and this has resulted in but a small amount of manufacture being undertaken by the railways themselves; in at least one railway (the Midland) the interest against steel-making was so strong as to cause its abandonment even after erection of furnaces. In India no such interest is likely to come into play, and there is nothing to prevent the Railway Companies from competing against any individual establishment which might be started.

The best means to take is to prepare for manufacture on a scale and with a completeness of apparatus which would enable the material to be turned out cheaper than it could be made by the Railway Company or imported. An instance of the possibility in securing trade as a monopoly by the reduction of cost of outturn is given by the results of the great Carnegie steel works of Pennsylvania. This Company having completed their works on a scale of unequalled perfection have reduced the price of their rails by 4 dollars per ton; cutting out the profit at which the best equipped of the remaining works in America can work and securing a practical monopoly of orders within a very large radius.

The manufacture of rails themselves is the chief production. In this country there are undoubtedly immense possibilities. Given a stable currency and a consequent great inflow of European capital and enterprise, the railway system must grow largely. It at present consists of some 20,000 miles of rails, and a moderate estimate would give 250,000 tons as the requirement annually. Say 600 tons per week, this would not be more than would be required to give full occupation to a rail mill of moderately large size.

The manufacture of angle-bar, rod, galvanised sheet, plate, wire†, beams, girders, pipes nails, screws, amounts to about 200,000 tons more as judged by the amount at present imported.

Given therefore the possibility of placing at any point of the coast line or in any Eastern country any of the above detailed items at a lower rate than the same can be imported from Europe, there seems to be sufficient trade for 500,000 tons of finished iron and steel annually, which is amply sufficient for a complete works on a large scale in full work. Moreover, this estimate is likely to increase rather than the reverse for many years to come.

In the United States of America, with a population of 62 millions, it is not unusual for 10,000 miles of new rails to be laid in a year.

In India, with a population 4 times greater, barely 500 miles of new rails are at present laid annually.

The production of rails in the United States of America amounts to over one million of tons annually, and in the United Kingdom about 400,000 tons.

The average life of a steel rail in India with low speeds and small traffic may be taken at the outside at fifteen years, which alone would give a production of 160,000 tons annually (at 120 tons per mile) without extensions. Extension to the extent of 500 miles only, which must be enormously exceeded sooner or later, gives 60,000 tons more. It is reasonable to count on 250,000 tons of annual requirement within the next five years.

SECTION III.

THE NATURE OF THE MATERIAL REQUIRED AND OBTAINABLE, AND ITS COST.

(*a*) *The Ore.*—Appended is a table showing the approximate constitution of ordinary hematites from the chief centres:—

—	Furness ores.	Whitehaven.	Spanish.	Salem.
Iron	60·5—66	66·6—68·7	54·6—56	67·76
Phosphorus	TR.	TR.	TR.	TR.
Sulphuric Acid	·11	·09	·01—·03	TR.
Residue, chiefly silicious	5—14	1·5—4	10—10½	4·72

* Assuming as appears to be the case that the Singareni coal is non-coking.

† 6,000 miles alone would be taken annually by the Telegraph Department.

The working of hematite ores in the blast furnace, specially for the production of Bessemer iron, often present considerable difficulties. As a rule, the hematite furnaces in the English districts are smaller than those working on the Cleveland and other non-hematitic irons. The Cumberland hematites contain very little alumina, and in consequence the slag found is trouble-some to deal with. To avoid this, it is customary to mix a proportion of aluminous Irish ores, the best of which from Red Bay contains about 20½ per cent. of Al_2O_3. From 3 to 4 cwts. are required.

There is little doubt, but that the magnetite of Salem would require similar treatment owing to the quartsose nature of the gangue. There would, however, be no difficulty in obtaining aluminous ore for the purpose of mixing with it.

In this respect the red and brown hematites of Spain, though probably on the whole poorer in iron than the English or Salem hematites, are much sought after on account of the facilities they offer for the extraction of iron.

The main consideration in the mining of Bessemer ores, *viz.*, freedom from phosphorous, very greatly reduces the available quantity.

In England an average output of 14 millions of tons of ores contains only 12½ per cent. fit for acid steel manufacture, the total make of Bessemer pig being only 17 per cent. of the production of 7¼ millions of tons.

The richest deposits are those of the Furness and Whitehaven districts, of which the analysis is given above, the Park, Roanhead and Askham mines in the Furness District being mined at from 12 to 70 fathoms in depth.

The Lake Superior mines are worked at depths of from 100 to 120 fathoms.

The Spanish ores are quarried in the open on the hill sides.

The methods possible in the Salem district will be very similar to the latter.

The cost of collecting iron ore in the United States is estimated at—

	£	s.	d.
Labour	0	4	3¾
Officials	0	0	2½
Stores and repairs	0	1	6
Taxes	0	0	1¾
Interest and depreciation and insurance	0	0	6
Royalty	0	0	10¼
Total ...	0	7	6¼

In Lancashire and Cumberland the cost of raising and collecting is put at 7/ and 8/, respectively.

In Spain the labour in quarrying is from 1/ to 2/6 per ton, the ore being delivered in ship in Bilbao river at 7/ per ton.

The ore is carried from the mines about 1½ miles to the sea by complete system of wire tram-lines, inclined planes and railways or combinations of all three. Some 700,000 tons are, however, still carried annually by bullock cart at a cost of *s.* 2/1 to *s.* 2/9 per ton.

It would appear then that the cost of the raised ore at Bilbao mines is from *s.* 3/6 to *s.* 4/ at the quarries.

Of the 2¼ millions of tons raised, 70 per cent. is exported to England, the cost in the Tyne being *s.* 12/ to *s.* 12/6 (at present* about *s.* 13/).

A consideration of the foregoing leads to the estimate that, with complete appliances for conveying the ore from the Salem quarries to the railway, which is situated at the foot of the hills, the cost of ore placed in trucks should be somewhat less than the cost on ship in Bilbao. Say 4/ for raising and collecting and *s.* 1/ for loading or *s.* 5/ per ton in truck. And work on a larger scale should reduce this to *s.* 4/8 per ton or *s.* 8/5 per 36 cwts.

The cost of conveyance of ore to various works from mines may be taken as under:—

		£	s.	d.
Cumberland works local @ 1*s.* 2*d.*	36 cwts. cost	0	2	2
Middlesborough (from Bilbao) 9*s.*	do.	0	16	2
Pittsburgh at 10*s.* 1½*d.* (Lake Superior)	do.	0	18	2
Calcutta (Salem)	do.	1 to 0	2 19	4 0½

see note, page 9.

The latter item of cost, which is one of the most important in the whole problem, is calculated as follows:—

Railway freight, Salem to Madras, 200 miles—the Compr nt offers to convey at 6·75 pies per ton per mile, a total of Rs. 7–0–6 for the distan culated at 1/2*d.* per rupee: this equals ·5*d.* per ton mile. The freight in the United S. nes to about ·436 and

* 1896.

in England to ·650. There seems no immediate probability that the rate would be reduced below the sum named; it is possible, however, that the Madras railway not being well off for freight and the traffic in ore being probably a large one would reduce the cost to ·4*d.* per mile. The more so as coal is now carried on Bengal railways at ·28*d.* per ton mile.

Calculated at this rate (·4*d.* per mile), cost of conveyance to Madras is *s.* 6/8 per ton.

The onward transit to the works in Calcutta must be unquestionably by steamers belonging to the Company; and an arrangement must subsist between the Company and the Madras railways by which Bengal coal is delivered for their consumption.

It is probable that steamers of moderate size, capable of carrying 2,000 tons of cargo, would be found the best for the trade, to lie up to the Madras jetties and to navigate the Mutlah river at all stages of tide. Larger steamers might, however, be found economical.

For purposes of calculation assume a 2,000-ton steam vessel—

	Rs.
Monthly cost of crew	8,000
,, of coal	8,000
,, of sundry stores	1,500
,, of repairs	1,500
,, of port dues	1,000
,, of pilotage	1,200
,, of sundries	800
Total	22,000
Interest and depreciation at 14 per cent. of "block"	5,000
Grand Total	27,000

Assuming 36 voyages per annum and a carriage of 72,000 tons of ore inwards and, say, 15,000 tons of coal outward per ship used, also assuming a profit of Re. 1 per ton of coal up to 150,000 tons landed in Madras, the cost runs out to Rs. 4-8 per ton of ore brought to Calcutta.

This rate would enable best Bengal coal costing on truck at the mine —

say Rs. 2.
at Port, say Rs. 6¼ per ton.
at Madras, say Rs. 10¾ per ton.
to be sold at Rs. 11¾ per ton.

In support of this calculation it is believed that market in Madras would be found as under:—

	Rs.
Madras Railway consumption, tons 50,000, average present cost.	12·39 per ton.
South Indian Railway consumption, tons 65,000, average cost ...	15·03 ,,
Foreign lines and public, tons 35,000, average cost (landed on West coast), English coal	16
Singareni coal on Southern Mahratta Railway	Rs. 10 1 6

It would therefore appear inside the possibilites to place Bengal coal which is to English coal as ·85 : 1·125 at Rs. 11¾, or even more.

Singareni coal would undoubtedly compete close at all events for the foreign line traffic, but this coal is said at present to cost Rs. 6 per ton on truck at pit, and has a long railway lead to nearest foreign railway.

Assuming therefore Rs. 4½ per ton as the cost of carriage of ore from port of Madras to port of Calcutta or 5*s.* 3*d.* per ton, plus handling charges at 6*d.*, the cost of transfer from Salem to Calcutta amounts to 12*s.* 6*d.* * or 22*s.* 4*d.* per 36 cwts.

NOTE.—Should a traffic of 700,000 tons of ore be taken over the Madras line, the ore would no doubt be carried at the same rate as coal in Bengal—say 4 pies per ton mile—and the conveyance of ore would reduce to 10*s.* 7*d.* [1] or 19*s.* ½*d.* per 36 cwts. from Salem to Calcutta.

	s.	*d.*
* Rail	6	8
Handling	0	6
Sea	5	3
Total	12	5

	s.	*d.*
[1] Rail	4	10
Handling	0	6
Sea	5	3
Total	10	7

Coke.—There is no more important problem in the whole question than that of procuring coke, not only of proper quality, but also at a reasonable cost. And it is most unfortunate that at present no coal is worked in India which can be said to be a thoroughly good coking coal.

The approximate constitution of the better known cokes is—

—	Sulphur.	Ash.	Volatile.	Carbon.
Durham	·7	5·0	·92	93·38
English Ordinary	·8	5·45	5·4	88·69
Connelsville, U. S. A.	1·0	10 to 12	..	88
Indian (Damuda)	·51	14·63	10·18	75·19

From this it appears that, though the Indian coke is remarkably free from sulphur, a fact that would have a beneficial effect on the pig iron, it is considerably lower in carbon. It is doubtful whether this sample is the best coke obtainable, but it is probably representative; and its value, other things being equal, is ·83, coke of 90 per cent. carbon being taken as unity.

The cost of raising bituminous coal is as under :—

United States	*s.* 4-2·77
Great Britain	*s.* 4-8·22
India	*s.* 2-4 to 3-7·2

And the cost of coke at the ovens—

United States, average	*s.* 7-9·33
Great Britain ,,	*s.* 8-11·5
India (say)	*s.* 7-8·4

This is made up per ton of coke—

—	Coal.	Cost.	Labour.	Sundry.	Total.
	cwt.				
United States	33·86	6-0	1-6·44	0-2·68	7-9·3
Great Britain	33·02	6-8·25	1-7	0-8	8-11·5
India	38·0	5-8·4	1-0	1-0	7-8·4

The cost of conveyance to the blast furnace is—

	cwts.		
Pitsburgh (Connelsville)	21	@ *s.* 5-3	*s.* 5-6
Cumberland (Durham)	21	@ *s.* 7-3¼	*s.* 7-7¾
India (Girideh) 210 miles at 2⅞ pies per ton mile	25	@ *s.* 5-1	*s.* 7-4½

The ultimate cost at the blast furnace is—

	cwts.	
United States	21	*s.* 13-7·2
Cumberland	20	*s.* 17-0·5
India	25	*s.* 16-11¾

The Connelsville coking coal of Pennsylvania is composed—

Water	1·26
Volatile	30·107
Carbon	57·616
Sulphur	·784
Ash	8·233

English Durham coking coal is—

Volatile	26·00
Carbon	66·21
Sulphur	1·69
Ash	5·96
Water	1·13

And Indian is as under—

	Damuda.	Sanctoria.
Volatile	40·57	40·07
Carbon	48·04	48·48
Ash	11·39	11·45
Sulphur	·3	·3

In the question of hardness, Indian coke fails considerably, although it is at the outset a denser and heavier coke than English, the weight of a cubic foot of each being approximately—

	lb.
English	50·8
Indian	52·3

The crushing weight, which is an important consideration in connection with the size and burden of the blast furnace, is in favour of English coke by nearly 2 to 1. The Indian coke having a poor coherency, to what extent this would be improved by coking on a large scale and on scientific principles cannot at present be determined. The crushing weight actually found per square inch is—

	lb.
English, about	500
Indian „	025

These figures can, however, only be taken as comparative owing to the difficulty of determining when disintegration commences. In the United States a series of experiments showed the weight of coke to vary from 42 to 55 lb. per cubic foot and to crush under 200 to 281 lb. per square inch. Tested by these figures, the performance of Indian coke may be regarded as fair.

It is not improbable that manufactured under best conditions a fair blast furnace coke would be produced, but it would not be safe to count on a less expenditure than 25 cwts. per ton, and even this only under best conditions of ore and flux, both of which may be counted on.

Limestone.—It is rare in European or American blast furnace practice to find the selected site without good limestone in the immediate neighbourhood. The South Stafford and vicinage of Glasgow are, however, exceptions, and in consequence the limestone used at these places cost 5*s.* per ton at the works.

In the States the average cost is per ton—

Labour.	Stores, taxes, &c.	Total cost.
1-1·65	0-2·95	*s.* 1-4·6

In Cumberland the figures are—

Labour.	Stores, taxes, &c.	Total cost.
1-1	0-5⅓	*s.* 1-6⅓

The cost of conveyance reckoned at 10 cwts. per ton of pig is—

	Rs.	A.	P.
United States, 10 cwts., @ *s.* 1-8	0	0	10
Cumberland 10 do. @ *s.* 1-0	0	0	6

The average composition of English (Stainton) stone is—

	Per cent.
Carbonate of lime	95
Magnesium carb	4·2
Silica	·6
Iron, Aluminium, &c.	·3

In the case of the Indian steel works at the selected site, unfortunately limestone does not exist, and the problem will be to place a suitable limestone at the works at a "possible" price.

The landward limestones may be at once neglected, as the cost of carriage would amount, even in the case of the nearest, to over 6*s.* per ton.

It appears, however, that by a well organised system the limestones of the Arakan Coast could be placed at the works at a cost which would make its use feasible. The island of Ramri, distant about 400 miles, is, so far as I am at present aware, the nearest source, but it is more than probable that the hilly ranges of the northern coast of Burma would be found to yield a supply closer at hand.

The Ramri limestone appears to be well suited to the purpose, and is available in inexhaustible quantities. At a place called Bamni, somewhat further south on the same coast, an even better stone is procurable. The analysis of both is given—

	Ramri.	Bamni.
Carbonate	94·4	96·4
Magnesia Carbonate	·5	...
Iron, &c., and metal	5·1	3·1

Of this stone, 10 cwts. per ton may be taken.

The cost of getting and loading of the large quantity required is assumed at 1-0 per ton, proper appliances being provided.

The carriage by water the whole way should not exceed Rs. 3½ per ton, or, say, 4*s.* 1*d.*, total at the furnaces 5*s.* 1*d.*

We have then in comparison—

		Cwts. per ton of pig at 10 cwts.
United States	@ 3*s.* 0·6	1*s.* 6*d.*
Cumberland	@ 2*s.* 10·5	1*s.* 6*d.*
India	@ 5*s.* 1	2-6·5

resultant cost of material.

Examination of the foregoing shows cost of raw material at furnaces to be, including raising and conveying—

	Ore.	Fuel.	Lime.	Total.
United States	1 9 10	0 13 8	0 1 6	2 5 0
Cumberland	0 17 0	0 17 1	0 1 6	1 15 7
India	1 10 9	0 16 11¾	0 2 6½	2 10 3
or see note	1 7 5½	0 16 11¾	0 2 6½	2 6 11¾

NOTE.—Analysis of some of the purer Indian ores is as under, but it is doubtful if any of them would be available in sufficient quantity without admixtures of impure ores, and, so far as I can see at present, the importation of Salem ore is a necessity.

Red hematite from Aguria iron	59·6	Phos.	07·8 Sul. ·08
Iron S... ...om Jheria iron	68·97	„	·03 „ ·06
Iron stone from Purulia	46·5	„	·02 „ ·02
Iron ore from Wun	49·8	„	·04 „ ·04

SECTION IV.

THE LABOUR AND COST, ALSO SUNDRIES.

The mean labour per ton of pig in the United States is given over a very large number of examples at—

	s.	*s.*
Labour	7-11	8-4⅓
Officials, &c.	0-5⅓	

In England the figures are—

	s.	*s.*
Labour	2-9⅔	2-11¾
Officials	0-2¾	

In India the cost of wages was estimated for the Barrakur Steel Works project at—

Rupees 3½ to Rs. 2¾ per ton, including officials, or *s.* 4–1 to 3–0½. But it is scarcely conceivable that in a large works in full employment and using the most modern appliances the cost of labour should exceed that in England. It should even be somewhat less. It may be assumed at—

s. 2-11-¾ per ton of pig iron.

Sundry charges, including stores, repairs and taxes are given at—

States	2-10¼
Britain	1- 9¼

The former figure would be the safest to assume in this country.

SECTION V.

THE ULTIMATE COST OF PIG IRON.

The foregoing shows ultimate cost of pig iron to be—

	Material.	Labour, &c.	Total.
United States	2 5 0	0 11 2¾	2 16 2¾
England	1 15 7	0 4 9	2 0 4
Indian From	2 6 11¾	0 5 10	2 12 9¾
Indian To	2 10 3	0 5 10	2 16 1

From the above it is clear that competition from the States is out of the question. It might, at first sight, be considered that English hematite should easily compete in the States with the local production. But an import duty of 28*s.* per ton, in addition to freight, more than squares the balance, and leaves the American pig iron a clear field for home consumption.

The *selling* prices of English hematite iron are given below :—

	s.		*s.*	
1890	32-0	to	49-4	F. O. B. Cumberland ports.
1891	53-3	„	47-1	
1892	57-6	„	60-0	
1893	46-6	„	44-7	
1896	60-0	„	70-0	

The minimum price may be taken at 45/-, and freight to India is unlikely in any year to fall below 10/-; deliveries ex-ship in Indian ports would be therefore :—

	£.	s.	d.
English hematite (minimum)	2	15	0
Indian „	2 16 1 to 2 12 9		
Calcutta ...	2	12	9
Bombay ...	2	18	9

And in taking the above rates for English pig it must be noted that they are minimum, whereas in India they are average.

A more average comparison would be; India as above—

	£
England	3

Taking one year with another, the rates of delivery of pig iron would apparently allow competition with English pig of similar quality in any port of India, and considerable profit in Eastern India.

A small import duty on English pig would settle the question undoubtedly in favour of Indian pig.

NOTE.—The distances over which the materials have to be carried to works in various sites may be given as under :—

—	Ore.	Fuel.	Limestone.
England, West coast	Adjacent ..	100	Adjacent.
Do. East coast	850 miles ..	200	Do.
States, Pittsburgh	1,000 miles ..	70	Do.
India, Port Canning	1,090 miles ..	240	400

SECTION VI.

THE CAPITAL REQUIRED.

Since an Indian steel works will be within a freight distance of 15*s.* to 20*s.* per ton of the cheapest and most perfectly equipped iron-producing country in the world, and will be moreover weighted by sundry charges due to distances and assembling of materials, it may be premised that it would be utterly futile to commence any commercial concern unless on a large scale and with all the most modern appliances. Any supposition that the works might commence 'small' and grow from its profits would most infallibly produce only failure and disappointment. A bold and complete programme carried out unflinchingly by a powerful Company with ample capital could alone hope for success, and, as has already been stated, it must be on a scale large enough to prevent the formation of other concerns, causing sub-division of orders.

The margin in favour of profitable working is too small to allow of dependence on intermediate agencies, as collieries, shipping agents, iron mines, &c., and the Company must be prepared to own its coal, ore, limestone, ships, &c, as well as the steel works itself and all the appliances connected.

The extent of the plant—concessions to be sought—depends on the outturn; and this again depends, to a great extent, on the possibility of a return trade to the port of Madras for the outward vessels.

Undoubtedly it is a question of serious moment, not only to be limited in the extent to which inward supplies can be profitably carried, but also to have the element of uncertainty as to the extent of the market available for outward freight.

In the foregoing it has been assumed that for every 72,000 tons of inward ore freight 15,000 tons of outward coal could be carried to a maximum of 150,000 tons. The ore supply is thus limited to 720,000 tons annually, equivalent to about 420,000 tons of pig iron.

This places the supply of coke at 525,000 tons annually, and limestone at 210,000 tons annually.

The capital registered of a few of the best known iron and steel companies is appended—

	£
(1) Barrow Hematite Steel Company	1,528,275
(2) John Brown & Co., Sheffield	1,340,000
(3) Bolchow, Vaughan & Co., Middlesborough	3,218,380
(4) Steel Company of Scotland	495,600

Of these, No. 1, in addition to the iron and steel works, own their own iron mines and limestone, but no coal.

No. 2, I believe, own their own coal and limestone, but no ore.

No. 3 are owners of all these, but import their hematite ores from Spain.

No. 4 are simply iron and steel makers, depending on external supply for raw material.

Again No. 1 comprises sixteen blast furnaces, producing a weekly average of 6,000 tons, or, say, 300,000 tons annually.

No. 3 have at their Eston Works seven blast furnaces, with a production of 3,500 tons weekly.

No. 2 have at Grimthorpe three blast furnaces, producing about 1,000 tons of pig weekly.

A few figures from American blast furnace practice will show the enormous difference between an average outturn in England and America, and, though attention has been directed very largely in England lately to the possibility of getting more out per furnace, there are still many experienced managers who hold that the high pressure of blast and rapid wear of linings produced by the over-production in American furnaces does not pay.

At the Edgar Thompson Steel Works are nine furnaces, of which eight are on Bessemer iron, having a total weekly production of 10,850 tons. In 1892 these works produced—

	TONS.
Pig iron	850,000
Bessemer ingots	533,000
„ rails	425,000

The outturn required is therefore about half that of the last-named works and approximately equal in extent to the Barrow Hematite Works, and it may be assumed that a capital of not less than 1½ millions would be necessary to set up the necessary works and to acquire the land and concessions in coal and iron. The purchase of the shipping necessary would be at least £250,000 additional.

In a future note I should propose, if necessary, to detail the plant and its cost, but this seems unnecessary at present. I do not think it at all probable that a less sum than 1¾ millions sterling would suffice to place the works in a position to compete with imported iron and steel, but more precise figures would require enquiry from a directorate authorized and prepared to treat for concessions. The mere detail of cost of plant could be easily put on paper, if necessary.

Order—Mis. No. 127, Revenue, dated 9th January 1897.

Communicated to the Board of Revenue in continuation of Government Order, No. 3697, Revenue, dated 10th September 1896.

(True Extract.)

(Signed) G. STOKES,
Ag. Secretary to Government.

To the Board of Revenue (Land Revenue).

RESOLUTION—No. 24, dated 19th January 1897.

In Government Order, No. 3506, dated 1st September 1896, Government called on the Board to make a careful examination of the figures and arguments contained in Mr. Jeremiah Head's memorandum on the practicability of conducting an iron industry at or near Salem, and report whether, in the Board's opinion, it was desirable to send a consignment of 300 tons of Salem iron ore to England for experimental purposes.

2. Mr. Head concluded his memorandum with a summary of eight conclusions, and in its Proceedings, No. 361, dated 23rd September 1896, the Board pointed out that further discussion was required before the fourth, fifth, sixth and eighth conclusions could be accepted, and called for further information for the purpose.

3. The first and second conclusions are mere statements of fact which call for no discussion.

4. The third conclusion seems to the Board to have been satisfactorily established by Mr. Head.

5. There remains the seventh, which is really the most important of all, but as the Board was not in possession of information which would enable it to deal with the subject when issuing its resolution above quoted, it was left over for consideration later on, and Government was requested to place the papers at the disposal of the press and to invite free discussion. This recommendation was accepted by Government in its Order, No. 666, Revenue, dated 24th November 1896.

6. The Board has now received from Government a letter from the Government of India, forwarding for information a report and letter by Major Mahon, R.A., on the question of working the Salem iron ores successfully, and after perusing these papers, the Board is satisfied that no further discussion need be awaited before deciding that Mr. Head's unfavourable seventh conclusion cannot be accepted, without a practical experiment on a large scale. If by such an experiment it is shown that the Salem magnetite ore which is admittedly of exceptional purity, can produce when smelted with coke made from Barrakur coal, a Bessemer iron which can compete as regards quality with imported hematite, it is probable that the cost of making it locally will be far from prohibitive.

7. The conclusion in question was stated by Mr. Head in the following terms:—

"That the substitution for charcoal of Singareni coal at Kanjamalai or at Madras, or of Barrakur coal at the latter place, would not improve the chances of success."

8. In its former resolution quoted above, the Board has given *primâ facie* reasons for believing that charcoal iron could be manufactured at Kanjamalai at a much lower figure than that assumed by Mr. Head, but as pointed out by Major Mahon, charcoal fuel can never form anything but a small adjunct to that required for an iron industry for general trade purposes, and whatever may be the conclusion eventually arrived at with reference to the manufacture of iron at Kanjamalai with charcoal fuel, it is necessary to investigate independently the practicability of working Indian iron with Indian coke.

9. From the information available it would seem that Singareni coal will not coke, and investigation may therefore for the present be limited to the practicability of working Salem (or perhaps Kurnool) ore with Barrakur coke.

10. Some of Major Mahon's figures are, perhaps, open to criticism. For instance, it is not certain that the Madras Railway could carry iron ore at 4 pies per ton, but, on the other hand, it is probable that ore could be mined at Kanjamalai cheaper than at Bilbao, and, on the whole, the Board sees no reason to reject the estimate of Rs. 45–15–1 given by Major Mahon as the cost of putting Salem iron on the Calcutta market. His criticisms on some of Mr. Head's figures are very similar to those made in Board's Proceedings, No. 361, dated 23rd September 1896.

11. The rate of exchange assumed by Major Mahon (1*s.* 2*d.*) is probably more favourable than can be relied on in future, but even if it be taken at 1*s.* 4*d.*—a rate which is never likely to be materially exceeded under the present currency laws—it seems to the Board that a good *primâ facie* case has been made out for the assumption that an Indian iron, suitable for all ordinary steel-making, can be produced at a rate which will compare favourably with that at which hematite iron can be imported.

12. The matter being one of such momentous importance to the well-being of the country, the Board considers that there should not be any hesitation about the immediate adoption of Major Mahon's recommendation that 300 tons of Salem iron ore and 600 tons of Bengal coal, of a quality equal to Sanctoria coal, should be at once ordered to

be despatched to Messrs. Bolchow, Vaughan & Co. of Middlesborough-on-Tees, in view to an experimental manufacture, which will enable a definite estimate to be made of the value of the pig iron which can be made from Indian ore with Indian coke and the cost at which it can be made. It is observed that the Secretary of State in his letter of the 2nd July 1896, No. 10, has accepted Sir Frederick Abel's opinion that any experiment of the kind may well be entrusted to that firm which has expressed its readiness to undertake it. With reference to the possible need for the admixture of a proportion of an aluminous ore, referred to at the bottom of page 7, it might be as well also to send home a certain quantity of a suitable aluminous Indian ore. Major Mahon might be asked for advice on the point.

13. The Agent of the Madras Railway will be asked to favour the Board with a report as to the lowest rate at which Salem iron ore could be conveyed to Madras in very large quantities. The amount taken by Mr. Head as sufficient for working at a minimum railway freight is 500,000 tons *per annum*. So high a figure need not be considered for the present, but it may be remarked that this would not produce much more than one-half of Major Mahon's estimate of the annual demand in eastern countries which could be supplied from successful local iron works. It is presumed that the rate of 6 pies per ton per mile given in the Agent's letter of the 12th November 1896, No. 8579/11163, referred only to the small quantities under discussion in the Board's Proceedings to which his letter was a reply.

14. In discussing the question of the most advantageous site for iron works, Major Mahon expresses himself in favour of the neighbourhood of Calcutta, but on this point a final decision can probably be arrived at only after receipt of the results of the proposed experimental manufacture, without which information it is impossible to make definite estimates of the different items of cost.

15. If the Kurnool hematite iron ore, with regard to which Government has ordered an investigation in Government Order, Mis. No. 4864, dated 30th November 1896, is found to be satisfactory both as regards quantity and quality, it is possible that a suitable site would be found at Bezwada, which, after the completion of the East Coast Railway, will be an important convergent railway site, with short canal communication to the port of Masulipatam. To works on this site it would also probably be possible to supply limestone flux from the Palnad taluk more cheaply than it could be brought to Calcutta from the coast of Arakan.

(True Copy and Extract.)

Secretary.

To the Secretary to Government, Revenue Department.
" Collectors of Salem and Kurnool.
" Agent and Manager, Madras Railway.
" Settlement Department.
" Forest Branch.
" Trades Association.
" Secretary, Chamber of Commerce.
" Superintendent, Government Central Museum.

Exd. T. K. Narayana Aiyangar.

24

REVENUE DEPARTMENT.

1897.

Board of Revenue

(Land Revenue),

MADRAS.

Printed February th.

Proceedings, No. 24, 19*th January* 1897.

Passing remarks on Government Order, Revenue Department, communicating letter from the Government of India forwarding, for information, a report and letter by Major Mahon, R.A., on the question of working the Salem iron ores successfully, and recommending to Government that 300 tons of Salem iron ore and 600 tons of Bengal coal be at once ordered to be despatched to Messrs. Bolchow, Vaughan & Co. of Middlesborough-on-Tees for experimental purposes.

Exploitation of Salem Iron Ores. 25

Read Current No. 1428 of 1897.

Hon'ble Mr. Rose C.I.E.
H.E. the Governor

Printed soon

25/3/97

27.3.97

Issue Warrants

Order No. 221 of 30-3-97.

The Govt. agrees with the Board in considering that it is desirable to despatch to Messrs. Bolchow, Vaughan and Co. of Middlesborough-on-Tees a consignment of Salem ore and Bengal coal for the purpose of determining by actual experiment the value and cost of production of pig-iron made from Indian ore with Indian coke. The Govt. of India will accordingly be addressed on the subject and the Board of Revenue will be requested in the meantime to ascertain the cost of collecting the necessary quantity of iron ore and conveying it to Middlesborough, and further to make such arrangements as may be practicable in order to secure the early despatch of the consignment in the event of the proposal being approved by the Govt. of India.

C. 23/3/97

DA 19.3.97

26

To the Board of Revenue, L. R.

D

Letter No. 222.

To the Secretary to the Govt. of India,

Department of Revenue and Agriculture.

Sir,-

With advertence to Mr. Sly's letter No. 2285/36-4, dated 26th August 1896, regarding the iron ores of the Salem District and the possibility of establishing an indigenous iron industry, and in continuation of my letter No. 127A, dated 9th January 1897, regarding the same subject, I am directed to forward a copy of the Proceedings of this Govt. No. 221 dated 30-3-97 from which it will be seen that H.E. the Governor in Council deems it expedient to accept the recommendation of Major R. H. Mahon R. A. to send a consignment of Salem iron ore and Bengal coal to Messrs. Bolchow, Vaughan & Co of Middlesborough on Tees, for the purpose of determining by experimental manufacture the value and cost of production of pig-iron made from Indian ore with Indian coke. The quantity of iron ore which it is proposed to despatch is 300 tons being the amount described in Sir Frederic Abel's letter of the 30th January 1896 as constituting a proper and sufficient charge for a blast furnace. If Major Mahon's recommendation be accepted this should be accompanied by a consignment of 600 tons of Bengal coal of a quality equal to the Sanctoria coal. With reference to the remarks contained in section III of that officer's report on the manufacture of iron and steel in India, it would also seem desirable to make arrangements for the collection and despatch of a suitable quantity of aluminous ore of Indian origin; and I am therefore to request that with the permission of His Excellency the Governor-General in Coun-

27

¤ Enclosure No. 3 to the Secretary of State's Despatch to the Madras Govt. d/ 2nd July 1896, No. 10 Revenue.

Flagged A

cil Major Mahon may be asked for advice on the point. Should the proposals in this letter meet with the approval of the Government of India I am to say that H. E. the Governor in Council ~~hopes that~~ probably he will be in a position to despatch the necessary consignment of iron ore at a very early date, and, as the subject is one of considerable importance I am therefore to request the favour of an early reply to this communication.

20.3.97

50/2

1897.

DEPARTMENT OF REVENUE AND AGRICULTURE.

From *The Government of Fort St. George.*

Recd. } 1897. *Enclosures*

Regd. } *Spare copies*

Letter, No. 222, 30th March 1897.

MARCH.

STATING that this Government deems it expedient to accept the recommendation of Major R. H. Mahon, R.A., to send a consignment of Salem iron ore and Bengal coal to Messrs. Bolchow, Vaughan and Co. of Middlesborough-on-Tees, for the purpose of determining, by experimental manufacture, the value and cost of production of pig-iron made from Indian ore with Indian coke.

No. 222, Revenue, 30th March 1897.

DF

REVENUE DEPARTMENT.

The Hon'ble Mr. G. STOKES, I.C.S.,
Acting Secretary to the Government of Madras,

To

The SECRETARY to the GOVERNMENT of INDIA,
Department of Revenue and Agriculture.

Dated Fort St. George, 30th March 1897.

Sir,

With advertence to Mr. Sly's letter No. 2283—36-4, dated 26th August 1896, regarding the iron ores of the Salem district and the possibility of establishing an indigenous iron industry, and in continuation of my letter No. 127-A, dated 9th January 1897, regarding the same subject, I am directed to forward a copy of the Proceedings of this Government, No. 221, dated 30th March 1897, from which it will be seen that His Excellency the Governor in Council deems it expedient to accept the recommendation of Major R. H. Mahon, R.A., to send a consignment of Salem iron ore and Bengal coal to Messrs. Bolchow, Vaughan and Co. of Middlesborough-on-Tees, for the purpose of determining, by experimental manufacture, the value and cost of production of pig-iron made from Indian ore with Indian coke. The quantity of iron ore which it is proposed to despatch is 300 tons, being the amount described in Sir Frederick Abel's letter* of the 20th May 1896, as constituting a proper and sufficient charge for a blast furnace. If Major Mahon's recommendation be accepted, this should be accompanied by a consignment of 600 tons of Bengal coal of a quality equal to the Sanctoria coal. With reference to the remarks contained in section III of that officer's "Report on the manufacture of Iron and Steel in India," it would also seem desirable to make arrangements for the collection and despatch of a suitable quantity of aluminous ore of Indian origin; and I am therefore to request that, with the permission of His Excellency the Governor-General in Council, Major Mahon may be asked for advice on the point. Should the proposals in this letter meet with the approval of the Government of India, I am to say that His Excellency the Governor in Council will probably be in a position to despatch the necessary consignment of iron ore at a very early date, and, as the subject is one of considerable importance, I am therefore to request the favour of an early reply to this communication.

Miscellaneous.

* Enclosure No. 3 to the Secretary of State's Despatch to the Madras Government, dated 2nd July 1896, No. 10, Revenue.

I have the honour to be,
Sir,
Your most obedient servant,

(Signed) G. STOKES,
Ag. Secretary to Government.

Exd. Shaik Karim.

50 Copies.

Government (1897) of Madras.

REVENUE.

Recd. } 1897. Enclosures
Regd. } Spare copies

G.O., No. 221, 30th March 1897.

MARCH.

Pig-iron.

Agreeing with the Board of Revenue in considering that it is desirable to despatch to Messrs. Bolchow, Vaughan and Co. of Middlesborough-on-Tees, a consignment of Salem ore and Bengal coal for the purpose of determining, by actual experiment, the value and cost of production of — made from Indian ore with Indian coke.

GOVERNMENT OF MADRAS.

REVENUE DEPARTMENT.

Read—the following Proceedings of the Board of Revenue (Land Revenue), No. dated 19th January 1897:—

Read—the following Government Order, Mis. No. 127, Revenue, dated 9th January 1897:—

Read—the following letter from the Government of India, Department of Revenue and Agriculture, dated 3rd December 1896, No. 4371/36-9:—

In continuation of my letter, No. 2283, dated 26th August 1896, I am directed to forward, for the information of His Excellency the Governor, a copy of Military Department endorsement, No. 4915-D., dated 5th October 1896 and enclosures, being a report and letter by Major R. H. Mahon, R.A., on the question of working the Salem iron ores successfully. In this connection I am to refer to my letter, No. 2283, dated the 26th August 1896, to which a reply is still awaited.

Enclosure No.1.

Memorandum from Major E. G. BARROW, Officiating Deputy Secretary to the Gover. ment of India, Military Department, to the Secretary to the Government of India, dated Simla, 5th October 1896, No. 4915-D.

Transferred * for favour of such action as may be considered necessary.

* From the Director-General of Ordnance in India, No. 2042-E., dated 21st September 1896, and enclosures.

Enclosure No. 2.

From Major-General A. WALKER, Director-General of Ordnance in India, to the Secretary to the Government of India, Military Department, dated Simla, the 21st September 1896, No. 2042-E.

With reference to Military Department Memorandum, No. 4287-D., dated 28th August 1896, forwarding a Despatch from Her Majesty's Secretary of State, No. 75, dated 2nd July 1896, for record, I have the honour to submit a report and letter by Major R. H. Mahon, R.A., Superintendent, Foundry and Shell Factory, Cossipore, on the question of working the Salem iron ores successfully. The report and letter might be sent to the Madras Government and the Secretary of State for India. The day must come when these Salem ores will be put on the market, and any capitalist who may undertake the manufacture of iron and steel from these ores will, in my opinion, reap a rich harvest.

Enclosure No. 3.

From Major R. H. MAHON, R.A., Superintendent, Foundry and Shell Factory, Cossipore, dated Simla, the 17th September 1896.

I have read with interest the papers enclosed under the Right Honourable the Secretary of State's Revenue Despatch † No. 75, dated 2nd July 1896.

† *F. 36, S. 3.*

Mr. Head has dealt very effectively with a scheme having for its basis the export of Indian ores to England, but it would not appear that any proposal to export ores having a 200-mile railway lead, *plus* a 7,000-mile sea lead, by way of so expensive a route as the Suez Canal, would have any chance of success against Spanish ores quarried on the coast with 1,000 miles of sea lead, closely competing shipping companies and more suitable ore, or against Swedish ores, with rather greater leads.

…l to the statement made by Mr. Head that even should the S…anish Govern-…t duty on ores, which is said to be probable as a result of recent events in …ediate result would be to bring first other European ores, and then American ores, …ion, and to increase the output of the Cleveland mines. It is not at present within …The …abilities that any state of the European markets would enable Indian ore to …

…s equally futile to expect an iron industry, in the proper acceptation of the term, to grow from any scheme for using charcoal fuel only. Iron made by such means is adapted for special purposes and commands a special price, but for railway work and ship building, as well as for general trade purposes upon which it is indispensable that a country intending to foster its iron manufactures should rely, such iron would be altogether unsuitable. In no country and under no conceivable circumstances could charcoal fuel form anything but a small adjunct to that required for the iron industry proper.

It may be laid down as an axiom that entry into the iron and steel trade proper, without reference to special irons or steels, necessitates plant of the most modern description worked on an extensive scale. It may be of interest to note that the new blast furnaces of the Edgar-Thomson works are turning out 11,000 tons of pig iron monthly per furnace, while English practice, which has a strong tendency to follow the American, at present is best represented at Dowlais with 1,250 tons per week per furnace. And the question may be asked, would it be possible to compete with such outturns as these, having the reduction in general charges consequent on large business, with any outturn necessarily limited by the small supply of fuel available, 5,000 tons per annum as stated by the author, costing Rs. 24 per ton, as against about Rs. 14 or less, the value of the fuel in England and America. If a demand for tin plates, rolled sheets for pens, steel for cutlery, special steels for tools, and pig iron for special castings were likely to arise in India, the erection of a charcoal furnace might be justified, but to commence with such, leaving the great industries, which absorb $\frac{99}{100}$ lb. of the iron and steel of the world, untouched, would be the reverse of business-like.

Mr. Head dismisses the subject of the manufacture of iron with coke fuel in a few lines. But I submit that a further and closer attention on lines of more accurate local knowledge would repay the labour, and on this subject there are already valuable papers contributed by Mr. Gilchrist, F.R.S., and Mr. Mannaberg, a perusal of which, even though not dealing directly with Salem ores, would lead to useful results.

In regard to the detail of Mr. Head's report, I observe, for your information, that the cost of "collecting, mining, quarrying and picking" at Rs. 1¼ per ton (page 8—9 in Board's Proceedings, No. 361, dated 23rd September 1896, table No. 2) is probably too low. In my own paper on the subject I have taken 4*s.* per ton (= Rs. 3-4). I think Mr. Head is misled by the *present* cost of picking *surface* deposits, quarrying must, however, be soon resorted to which will be more costly. My figures are taken from average results at Bilbao mines, the working of which resembles that which will be used at Salem. On the other hand, 1*s.* per ton taken by me is an ample charge for loading, if proper appliances are arranged.

Mr. Head assumes a rate of 3 pies per ton mile, Salem, Madras: this is decidedly too low. At present the rate would be 6¾ pies. But in my paper I have taken 3·9, say, 4 pies per ton mile, this being the coal rate in Bengal. It is not probable that 3 pies (= ·22*d.*) could ever be attained.

With proper appliances I think loading at Madras may be reduced to 6*d.*, say, 7 annas per ton.

Probably Government would be content with a smaller seigniorage than 6 annas per ton assumed by Mr. Head. I have neglected this item, and I make the cost of Salem ore f. o. b., Madras 9*s.* 4*d.* per ton against 8*s.* 0½*d.* I think the higher figure is the more correct.

In the cost of charcoal Mr Head assumes Rs. 24 per ton which is not below the mark, and one ton as required per ton of iron: in his estimate, however, on page 24—21 in Board's Proceedings, No. 361, dated 23rd September 1896, clauses "*b*" and "*e*" he is certainly wrong in assuming 20 cwt. of Indian coke as sufficient per ton of pig iron. Nor is the cost per ton of Barrakur coke delivered in Madras correct.

In the matter of labour (table 11, page 18—17 in Board's Proceedings, No 361, dated 23rd September 1896), Mr. Head has adopted so high a figure, Rs. 17, that I think he must have followed Mr. Maylor's figures without full consideration In 1858 the cost in labour appears to have amounted to Rs. 15 per ton (page 12, table No. 6), but if the enterprise is to be successful at all, the method of working would bear so little resemblance to the working in 1858 that the labour expended at that time must be reconsidered.

The most recent statistics (1896) show labour, including everything in connection with the blast furnace from unloading the ores to loading up the pig iron (excluding establishment charges), to be 24 pence per ton as a minimum rising to 30 pence for hematite iron, whilst establishment charges vary from 3 pence to 4 pence extra in England. Rs. 2¾ to Rs. 3½ was the estimate of Mr. Mannaberg at Barrakur (see also page 15, section IV of my report). Taking the highest figures (for England) we have 2*s.* 10*d.* = Rs. 2-4 against Rs. 21 for wages, salaries and establishment estimated by Mr. Head! I can see no reason why the English price should be *exceeded*.

If the plant is planned on a suitable scale, one might, indeed, expect the re
refer to coke-worked furnaces. I have no statistics before me here relating t
it is impossible to imagine such a difference to exist. Mr. Head's high estim
be governed by the small scale of the plant he had in view.

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The item "agent at port" Rs.
unnecessary and should be included i
lishment charges.

Page 18 (17 in Board's Proceedings, No. 361, dated 23rd September 1896).

The item "stores and renewals" should not exceed 3*s.* (see bottom of page 15, my paper).

In the States this item is 2*s.* 10½*d.* = say, Rs. 2–6.

In several points I observe that Mr. Head's calculations and opinions confirm what I wrote in 1894. In this paper I have made some corrections as I have found the railway lead, Salem to Madras, was wrongly stated at 240 miles. I have also added capital charges (wrongly included at first in general charges) in connection with the freight steamers, thus raising the cost of carriage per ton from Rs. 3 to Rs. 4½, and it may be noted that this rate only takes into consideration a small part of the utility of steamers on the outward voyage.

I append a statement in the form of Mr. Head's table 11, page 18—17 in Board's Proceedings, No. 361, dated 23rd September 1896, applicable to the Calcutta site—

	Rs.	A.	P.
Iron ore f. o. b., Madras, 1 ton 16 cwt. @ Rs. 8	14	6	5
Madras to Calcutta @ Rs. 4½ per ton	8	1	7
Coke fuel, 25 cwt. @ Rs. 13 per ton	16	4	0
Limestones, 10 cwt. @ Rs. 4-6-4	2	3	2
Stores renewals and sundries	2	9	6
Wages, salaries, establishment	2	6	5
Total ...	45	15	1

or £2-13-6 (see also page 15, Section V, my paper). Suitable hematite pig iron could not, at the present moment, be landed under £3–5–0.

Reviewing my paper again after a lapse of 2½ years, I am unable to find serious flaws in it, and the advantage derived from reading and criticising Mr. Head's report tends to confirm my opinion that, properly conducted and on a suitable scale, an iron work at Calcutta should be able to produce hematite iron suitable for all ordinary steel making at a price between £2–12–0 and £2–16–0 per ton.

The energy and enterprise that would be required in the manager of a concern, mining its own ore, fuel and fluxes, transforming the fuel to coke on approved principles, carrying and transferring with the latest appliances, and finally smelting, converting and rolling the products to rails and sections on a scale suitable to the demand, opens up a prospect to a capable individual which might excite enthusiasm in the least sanguine.

I have only to add that the proposal to send 300 tons of Salem ore to Messrs. Balchow, Vaughan & Co. should, I think, have the warmest support. If, after experimenting with the ore, that firm could be induced to take up the question of local manufacture either with or without Government assistance or guarantee, no more competent or enterprising iron-masters could be found, they having wide experience not only in acid steel making but also in the basio processes which would be applicable to the ores of Bengal.

P.S.—If the despatch of 300 tons of ore is approved, I recommend that 600 tons of Bengal coal, of a quality equal to the Sanctoria coal, may also be despatched to Messrs. Balchow, Vaughan, to be coked by them on principles most suitable to the coal and used in the reductions of the ore. By such means only can a reliable forecast of the quantity of fuel and flux be made, and further information of value in reference to the suitable size of blast furnace obtained.

MANUFACTURE OF IRON AND STEEL IN INDIA.

REPORT BY MAJOR MAHON, R.A.,

SUPERINTENDENT, FOUNDRY AND SHELL FACTORY, COSSIPORE.

DATED COSSIPORE THE 5TH MAY 1894.

		Page as given in the original.	Page as now printed.
SECTION I.	—THE QUESTION OF SITE	1—4	7—10
" II.	—EXTENT AND NATURE OF TRADE	4,5	10
" III.	—NATURE AND COST OF RAW MATERIAL	5—10	10—15
" IV.	—LABOUR AND COST, ALSO TOTAL COST	10	15
" V.	—THE ULTIMATE COST OF PIG IRON	10, 11	15—16
" VI.	—THE CAPITAL REQUIRED	11, 12	16—17

NOTE.—I have selected throughout for general comparison the cost of manufacturing Hematite iron in the West of England, as exponent of the best English practice; and at Pittsburgh, United States of America, as exponent of the best American practice.

NOTE.—The figures representing price are in most cases in shillings and pence, exchange being taken at 1*s.* 2*d.*

If the plant is planned on a suitable scale, one might, indeed, expect the verse. My figures refer to coke-worked furnaces. I have no statistics before me here relating to charcoal iron, but it is impossible to imagine such a difference to exist. Mr. Head's high estimate may, perhaps, be governed by the small scale of the plant he had in view.

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Reviewing my paper again after a lapse of 2½ years, I am unable to find serious flaws in it, and the advantage derived from reading and criticising Mr. Head's report tends to confirm my opinion that, properly conducted and on a suitable scale, an iron work at Calcutta should be able to produce hematite iron suitable for all ordinary steel making at a price between £2-12-0 and £2-16-0 per ton.

The energy and enterprise that would be required in the manager of a concern, mining its own ore, fuel and fluxes, transforming the fuel to coke on approved principles, carrying and transferring with the latest appliances, and finally smelting, converting and rolling the products to rails and sections on a scale suitable to the demand, opens up a prospect to a capable individual which might excite enthusiasm in the least sanguine.

I have only to add that the proposal to send 300 tons of Salem ore to Messrs. Balchow, Vaughan & Co. should, I think, have the warmest support. If, after experimenting with the ore, that firm could be induced to take up the question of local manufacture either with or without Government assistance or guarantee, no more competent or enterprising iron-masters could be found, they having wide experience not only in acid steel making but also in the basic processes which would be applicable to the ores of Bengal.

P.S.—If the despatch of 300 tons of ore is approved, I recommend that 600 tons of Bengal coal, of a quality equal to the Sanctoria coal, may also be despatched to Messrs. Balchow, Vaughan, to be coked by them on principles most suitable to the coal and used in the reductions of the ore. By such means only can a reliable forecast of the quantity of fuel and flux be made, and further information of value in reference to the suitable size of blast furnace obtained.

MANUFACTURE OF IRON AND STEEL IN INDIA.

REPORT BY MAJOR MAHON, R.A.,

SUPERINTENDENT, FOUNDRY AND SHELL FACTORY, COSSIPORE.

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		Page as given in the original.	Page as now printed.
SECTION I.	—The question of site	1—4	7—10
" II.	—Extent and nature of trade	4,5	10
" III.	—Nature and cost of raw material	5—10	10—15
" IV.	—Labour and cost, also total cost	10	15
" V.	—The ultimate cost of pig iron	10, 11	15—16
" VI.	—The capital required	11, 12	16—17

Note.—I have selected throughout for general comparison the cost of manufacturing Hematite iron in the West of England, as exponent of the best English practice; and at Pittsburgh, United States of America, as exponent of the best American practice.

Note.—The figures representing price are in most cases in shillings and pence, exchange being taken at 1*s.* 2*d.*

Enclosure No. 4.

SECTION I.

THE QUESTION OF SITE.

In this country I regard contiguity to the seaboard practically essential. Not only is it improbable that juxtaposition of ores, fuel and flux is likely to be found in any one place of a suitable nature for Bessemer * work, but it is improbable that any successful works operated on a large scale could work profitably at an inland site in this country, at least until the lapse of a great number c when competition between different railways, canals, or other means of transit ensure low freight.

It may be argued that carriage landward may be ultimately necessary, but it must be remembered that in this country no landward position is central to a large area of supply, and when the radius, within which profitable freight is possible, is satisfied, production must be checked by the supplies coming from more favourably situated sources. A seaward site on the contrary is enabled to tap landward communications from many points, as also to open up new communications with other countries.

On the other hand, the fact must not be lost sight of that it takes from 3½ to 5 tons of material to turn out one ton of pig iron, depending on the richness of the material used; and one of the main questions in deciding on site is the cost of conveyance of raw material to the works *versus* the cost of conveying finished material from the works. But this is not the only question; proximity of suitable labour and healthiness is an important point, especially in this country.

Examination of existing instances will help a decision.

In Great Britain the most favourably situated districts—the Black Band Field of Scotland and the Cleveland districts of the east coast of England—are perhaps the most notable instances † of works so situated as to draw all their material from the immediate neighbourhood, but in neither of these is the ore suitable for the production of Bessemer iron, and in both, for this purpose, importation either of ore or fuel is necessary.

The main areas of the occurrence of Bessemer ores are—

The Bilbao District, Northern Spain,
The Island of Elba,
The Cumberland and North Lancashire Districts,
The Lake Superior region in America,
In India, the Salem District.

See also note at the end of Section III.

At Bilbao the small works of Messrs. Ybarra are worked almost entirely from coke imported from the Durham District about 1,000 miles distant, while the greater part of the ore raised is exported to English works there to be worked in greater or less contiguity to the fuel.

In Cumberland and Lancashire the ores are worked entirely with coke brought from the Durham Fields.

In America the greater part of the ores are conveyed distances of 650 to 1,000 miles to the works situated in Pennsylvania and the North Eastern States, and worked with coke from the Connelsville coal.

We have here instances in which ore is brought to fuel and fuel to ore; the site in each case being governed by proximity to one or other, and also very largely by its proximity to a trading centre. It is, however, evidently possible, and is in fact frequently the case, that a work may be situated at a place intermediate between the ore and fuel.

In England the great iron work centres are on the Tyne, Tees, Clyde, Mersey, or at seaports, as Cardiff, Newport, Swansea,—or at the centres of a network of railways as Sheffield. In America the neighbourhood of Pittsburgh and Chicago with their immense convergence of railways are instances of inland situations.

In India the want of a convergent railway site practically reduces the question to a choice of seaboard or at least water approached situations. And in this respect the coast of the Bay of Bengal appears to offer the greatest advantages.

Some statistics on the cost of assembling materials at different centres will be useful.

---

* By Bessemer ore or Bessemer iron is meant ore fit for steel making and containing a maximum of ·04 per cent. phosphorous.

† Almost the only instances.

United States, distances of 101=150 miles	
Do. distances of 630 miles	
United Kingdom, distances of 101=150	
India, distances of 240 miles	
United States, distances of 1,000 miles, partly by rail, partly by water	
Europe, Spanish coast to Tyne	·128
India, Madras coast to Calcutta	·07
India, Salem to Calcutta	† ·07
	·11

the total distance being about 1,090 miles from Salem to Calcutta.

At Pittsburgh and the West of England, both using hematite ore, the cost of production is as under:—

	Quantity used per ton of pig iron.		s. d.	s. d.
Prime cost of ore at mine	35·8 cwt.	@	6-6	11-7¼
Coke	21·0 „	@	7-9·33	8-2
Limestones	10 „	@	1-4·5	0-8¼
Conveyance of material—				
	to Pittsburgh.			
Ores	@	10-1⅓		18-2
Coke	@	5-3		5-6
Limestone	@	1-8		0-10
Labour				5-9
Other charges				3-0
				2-13-9

West coast of England—

			£ s. d.
Prime cost of Ore	37-1 cwts.	@ 8-0	0 14 10
	Coke 21 „	@ 8-11½	0 9 5
	Lime 10 „	@ 1-10½	0 1 0
Conveyance	Ore @ 1-2		0 2 2
	Coke @ 7-3¼		0 7 8
	Lime @ 1-0		0 0 6
	Labour		0 2 9
	Other charges		0 2 0
		Total	2 0 4

And similarly examined approximately for India (*established near Calcutta*).

			£ s. d.
Prime cost	Ore 36 cwts.	@ 4-8	0 8 5
„	Coke 25 „	@ 7-8½	0 9 7½
„	Lime 10 „	@ 1-0	0 0 6
	s. d.		
Conveyance	Ore @ 12-5		1 2 4
	Coke @ 5-1		0 7 4
	Lime @ 4-1		0 2 0½
	Labour		0 2 0
	Other charges		0 2 6
		Total	2 15 9

If the steel works were established at Girideh, the cost might be shown to be considerably higher.

In other words, to establish the works near the fuel and convey the other material thither appears to be more costly than an intermediate site.

These figures show that the cost of conveyance and the distances over which the raw material is brought do not greatly differ in this country and the United States. It also shows that the intermediate position of Calcutta would be more profitable than the immediate neighbourhood of the coal. While a very important item referred to more extensively below renders the neighbourhood of Calcutta preferable to the neighbourhood of the ore, *i.e.*, Salem, Madras. (But see note on Salem.)

* Exchange 1/-=1 R., calculated from 6·75 pies per ton mile. † See calculation of freight.

1s-2d.

…eptible of reduction are—

…rime cost of coke.

…e conveyance of ore.

…esent nor being reduced by the coking and coal works being within the same ownership

The works; and the latter by the vessels, especially built for the trade, being owned by …pany for the *export of coal to Madras* and the import of ore on the return journey. There … doubt but that the profits on the export of coal to Madras would go far to reduce the cost of bringing up the ores on the return journey. And the advantage of being able to carry an item of such prime necessity on the outward voyage is the deciding factor in the site of the Indian steel works. I cannot suggest any other site from which coal could be cheaply shipped to Madras on the outward voyages.

Taking the foregoing into consideration, I believe the neighbourhood of Calcutta is the most advantageous situation. And it would appear probable that the advantages offered by …anning, and the probability that, together with its existing appliances, it would be obtained advantageously, leads me to point to it as the best site.

The only other place on the Bay of Bengal which could apparently compete would be the neighbourhood of Cocanada, working the Singareni Fields, but the want of facilities for transit and the fact that all the district is a century behind the Bengal area leads me to neglect it in favour of Calcutta.

NOTE.—The neighbourhood of Masulipatam on the Madras coast is a site which would have advantages which should certainly be considered.

It has practically the same market as the Calcutta site.

Could be connected by rail with the Singareni Field.

The difficulties and expenses can hardly, however, be calculated, as the east coast ports are closed frequently during monsoon weather. The country is but little opened up, and the coking quality of Singareni coal is doubtful.

The question should, however, be carefully gone into before pitching on the Calcutta site, of which these notes take detailed notice.

NOTE ON THE SALEM SITE.

The cost of the assembled materials appears to be—

			£ s. d.
Ore @	4 6	per ton	0 8 1½
Lime @	1 6	„ „	0 0 9
Coke (as under)			1 15 10
		Total ..	2 4 8½

Coke.—25 cwts. at Calcutta	0 16 10
Calcutta to Madras	0 5 0
Madras to Salem	0 12 0
Handling 3 times	0 2 0
Total ..	1 15 10

The resultant cost of the pig at Salem is then—	
Material ..	2 4 8½
Labour, &c.	0 5 10
Total ..	2 10 6½

But as 90 per cent. of the finished product would require transportation to the coast, an additional 10 shillings must be added before it can be compared with the cost of the pig at the Calcutta site: the result is £3-0-6½ and is unfavourable.

But the question is evidently one of the price of …, and calculation shows that, if the price can be reduced to a total of 28 shillings per ton of pig iron, the Sale… would not be impossible, although advantage would still lie with Calcutta as a trading centre with facilities for …ment.

To the extent, however, that it rem… uncertain whether a coking coal will be ultimately procured in the neighbourhood of Salem, the establishment of … works at Calcutta contains an element of hasard. The point is one regarding which the promoters should well satisfy themselves.

ADDITIONAL NOTE ON SINGARENI.

According to the terms of the scheme put forward for establishing steel works in the neighbourhood of the Singareni Fields, the conveyance cost of the finished product is put at—

	s. d.
From works to Gódávari, 182 miles by rail, say	4 3
Gódávari to Cocanada, 50 miles by boat, say including handling on shipboard in harbour.	4 1

The pig iron being estimated to cost as under:—

			Rs. A. P.
40 cwts.	iron stone @	Rs. 3 per ton	6 0 0
40 „	coal @	„ 4 „ „	8 0 0
15 „	limestone @	„ 2 „ „	1 8 0
	Labour		2 0 0
	Stores		1 4 0
	Office		1 4 0
		Total ..	20 0 0

or at 1/2 say £1-3-4
or at coast say £1-11-8

In this scheme it is proposed to work on the anthracitic method—that is, using raw co[illegible] an anthracitic nature instead of coke.

This method has been used with some success in America, in the neighbourhood of the w[illegible]nown Pennsylvanian anthracite which contains from 87·127 to 90·685 of fixed carbon, but the mechanical difficulties met with have caused a large reduction of the output of iron made in this way.

In 1880 the output of iron smelted by anthracite was 1,807,651 tons; in 1890 this had fallen to 2,128 ; it is also stated that in the Northern States only one furnace continued on this method in 1889 out of 66 for 97

Moreover, it is in the last degree unlikely that the Singareni coal contains anything near the same quantity of carbon that is contained in the anthracite alluded to.

For this reason it may be most reasonably assumed that coke* will have to be brought from Bengal at an average freight, including conveyance, of not less than 30/ per ton, or for 25 cwts. say 37½, which would bring up the price of the finished product on the coast to £3–1–6, a price which would not compete with the rates at the proposed site.

SECTION II.

THE EXTENT AND NATURE OF TRADE.

In this country, as in most others, the railways must be the main support of any steel and iron works, and the growing tendency of the Great Indian Railways to be their own manufacturers is a factor in the question that must not be neglected. In England the railway directorate is very largely composed of men interested in the production of manufactured iron and steel, and this has resulted in but a small amount of manufacture being undertaken by the railways themselves; in at least one railway (the Midland) the interest against steel-making was so strong as to cause its abandonment even after erection of furnaces. In India no such interest is likely to come into play, and there is nothing to prevent the Railway Companies from competing against any individual establishment which might be started.

The best means to take is to prepare for manufacture on a scale and with a completeness of apparatus which would enable the material to be turned out cheaper than it could be made by the Railway Company or imported. An instance of the possibility in securing trade as a monopoly by the reduction of cost of outturn is given by the results of the great Carnegie steel works of Pennsylvania. This Company having completed their works on a scale of unequalled perfection have reduced the price of their rails by 4 dollars per ton; cutting out the profit at which the best equipped of the remaining works in America can work and securing a practical monopoly of orders within a very large radius.

The manufacture of rails themselves is the chief production. In this country there are undoubtedly immense possibilities. Given a stable currency and a consequent great inflow of European capital and enterprise, the railway system must grow largely. It at present consists of some 20,000 miles of rails, and a moderate estimate would give 250,000 tons as the requirement annually. Say 600 tons per week, this would not be more than would be required to give full occupation to a rail mill of moderately large size.

The manufacture of angle, bar, rod, galvanised sheet, plate, wire†, beams, girders, pipes nails, screws, amounts to about 200,000 tons more as judged by the amount at present imported.

Given therefore the possibility of placing at any point of the coast line or in any Eastern country any of the above detailed items at a lower rate than the same can be imported from Europe, there seems to be sufficient trade for 500,000 tons of finished iron and steel annually, which is amply sufficient for a complete works on a large scale in full work. Moreover, this estimate is likely to increase rather than the reverse for many years to come.

In the United States of America, with a population of 62 millions, it is not unusual for 10,000 miles of new rails to be laid in a year.

In India, with a population 4 times greater, barely 500 miles of new rails are at present laid annually.

The production of rails in the United States of America amounts to over one million of tons annually, and in the United Kingdom about 400,000 tons.

The average life of a steel rail in India with low speeds and small traffic may be taken at the outside at fifteen years, which alone would give a production of 160,000 tons annually (at 120 tons per mile) without extensions. Extension to the extent of 500 miles only, which must be enormously exceeded sooner or later, gives 60,000 tons more. It is reasonable to count on 250,000 tons of annual requirement within the next five years.

SECTION III.

THE NATURE OF THE MATERIAL REQUIRED AND OBTAINABLE, AND ITS COST.

(*a*) *The Ore.*—Appended is a table showing the approximate constitution of ordinary hematites from the chief centres :—

	Furness ores.	Whitehaven.	Spanish.	Salem.
Iron	60·5—66	66·6—68·7	54·6—56	67·76
Phosphorus	TR.	TR.	TR.	TR.
Sulphuric Acid	·11	·09	·01—·03	4·72
Residue, chiefly silicious	5—14	1·5—4	10—10½	

* Assuming as appears to be the case that the Singareni coal is non-coking.
† 6,000 miles alone would be taken annually by the Telegraph Department.

The working of hematite ores in the blast furnace, specially for the production of Bessemer iron, often present considerable difficulties. As a rule, the hematite furnaces in the English [illegible]ore smaller than those working on the Cleveland and other non-hematitic irons. The [illegible]resent hematites contain very little alumina, and in consequence the slag found is trouble-[illegible]The with. To avoid this, it is customary to mix a proportion of aluminous Irish ores, [illegible] which from Red Bay contains about 20½ per cent. of Al_2O_3. From 3 to 4 cwts. are

There is little doubt, but that the magnetite of Salem would require similar treatment owing to the quartsose nature of the gangue. There would, however, be no difficulty in obtaining aluminous ore for the purpose of mixing with it.

In the [illegible] the red and brown hematites of Spain, though probably on the whole poorer in iron than the English or Salem hematites, are much sought after on account of the facilities they offer for the extraction of iron.

The main consideration in the mining of Bessemer ores, *viz.*, freedom from phosphorous, very greatly reduces the available quantity.

In England an average output of 14 millions of tons of ores contains only 12½ per cent. fit for acid steel manufacture, the total make of Bessemer pig being only 17 per cent. of the production of 7¼ millions of tons.

The richest deposits are those of the Furness and Whitehaven districts, of which the analysis is given above, the Park, Roanhead and Askham mines in the Furness District being mined at from 12 to 70 fathoms in depth.

The Lake Superior mines are worked at depths of from 100 to 120 fathoms.

The Spanish ores are quarried in the open on the hill sides.

The methods possible in the Salem district will be very similar to the latter.

The cost of collecting iron ore in the United States is estimated at—

	£	s.	d.
Labour	0	4	3¾
Officials	0	0	2½
Stores and repairs	0	1	6
Taxes	0	0	1¾
Interest and depreciation and insurance	0	0	6
Royalty	0	0	10¼
Total ...	0	7	6¼

In Lancashire and Cumberland the cost of raising and collecting is put at 7/ and 8/, respectively.

In Spain the labour in quarrying is from 1/ to 2/6 per ton, the ore being delivered in ship in Bilbao river at 7/ per ton.

The ore is carried from the mines about 1½ miles to the sea by complete system of wire tram-lines, inclined planes and railways or combinations of all three. Some 700,000 tons are, however, still carried annually by bullock cart at a cost of *s.* 2/1 to *s.* 2/9 per ton.

It would appear then that the cost of the raised ore at Bilbao mines is from *s.* 3/6 to *s.* 4/ at the quarries.

Of the 2¼ millions of tons raised, 70 per cent. is exported to England, the cost in the Tyne being *s.* 12/ to *s.* 12/6 (at present* about *s.* 13/).

A consideration of the foregoing leads to the estimate that, with complete appliances for conveying the ore from the Salem quarries to the railway, which is situated at the foot of the hills, the cost of ore placed in trucks should be somewhat less than the cost on ship in Bilbao. Say 4/ for raising and collecting and *s.* 1/ for loading or *s.* 5/ per ton in truck. And work on a larger scale should reduce this to *s.* 4/8 per ton or *s.* 8/5 per 36 cwts.

The cost of conveyance of ore to various works from mines may be taken as under :—

	£	s.	d.
Cumberland works local @ 1*s.* 2*d.* ... ... 36 cwts. cost	0	2	2
Middlesborough (from Bilbao) 9*s.* ... ... do.	0	16	2
Pittsburgh at 10*s.* 1½*d.* (Lake Superior) ... ... do.	0	18	2
Calcutta (Salem) ... ... do.	1	2	4 to 0 19 0½

see note, page 9.

The latter item of cost, which is one of the most important in the whole problem, is calculated as follows :—

Railway freight, Salem to Madras, 200 miles—the Company at present offers to convey at 6·75 pies per ton per mile, a total of Rs. 7–0–6 for the distance and calculated at 1/2*d.* per rupee : this equals ·5*d.* per ton mile. The freight in the United States comes to about ·436 and

* 1896.

in England to ·650. There seems no immediate probability that the rate would be reduced below the sum named; it is possible, however, that the Madras railway not being well off for freight and the traffic in ore being probably a large one would reduce the cost to ·4*d.* per ... The more so as coal is now carried on Bengal railways at ·28*d.* per ton mile.

Calculated at this rate (·4*d.* per mile), cost of conveyance to Madras is *s.* 6

The onward transit to the works in Calcutta must be unquestionably by steam... ing to the Company; and an arrangement must subsist between the Company and th... railways by which Bengal coal is delivered for their consumption.

It is probable that steamers of moderate size, capable of carrying 2,000 tons of cargo, would be found the best for the trade, to lie up to the Madras jetties and to navigate the Mutlah river at all stages of tide. Larger steamers might, however, be found economical.

For purposes of calculation assume a 2,000-ton steam vessel—

		Rs.
Monthly cost of crew		8,000
„ of coal		8,000
„ of sundry stores		1,500
„ of repairs		1,500
„ of port dues		1,000
„ of pilotage		1,200
„ of sundries		800
	Total ...	22,000
Interest and depreciation at 14 per cent. of "block"		5,000
	Grand Total ...	27,000

Assuming 36 voyages per annum and a carriage of 72,000 tons of ore inwards and, say, 15,000 tons of coal outward per ship used, also assuming a profit of Re. 1 per ton of coal up to 150,000 tons landed in Madras, the cost runs out to Rs. 4-8 per ton of ore brought to Calcutta.

This rate would enable best Bengal coal costing on truck at the mine —

say Rs. 2.
at Port, say Rs. 6¼ per ton.
at Madras, say Rs. 10¾ per ton.
to be sold at Rs. 11⅝ per ton.

In support of this calculation it is believed that market in Madras would be found as under:—

	Rs.
Madras Railway consumption, tons 50,000, average present cost.	12·39 per ton.
South Indian Railway consumption, tons 65,000, average cost ...	15·03 „
Foreign lines and public, tons 35,000, average cost (landed on West coast), English coal	16
Singareni coal on Southern Mahratta Railway	Rs. 10 1 6

It would therefore appear inside the possibilites to place Bengal coal which is to English coal as ·85 : 1·125 at Rs. 11⅝, or even more.

Singareni coal would undoubtedly compete close at all events for the foreign line traffic, but this coal is said at present to cost Rs. 6 per ton on truck at pit, and has a long railway lead to nearest foreign railway.

Assuming therefore Rs. 4½ per ton as the cost of carriage of ore from port of Madras to port of Calcutta or 5*s.* 3*d.* per ton, plus handling charges at 6*d.*, the cost of transfer from Salem to Calcutta amounts to 12*s.* 6*d.* * or 22*s.* 4*d.* per 36 cwts.

NOTE.—Should a traffic of 700,000 tons of ore be taken over the Madras line, the ore would no doubt be carried at the same rate as coal in Bengal—say 4 pies per ton mile—and the conveyance of ore would reduce to 10*s.* 7*d.* [1] or 19*s.* ½*d.* per 36 cwts. from Salem to Calcutta.

* Rail 6 8
Handling 0 6
Sea 5 3
Total ... 12 5

[1] Rail 4 10
Handling 0 6
Sea 5 3
Total ... 10 7

...There is no more important problem in the whole question than that of procuring ...ly of proper quality, but also at a reasonable cost. And it is most unfortunate that ...o coal is worked in India which can be said to be a thoroughly good coking coal.

The ...pproximate constitution of the better known cokes is—

—	Sulphur.	Ash.	Volatile.	*Carbon.
Durham	·7	5·0	·92	93·38
English Ordinary	·8	5·45	5·4	88·69
Connelsville, U. S. A.	1·0	10 to 12	..	88
Indian (Damuda)	·51	14·63	10·18	75·19

From this it appears that, though the Indian coke is remarkably free from sulphur, a fact that would have a beneficial effect on the pig iron, it is considerably lower in carbon. It is doubtful whether this sample is the best coke obtainable, but it is probably representative; and its value, other things being equal, is ·83, coke of 90 per cent. carbon being taken as unity.

The cost of raising bituminous coal is as under :—

United States	*s.* 4-3·77
Great Britain	*s.* 4-8·22
India	*s.* 2-4 to 3-7·2

And the cost of coke at the ovens—

United States, average	*s.* 7-9·33
Great Britain „	*s.* 8-11·5
India (say)	*s.* 7-8·4

This is made up per ton of coke—

—	Coal.	Cost.	Labour.	Sundry.	Total.
	cwt.				
United States	33·86	6-0	1-6·44	0-2·68	7-9·3
Great Britain	33·02	6-8·25	1-7	0-8	8-11·5
India	38·0	5-8·4	1-0	1-0	7-8·4

The cost of conveyance to the blast furnace is—

	cwts.		
Pitsburgh (Connelsville)	21	@ *s.* 5-3	*s.* 5-6
Cumberland (Durham)	21	@ *s.* 7-3¼	*s.* 7-7⅝
India (Girideh) 210 miles at 2·7 pies per ton mile	25	@ *s.* 5-1	*s.* 7-4¼

The ultimate cost at the blast furnace is—

	cwts.	
United States	21	*s.* 13-7·2
Cumberland	20	*s.* 17-0·5
India	25	*s.* 16-11⅝

The Connelsville coking coal of Pennsylvania is composed—

Water	1·26
Volatile	30·107
Carbon	57·616
Sulphur	·784
Ash	8·233

English Durham coking coal is—

Volatile	26·00
Carbon	66·21
Sulphur	1·69
Ash	5·96
Water	1·13

And Indian is as under—

	Damuda.	Sanctoria.
Volatile	40·57	40·07
Carbon	48·04	48·48
Ash	11·39	11·45
Sulphur	·3	·3

In the question of hardness, Indian coke fails considerably, although it is at th[illegible]d be reduced denser and heavier coke than English, the weight of a cubic foot of each being [illegible]well off fo[illegible] ximately—

	lb.
English	50·8
Indian	52·3

The crushing weight, which is an important consideration in connection with the size and burden of the blast furnace, is in favour of English coke by nearly 2 to 1. The Indian coke having a poor coherency, to what extent this would be improved by coking on a large scale and on scientific principles cannot at present be determined. The crushing weight actually found per square inch is—

	lb.
English, about	500
Indian „	~~925~~ 250

These figures can, however, only be taken as comparative owing to the difficulty of determining when disintegration commences. In the United States a series of experiments showed the weight of coke to vary from 42 to 55 lb. per cubic foot and to crush under 200 to 281 lb. per square inch. Tested by these figures, the performance of Indian coke may be regarded as fair.

It is not improbable that manufactured under best conditions a fair blast furnace coke would be produced, but it would not be safe to count on a less expenditure than 25 cwts. per ton, and even this only under best conditions of ore and flux, both of which may be counted on.

Limestone.—It is rare in European or American blast furnace practice to find the selected site without good limestone in the immediate neighbourhood. The South Stafford and vicinage of Glasgow are, however, exceptions, and in consequence the limestone used at these places cost 5*s.* per ton at the works.

In the States the average cost is per ton—

Labour.	Stores, taxes, &c.	Total cost.
1-1·65	0-2·95	*s.* 1-4·6

In Cumberland the figures are—

Labour.	Stores, taxes, &c.	Total cost.
1-1	0-5½	*s.* 1-6½

The cost of conveyance reckoned at 10 cwts. per ton of pig is—

	Rs.	A.	P.
United States, 10 cwts., @ *s.* 1-8	0	0	10
Cumberland 10 do. @ *s.* 1-0	0	0	6

The average composition of English (Stainton) stone is—

	Per cent.
Carbonate of lime	95
Magnesium carb	4·2
Silica	·6
Iron, Aluminium, &c.	·3

In the case of the Indian steel works at the selected site, unfortunately limestone does not exist, and the problem will be to place a suitable limestone at the works at a "possible" price.

The landward limestones may be at once neglected, as the cost of carriage would amount, even in the case of the nearest, to over 6*s.* per ton.

It appears, however, that by a well organised system the limestones of the Arakan Coast could be placed at the works at a cost which would make its use feasible. The island of Ramri, distant about 400 miles, is, so far as I am at present aware, the nearest source, but it is more than probable that the hilly ranges of the northern coast of Burma would be found to yield a supply closer at hand.

The Ramri limestone appears to be well suited to the purpose, and is available in inexhaustible quantities. At a place called Bamni, somewhat further south on the same coast, an even better stone is procurable. The analysis of both is given—

	Ramri.	Bamni.
Carbonate	94·4	96·4
Magnesia Carbonate	·5	...
Iron, &c., and metal	5·1	3·1

Of this stone, 10 cwts. per ton may be taken.

The cost of getting and loading of the large quantity required is assumed at 1-0 per ton, proper appliances being provided.

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[illegible]d at the [illegible]naces 5*s.* 1*d.*

by water the whole way should not [illegible]ed Rs. 3[illegible] ton, or, say, 4*s.* 1*d.*,

We [illegible]ave then in comparison—

		Cwts. per ton of pig at 10 cwts.
United States	@ 3*s.* 0·6	1*s.* 6*d.*
Cumberland	@ 2*s.* 10·5	1*s.* 6*d.*
India	@ 5*s.* 1	2-6·5

[illegible]esultant cost of material.

Examination of the foregoing shows cost of raw material at furnaces to be, including raising [illegible]onveying—

	Ore.	Fuel.	Lime.	Total.
United S[illegible]	1 9 10	0 13 8	0 1 6	2 5 0
Cumb[illegible]	0 17 0	0 17 1	0 1 6	1 15 7
India	1 10 9	0 16 11¾	0 2 6½	2 10 3
or n	1 7 5⅓	0 16 11¾	0 2 6½	2 6 11¾

Note.—Analysis o[illegible]me of the purer Indian ores is as under, but it is doubtful if any of them would be available in sufficient quantity witho[illegible] admixtures of impure ores, and, so far as I can see at present, the importation of Salem ore [illegible] a necessity.

Red hematite from Aguria iron	59·6	Phos.	07·8	Sul. ·08
Iron Sand from Jherria iron	68·97	„	·03	„ ·06
Iron stone from Purulia	46·5	„	·02	„ ·02
Iron ore from Wun	49·8	„	·04	„ ·04

SECTION IV.

The Labour and cost, also sundries.

[illegible]e mean labour per ton of pig in the United States is given over a very large number of [illegible]ples at—

	s.	*s.*
Labour	7-11	8-4½
Officials, &c.	0-5½	

In England the figures are—

	s.	*s.*
Labour	2-9½	2-11¾
Officials	0-2¾	

In India the cost of wages was estimated for the Barrakur Steel Works project at—

Rupees 3½ to Rs. 2¾ per ton, including officials, or *s.* 4–1 to 3–0½. But it is scarcely [illegible]conceivable that in a large works in full employment and using the most modern appliances the cost of labour should exceed that in England. It should even be somewhat less. It may be assumed at—

s. 2-11-¾ per ton of pig iron.

Sundry charges, including stores, repairs and taxes are given at—

States	2-10¼
Britain	1- 9¼

The former figure would be the safest to assume in this country.

SECTION V.

The ultimate cost of pig iron.

[illegible]ob

The foregoing shows ultimate cost of pig iron to be—

	Material.	Labour, &c.	Total.
United States	2 5 0	0 11 2¾	2 16 2¾
England	1 15 7	0 4 9	2 0 4
Indian From	2 6 11¾	0 5 10	2 12 9¾
Indian To	2 10 3	0 5 10	2 16 1

[illegible]s at th[illegible]ld be redr[illegible]

From the above it is clear that competition from the States is out of the qu[illegible] well off at first sight, be considered that English hematite should easily compete in the S[illegible] with the local production. But an import duty of 23*s.* per ton, in addition to freight, more th[illegible] squares the balance, and leaves the American pig iron a clear field for home consumption.

The *selling* prices of English hematite iron are given below :—

	s.		*s.*	
1890	32-0	to	49-4	F. O. B. Cumberland ports.
1891	53-3	„	47-1	
1892	57-6	„	60-0	
1893	46-6	„	44-7	
1896	60-0	„	70-0	

The minimum price may be taken at 45/-, and freight to India is unlikely in any year to fall below 10/-; deliveries ex-ship in Indian ports would be therefore :—

	£.	s.	d.
English hematite (minimum)	2	15	0
Indian „	2 16 to 2 12	1 to 9	
Calcutta ...			
Bombay ...	2	18	9

But. And in taking the above rates for English pig it must be noted that they are minimum, whereas in India they are average.

A more average comparison would be; India as above—

	£
England	3

Taking one year with another, the rates of delivery of pig iron would apparently allow competition with English pig of similar quality in any port of India, and considerable profit in Eastern India.

A small import duty on English pig would settle the question undoubtedly in favour of Indian pig.

Note.—The distances over which the materials have to be carried to works in various sites may be given as under :

—	Ore.	Fuel.	Limestone.
England, West coast	Adjacent ..	100	Adjacent.
Do. East coast	850 miles ..	200	Do.
States, Pittsburgh	1,000 miles ..	70	Do.
India, Port Canning	1,090 miles ..	240	400

SECTION VI.

The Capital Required.

Since an Indian steel works will be within a freight distance of 15*s.* to 20*s.* per ton of the cheapest and most perfectly equipped iron-producing country in the world, and will be moreover weighted by sundry charges due to distances and assembling of materials, it may be premised that it would be utterly futile to commence any commercial concern unless on a large scale and with all the most modern appliances. Any supposition that the works might commence 'small' and grow from its profits would most infallibly produce only failure and disappointment. A bold and complete programme carried out unflinchingly by a powerful Company with ample capital could alone hope for success, and, as has already been stated, it must be on a scale large enough to prevent the formation of other concerns, causing sub-division of orders.

The margin in favour of profitable working is too small to allow of dependence on intermediate agencies, as collieries, shipping agents, iron mines, &c., and the Company must be prepared to own its coal, ore, limestone, ships, &c., as well as the steel works itself and all the appliances connected.

The extent of the plant—concessions to be sought—depends on the outturn; and this again depends, to a great extent, on the possibility of a return trade to the port of Madras for the outward vessels.

Undoubtedly it is a question of serious moment, not only to be limited in the extent to which inward supplies can be profitably carried, but also to have the element of uncertainty as to the extent of the market available for outward freight.

[illegible] has been assumed that for every 72,000 tons of inward ore freight [illegible] coal could be carried to a maximum of 150,000 tons. The ore supply is [illegible] tons annually, equivalent to about 420,000 tons of pig iron.

[illegible] supply of coke at 525,000 tons annually, and limestone at 210,000 tons

[illegible]gistered of a few of the best known iron and steel companies is appended—

	£
[illegible]arrow Hematite Steel Company	1,528,275
John Brown & Co., Sheffield	1,340,000
Bolchow, Vaughan & Co., Middlesborough	3,218,380
[illegible]) Steel Company of Scotland	495,600

[illegible]ese, No. 1, in addition to the iron and steel works, own their own iron mines and [illegible]e, but no coal

[illegible]o. 2, I believe, [illegible]t their own coal and limestone, but no ore.

[illegible]o. 3 are owners o[illegible]hese, but import their hematite ores from Spain.

No. 4 are simply iron a[illegible] steel makers, depending on external supply for raw [illegible]rial.

Again No. 1 comprises sixteen blast furnaces, producing a weekly average of 6,000 tons, or, say, 300,000 tons annually.

No. 3 have at their Eston Works seven blast furnaces, with a production of 3,500 tons weekly.

No. 2 have at Grimthorpe three blast furnaces, producing about 1,000 tons of pig weekly.

A few figures from American blast furnace practice will show the enormous difference between an average outturn in England and America, and, though attention has been directed very largely in England lately to the possibility of getting more out per furnace, there are still many experienced managers who hold that the high pressure of blast and rapid wear of linings produced by the over-produc[illegible]n in American furnaces does not pay.

At the Edgar Thompso[illegible]el Works are nine furnaces, of which eight are on Bessemer iron, having a total weekly produ[illegible] of 10,850 tons. In 1892 these works produced—

	TONS.
Pig iron	850,000
Bessemer ingo[illegible]	533,000
„ rail[illegible]	425,000

The outturn required is therefore about half that of the last-named works and approximately equal in extent to the Barrow Hematite Works, and it may be assumed that a capital of not less than 1½ millions would be necessary to set up the necessary works and to acquire the land and concessions in coal and iron. The purchase of the shipping necessary would be at least £250,000 additional.

In a future note I should propose, if necessary, to detail the plant and its cost, but this [illegible]s unnecessary at present. I do not think it at all probable that a less sum than 1¾ millions sterling would suffice to place the works in a position to compete with imported iron and steel, but more precise figures would require enquiry from a directorate authorized and prepared to treat for concessions. The mere detail of cost of plant could be easily put on paper, if necessa[illegible].

Order—Mis. No. 127, Revenue, dated 9th January 1897.

Communicated to the Board of Revenue in continuation of Government Order, No. 3697, Revenue, dated 10th September 1896.

(True Extract.)

(Signed) G. STOKES,
Ag. Secretary to Government.

To the Board of Revenue (Land Revenue).

Resolution—No. 24, dated 19th January 1897.

In Government Order, No. 3506, dated 1st September 1896, Government called on the Board to make a careful examination of the figures and arguments contained in Mr. Jeremiah Head's memorandum on the practicability of conducting an iron industry at or near Salem, and report whether, in the Board's opinion, it was desirable to send a consignment of 300 tons of Salem iron ore to England for experimental purposes.

2. Mr. Head concluded his memorandum with a summary
and in its Proceedings, No. 361, dated 23rd September 1896, the B[illegible]ould be re[illegible]
further discussion was required before the fourth, fifth, sixth and [illegible]ing well o
could be accepted, and called for further information for the purpos[illegible]the qu[illegible] pe[illegible]

3. The first and second conclusions are mere statements of fact w[illegible] in the S[illegible] with the [illegible]t, more th[illegible] squares discussion. [illegible]tion.

4. The third conclusion seems to the Board to have been satisfactor[illegible] by Mr. Head.

5. There remains the seventh, which is really the most important of
the Board was not in possession of information which would enable it to deal
subject when issuing its resolution above quoted, it was left over for considerat[illegible]
on, and Government was requested to place the papers at the disposal of the pr[illegible]
to invite free discussion. This recommendation was accepted by Government
Order, No. 666, Revenue, dated 24th November 1896.

6. The Board has now received from Government a letter from the Government of India, forwarding for information a report and letter by Major Mahon, R.A., on the question of working the Salem iron ores successfully, and after perusing these papers, the Board is satisfied that no further discussion need be awaited before deciding that Mr. Head's unfavourable seventh conclusion cannot be accepted, without a practical experiment on a large scale. If by such an experiment it is shown that the Salem magnetite ore which is admittedly of exceptional purity, can produce when smelted with coke made from Barrakur coal, a Bessemer iron which can compete as regard quality with imported hematite, it is probable that the cost of making it locally will b[illegible] far from prohibitive.

7. The conclusion in question was stated by Mr. Head in the following terms:—

"That the substitution for charcoal of Singareni coal at Kanjamalai or at Madras, or of Barrakur coal at the latter place, would not improve the chances of success."

8. In its former resolution quoted above, the Board has given *primâ facie* reasons for believing that charcoal iron could be manufactured at Kanjamalai at a much lower figure than that assumed by Mr. Head, but as pointed out by Major Mahon, charcoal fuel can never form anything but a small adjunct to that required for an iron industry for general trade purposes, and whatever may be the conclusion eventually arrived at with reference to the manufacture of iron at Kanjamalai with charcoal fuel, it is necessary to investigate independently the practicability of working Indian iron with Indian coke.

9. From the information available it would seem that Singareni coal will not coke, and investigation may therefore for the present be limited to the practicability of working Salem (or perhaps Kurnool) ore with Barrakur coke.

10. Some of Major Mahon's figures are, perhaps, open to criticism. For instance, it is not certain that the Madras Railway could carry iron ore at 4 pies per ton, but, on the other hand, it is probable that ore could be mined at Kanjamalai cheaper than at Bilbao, and, on the whole, the Board sees no reason to reject the estimate of Rs. 45-15-1 given by Major Mahon as the cost of putting Salem iron on the Calcutta market. His criticisms on some of Mr. Head's figures are very similar to those made in Board's Proceedings, No. 361, dated 23rd September 1896.

11. The rate of exchange assumed by Major Mahon (*1s. 2d.*) is probably more favourable than can be relied on in future, but even if it be taken at *1s. 4d.*—a rate which is never likely to be materially exceeded under the present currency laws—it seems to the Board that a good *primâ facie* case has been made out for the assumption that an Indian iron, suitable for all ordinary steel-making, can be produced at a rate which will compare favourably with that at which hematite iron can be imported.

12. The matter being one of such momentous importance to the well-being of the country, the Board considers that there should not be any hesitation about the immediate adoption of Major Mahon's recommendation that 300 tons of Salem iron ore and 600 tons of Bengal coal, of a quality equal to Sanctoria coal, should be at once ordered to be despatched to Messrs. Bolchow, Vaughan & Co. of Middlesborough-on-Tees, in view

Revenue (1897) Department.

F R. 4 10,000—22-6-96.

[illegible]night be aske[illegible]

[illegible]'s Agent of the M[illegible] Paper take[illegible] Revr[illegible]
[illegible] the lowest rate at[illegible]
[illegible]s quantities. The amo[illegible]
[illegible]n railway freight is 500,
[illegible]red for the present, but it [illegible]
[illegible]chan one-half of Major Mah[illegible]
countries which could be supplied f[illegible]
that the rate of 6 pies per ton per mile[illegible]
ber 1896, No. 8579/11163, referred onl[illegible]
the Board's Proceedings to which his let[illegible]

14. In discussing the question of the i[illegible]
[illegible]hon expresses himself in favour of the ne[illegible]
[illegible]al decision can probably be arrived at[illegible]
[illegible]sed experimental manufacture, without [illegible]
[illegible]te estimates of the different items of cost.

15. If the Kurnool hematite iron ore, w[illegible]
o[illegible]d an investigation in Government Order, [illegible]
1896, is found to be satisfactory both as regards[illegible]
at a suitable site would be found at Bezwada, whic[illegible]
[illegible]ast Railway, will be an important convergent railway [illegible]
[illegible]m[illegible]nication to the port of Masulipatam. To works on this site it would also prob[illegible]
be possible to supply limestone flux from the Palnad taluk more cheaply than it could be brought to Calcutta from the coast of Arakan.

(True Copy and Extract.)

(Signed) R. C. C. CARR,
Secretary.

To the Secretary to Government, Revenue Department.
" Collectors of Salem and Kurnool.
" Agent and Manager, Madras Railway.
" Settlement Department.
" Forest Branch.
" Trades Association.
" Secretary, Chamber of Commerce.
" Superintendent, Government Central Museum.

Order—No. 221, Revenue, dated 30th March 1897.

Miscellaneous.

The Government agrees with the Board in considering that it is desirable to despatch to Messrs. Bolchow, Vaughan and Co. of Middlesborough-on-Tees, a consignment of Salem ore and Bengal coal for the purpose of determining, by actual experiment, the value and cost of production of pig-iron made from Indian ore with Indian coke. The Government of India will accordingly be addressed on the subject and the Board of Revenue will be requested in the meantime to ascertain the cost of collecting the necessary quantity of iron ore