Major-General TREMENHEERE explained,—with regard to a statement in the Paper, that it was only about five years since the subject of railways in India was taken into consideration by the Government—that although the question was brought forward in the year 1843, and a short experimental line, about 121 miles in length, from Calcutta to Raneegunge, was sanctioned by the Government in 1849, at an estimated cost of one million sterling—which was, however, only opened in February, 1855—yet it was not until 1853, during the Marquis of Dalhousie's administration, that the three main trunk lines now in course of construction were projected. These lines extended from Calcutta to Lahore, from Bombay to Madras and to join the Calcutta line, and from Madras to the West Coast.

Mr. CONYBEARE said, the subject of public work extension in India was one that had largely engaged his attention during a residence of upwards of ten years in that country. The account given by the General of the introduction of railway communication was accurate as far as related to Bengal; but from having taken part in their introduction on the opposite side of the peninsula, Mr. Conybeare could state, that the Bombay Presidency took the lead in that movement, and that the first section of the Bombay Railway was opened for traffic a year and a half prior to the opening of the first section of the Calcutta line. The history of the introduction of railways into Western India might be thus briefly stated. In 1843, Mr. G. T. Clark (who had been one of the resident engineers on the Great Western Railway during its construction) went out to Bombay, it was believed, at the invitation of the then Governor, Sir George Arthur, who was most desirous of seeing the public works of the Western Presidency carried out by private enterprise, and under the charge of Civil Engineers. Soon after his arrival, Mr. Clark organized a railway company, which was named the Great Eastern, for extending railway communication from Bombay to the country behind the ghauts, to the north-east and south-east. The proposed line was to cross to the mainland at Tannah, to bifurcate at Calian, one line extending thence, in a north-easterly direction, up to the Thul ghaut to Candeish, and so towards Bengal; the other south-easterly, and by the Bhore ghauts to Poona, and towards Madras. This was precisely the line at present followed by the Great Indian Peninsula Railway. It was the only one that a railway Engineer, if left to himself, would select, and it was the system that had been recommended many years before by Mr. Vignoles, in his Paper on Indian Railways, still on the records of the India House. In 1844, Mr. Conybeare joined Mr. Clark as Resident Engineer at the Bombay end of the proposed line. There was at that time a very strong local opposition to the introduction of railways into India.

A Government Committee, composed of Engineer and other military officers belonging to the East India Company's Service, reported unfavourably on the project, so that it was, for the time, abandoned, and remained for some months in abeyance. While this was going on at Bombay, Mr. Chapman had been busily engaged in London and at Manchester, in organizing a railway scheme, intended to centre at Bombay, and to embrace the Presidencies of Bengal and Madras in its operations. This project was designed as a complete system for the whole of India, and was consequently called the Great Indian Peninsula Railway, which name the undertaking still retained, though its character and scope had been altogether altered, by the sanction of separate systems for Madras and Bengal, altogether differing in route from those proposed by Mr. Chapman. His plan was to extend a trunk line due east from Bombay, up the Malsej ghaut, and across the peninsula to a harbour on the opposite coast, at the mouth of the Godavery, and half way between Calcutta and Madras. He intended, that the communication with, and between, these Presidencies should be completed, eventually, by branch lines skirting the coast; but in the meantime he proposed to employ steamers. This trunk line would have traversed the richest cotton districts in India. As soon as the ghauts were past, branches were to have diverged, one to the north-east, to the Ganges at Allahabad, with a branch extending through Rajpootana to Agra; and another to the south-east, towards Madras. On becoming aware of what was doing at Bombay, Mr. Chapman wrote to propose a coalition between the Great Eastern and the Great Indian Peninsula; and as the latter scheme was the more comprehensive, and the most strongly supported, the Great Eastern was merged in the Great Indian Peninsula, and Mr. Clark and Mr. Conybeare were appointed joint Engineers in India. Mr. Robert Stephenson, M.P., was the Consulting Engineer in England, and the projector, Mr. Chapman, was the Managing Director. The Malsej ghaut was the only pass in the Sahedree range compatible with the direction and objects of this system of lines, and it was consequently made a fixed point in the Engineers' instructions. The Bombay Committee (which then included Mr. R. W. Crawford, M.P., Mr. Ayrton, M.P., and Mr. Willoughby, M.P.,) disapproved of the extension of a trunk line across the peninsula, to a port on the opposite coast, on the grounds that one-half of it would be a competing line to the other half. Moreover, it soon became evident, that Bengal and Madras would be each granted an independent system of their own. The scope of the undertaking was consequently reduced, from that of a system intended to suffice for the railway requirements of the entire peninsula, to that of one aiming only to drain into the harbour of Bombay the produce of so much of the back country as could be

brought within a remunerative distance by means of railway communication. The producing districts lay beyond the ghauts in a north-easterly and south-easterly direction. If directness was to be the ruling consideration, the point of bifurcation would be below the ghauts, and two ghaut ascents would be inevitable. But these ghaut ascents being considered to be the great engineering difficulty of the country, the Bombay Committee thought it expedient to sacrifice directness to the supposed economy of a single ghaut ascent, by the Malsej, with a cis-ghautine point of bifurcation. They therefore agreed with Mr. Chapman in his selection of this ghaut. But as soon as Mr. Chapman's connection with the line had ceased, and the question had to be decided by Engineers, on engineering grounds, the original design of the Great Eastern scheme was naturally reverted to, and the general course of the existing route of the north-eastern and south-eastern traffic, by the Thul and Bhere ghauts, was adopted. During the years 1846 and 1847, the survey, reconnaissance, and collection of traffic statistics, were extended by Mr. Clark from Bombay to the summit of the Malsej ghaut, and from the point of bifurcation above the ghaut to Sholepore, to the south-east; and by Mr. Conybeare, from the Malsej ghaut, through Candeish, to the Nerbudda coal-fields to the east, and to Malwa and Rajpootana to the north. It was upon the surveys and statistics so made and collected that the case was established, and the sanction and guarantee of the Home Government obtained. The next year was consumed in the negotiations and discussions incidental to obtaining the guarantee. During the interval, Mr. Clark returned to England, and Mr. Chapman soon after retired from the undertaking. When the guarantee had been secured, and active operations were about to be commenced, the engineership in India was offered, in October, 1849, to Mr. Conybeare—Mr. R. Stephenson remaining the Consulting Engineer in England. On his declining it, the present Engineer, Mr. J. J. Berkley, M. Inst. C. E., was appointed, by whom the work had been carried out to the present time, with the greatest ability and success. The ascent of the Bhere ghaut, now nearly completed, was the grandest example of mountain railway-making that had yet been attempted.¹ The first contract out of Bombay was let in November, 1850, and the first section was opened for traffic in April, 1853—at least a year and a half prior to the opening of the first section of the Calcutta line.

The subsequent delays, by which the progress of Indian railways had been so much retarded, arose from several causes.

¹ An interesting account of this work has been communicated by Mr. Berkley to the Bombay Mechanics' Institution, and has been since published in the Calcutta "Engineers' Journal."—EDITOR.

Mr. F. W. Simms (M. Inst. C.E.) who had been appointed Consulting Engineer to the Supreme Government of India, recommended that the line from Calcutta should follow a straight course to Mirzapore and the upper provinces, traversing the Rajmahal hills en route; and that the Bombay line should follow the direct course of the eastern traffic to the north-east. On Mr. Simms' retirement, his military successor (Colonel Kennedy) laid down a rule, that no gradient steeper than one in two thousand was admissible on a trunk line. He therefore urged, that the East Indian Railway should follow the tortuous, and often inundated, line of the Ganges, to avoid the Rajmahal hills; and that the north-eastern traffic from Bombay should make a detour of 180 miles, by the Nerbudda Valley, to avoid the Ghaut ascent. The direct route was maintained in the latter case, but not until two, or three years had been wasted, in the profitless discussion of a point that no experienced Engineer would ever have dreamt of raising.

Shortly before the appearance of Colonel Kennedy's celebrated Blue-book, Colonel Grant, of the Bombay Engineers, wrote a book, in which he recommended (seriously) that the permanent way of all Indian railways should be suspended throughout their entire length, and over hill and dale, by regular suspension chains—like the Brighton chain-pier—at a minimum height of 8 feet above the ground, which he considered would be sufficient to place it out of the reach of animals. Colonel Grant went the length of having some very costly models of "his system" prepared and exhibited.

In 1849, Colonel Ffrench, the then Resident at Baroda, proposed a line, on which Mr. Conybeare reported favourably, from Tankaria, near the head of the Gulf of Cambay, to Baroda, to be ultimately extended by the line of the Mbye to Agra. This had been since developed into the Bombay and Baroda,—one of the guaranteed lines,—and it must ultimately become the Bombay and Great Northern, by being extended to meet the Indus line at Hyderabad. There would also be a branch to Indore, which must eventually be met by a branch from the Nerbudda section of the Great Indian Peninsula Railway.

Returning to the works more particularly enumerated by General Tremenneere, Mr. Conybeare remarked, that they unquestionably reflected great credit on the Engineer and Artillery officers by whom they were designed and executed, especially when due allowance was made, for the very limited opportunities of acquiring actual experience on works afforded them in the course of their professional training, as compared with the advantages, in that respect, enjoyed by the young civil engineer, during his three or five years' pupilage in the office and on the works of

an engineer in extensive practice. It must also be remembered, that military engineers, when employed on civil engineering duties in India, had almost invariably to carry out their works without the important aids derived by civil engineers practising in England—from the development of the contract system—from the assistance of various grades of practical subordinates versed in the minor details of work, and from the employment of skilled labour. The Ganges Canal was undoubtedly a work of great public utility. It was an extremely well-selected object for public expenditure, was strenuously pushed forward, by the most autocratic of Governors-General, who took a strong personal interest in its completion, as an illustration of his reign, and great engineering skill had been displayed by the Artillery officer, by whom it was designed and constructed. It was, in fact, the one show public work of the Indian Government, but the very constancy with which it, and it alone, was put forward, in all parliamentary discussions, on Indian public works extension, was alone sufficient to prove that such works were in India the rare exception, and by no means the general rule. The Ganges Canal and the Grand Trunk Road were in truth the only public works worth mentioning in the Bengal Presidency, and the latter of these was commenced and constructed, as far as Benares, by Captain Charles Rankin, during the government of Warren Hastings, between eighty and ninety years ago. These comparatively insignificant proceedings during the long interval of British rule in India, contrasted most unfavourably with the 36,000 miles of railway, and the tens of thousands of miles of efficient inland navigation, which had been carried into effect, by private enterprise, and during the last twenty-five years only, in the United States of North America.

It must be admitted, that the funds appropriated to public work extension in India had, hitherto, been altogether incommensurate with the requirements of so vast and so roadless a country. But it was equally notorious, that owing to a total want of any harmonious and comprehensive plan, to a defective system of administration, and to inappropriate agencies, the sums expended on public works in India had not, in the aggregate, and as a general rule, been productive of an equivalent commercial benefit. As an example, the case of the last twenty years' expenditure on public works in the Bombay Presidency might be cited. According to Parliamentary returns such expenditure, during the ten years ending 1845-46, amounted to £399,276. During the last ten years, the rate of expenditure on public works had notoriously increased. The expenditure on public works in that Presidency alone, during the last twenty years, might, therefore, be safely taken, at from eight hundred thousand to one million

sterling, exclusive of the expenditure on railways. In the case of Western India, the exigencies of the case were especially intelligible. A peculiarly rugged chain of mountains ran parallel to the coast, at an average distance of 40 miles, and completely shut out the productive provinces of the interior from the points of export. What "had to be done" first of all was, evidently to pierce this mountain barrier by great trunk roads, and so "tap" the extensive and productive districts behind them, and not a farthing should have been spent on works in the interior until this first desideratum had been accomplished. Yet up to the present time, that large expenditure had not afforded to the commerce of Bombay, a single trunk road, economically practicable throughout, for wheeled carriages traversing the Ghauts, and tapping the producing districts behind them. Indeed, the large sums spent had been absolutely without result, either in increasing the amount of cotton exported from Bombay, or in diminishing the cost of its conveyance from the interior to the coast. Under the present system, the public works executed by Government cost the country above 100 per cent. on the cost of construction in engineering superintendence alone; whereas in England, the charge was always under 5 per cent., and on the Continent usually under $2\frac{1}{2}$ per cent. Works of this class could seldom be productive until complete, and Government works in India were seldom completed within a single generation. Large sums were annually dissipated on the construction of discontinuous scraps of road, scattered over the interior, but no arterial line of communication was ever completely finished within a reasonable time. The fault was not in the agents, but in the system under which they were compelled to work. It was the difficulty experienced by a subordinate Government, in obtaining sanction for the expenditure of more than a very limited amount on any one single work in one year; coupled with the absence of any determinate and comprehensive plan, embracing the requirements of the whole country, that caused the very limited total annually available for internal improvements, to be frittered away in fifty different dribblets, each requiring a separate and distinct superintending establishment, instead of being concentrated, for the purpose of finishing some one important work. The construction of these discontinuous scraps of road in the interior was one of the principal causes why the large expenditure of the Indian Government on road-making had so little benefited commerce. For example, an officer connected with the Public Works Administration, wrote to a friend to inquire about a new bit of road lately executed under his Department in the Interior. The answer was: "A very excellent bit of road indeed: the only question is how to get on it, and how to get off it." This

actually occurred ; and the same might be said, with equal truth, of a very large proportion of the scraps of new road executed during the last twenty years in the three Presidencies.

The "Bombay Gazette," of the 30th September, 1851, contained an elaborate abstract of the Annual Reports (printed by authority) of the Bombay Road and Tank Department, for the nine years ending 30th April, 1850, showing the total cost of superintending the public works executed by that department, during such period, to have averaged 48 per cent., and to have amounted in some cases to upwards of 300 per cent. This statement, however, conveyed a very inadequate idea of the total cost, to the Indian Government, of the system under which the public works were executed ; for it was the practice, in all cases, to charge only a portion of the military engineer's total allowances to the work he superintended, although he might at the time have no other duties than the superintendence of that particular work. Thus, the total cost to Government of a Captain, employed as a first-assistant in the Road and Tank Department, was about 738 rupees per month, of which only 325 rupees, or less than half, were charged to the works which it was his sole employment to superintend. In comparing the cost of the system under which the public works of the Indian Government were constructed, with that adopted by European Governments, the expense of the pensions incidental to the former must also be considered. But even without the addition of this last item, the cost of such superintendence to the Indian Government would be above 100 per cent. This great cost of superintendence was not the principal evil of such a system, for few works could be productive until completed, and the loss of interest at present accruing during the tardy progress of a single work would, in many cases, be sufficient for the construction of two such works under better management. The following extract from the "Manchester Times and Examiner," was quite to the point.

"The greatest public work undertaken by the Indian Government, beyond all comparison, is that of the Doab Canal, in the north-west of Bengal, a work intended both for irrigation and navigation. It is estimated to cost a million and a half sterling, and for which purpose £50,000 a-year has been voted. As a means of navigation, it will produce no return till completed, and at the rate of £50,000 a-year, it will take thirty years to complete it, thus involving a loss of one million sterling by interest on unproductive capital, to say nothing of waiting thirty years for the advantages which it promises. In the hands of private enterprise the work would be completed in two years. The other principal works of irrigation in India, those of the Madras Presidency, have occupied a still greater length of time in their construction.

Operations were commenced on the Cauvery in 1809. In the course of forty-five years 3,900,000 rupees (£390,000) were expended on it, or at the rate of £8,600 per annum; the revenue (land revenue) having increased in this space of time from 3,100,000 rupees to 4,900,000 rupees, the gain being close upon 1,800,000 rupees per annum, the money invested being returned in about two years."

No one had more strongly deprecated the shortcomings of the administration of the Public Works Department than the more distinguished officers of the East India Company's Engineers. Shortly before Mr. Conybeare left India, the Chief Engineer at Madras was excluded from Government House because he had placed on record, an unpalatably strong opinion regarding the deficiencies of the system. Some years ago Colonel Dickenson, late Colonel-Commandant of the Bombay Engineers, addressed a series of letters to the "Times," under the signature of "An Old Indian," in which many examples were adduced of the terribly slow progress of public improvement in the Western Presidency under the present system; and the most distinguished of his successors had observed, that if the superintendence of public works cost 100 per cent. on their construction, as was the case in the Bombay Presidency, they were in his opinion bought too dear. Mr. Conybeare believed that all "fresh English minds," whether politicians, engineers, or merchants, who had had an opportunity of studying the question on the spot, united in the conclusion, that the public works of India could never be carried on economically, on the necessary scale and at the required speed, until the conduct of such undertakings was intrusted only to those whose professional training would enable them to do thorough justice to the work—until private enterprise was allowed freer scope than it had hitherto had, and until the advantages incidental to the development of the contract system, as attained in England, were more generally appreciated and realised in the Indian possessions.

The fact of the Government having guaranteed the lines now in course of construction in India, necessarily rendered the functions of the Government Inspecting Engineers of the Indian Railways Department much more detailed and technical than those of the engineer officers attached to the Railway Department of the Board of Trade in this country. It was therefore obvious, that the functions of an Inspecting Engineer of Railways in India could only be efficiently performed by gentlemen versed in railway engineering, and the appointment to these posts of officers who, however well intentioned, were of necessity wholly inexperienced in railway construction, had greatly retarded the progress of Indian railways, and had often led to much uninformed and vexatious

interference with the Civil Engineer in charge of these undertakings.

All new roads constructed by the Indian Government should henceforth be laid out as accessories and feeders to the great system of railways, which would form the arterial lines of communication of the country, and the necessary unity of design and action would never be secured until the appointments of Inspecting Engineer of Railways and Chief Engineer of Public Works were united in the same person. The duties of both functionaries might be well discharged by a single official, and the allowances, when united, would be sufficient to secure the services of an experienced Civil Engineer.

Mr. Conybeare had already suggested a plan for the reorganization of the Public Works Department on an efficient and systematic basis. He recommends, in the first place, the preparation, by a commission, of a map or maps, of the economic geography of the country, analogous to the atlas prepared by the Irish Railway Commission in 1837. Such a map would definitely determine what roads were to be made, and the order of sequence to be observed in their execution. The final settlement of all such questions would save much vexatious communication that now took place, between the Supreme and the Local Governments of India, regarding the details of every petty outlay on public works. Mr. Conybeare had also recommended that the main feeders to the trunk lines of railway should be laid out (whenever they could be without serious extra cost) as railways, in all that relates to curves and gradients, in order to facilitate their conversion into railways as soon as the traffic of the country was sufficiently developed.

Mr. GREAVES remarked, that it would be a valuable addition to the Paper, if the Author would furnish some information as to the rain-fall and the rate of evaporation that took place, in the district through which the Ganges Canal was carried. This was the first instance, he believed, of a communication being laid before the Institution giving an account of a canal made for the irrigation of land, where the country was suffering from drought. The subject of evaporation had not been, generally, sufficiently attended to. There was an abundance of rain-gauges, by which the amount of rain-fall throughout this country could be ascertained with the greatest accuracy; but the practical quantity of water issuing out in the rivers and delivered by springs could only be estimated by a compound process, which included the amount of water which fell and that which was evaporated. Having paid considerable attention to the subject of the water supply, he found that, in this latitude, the quantity of water issuing from springs was never more than one-third of the

total rain-fall, and that generally more than two-thirds were lost by evaporation. If that result took place in a country where the mean temperature was 51° , he would ask what would be the case where the mean temperature was 84° . He was aware, that the evaporation was not in proportion to the temperature, but was rather dependent on the hygrometric state of the air.

Having resided in India for some time, he could confirm many of the statements made by the Author, particularly as to the difficulties experienced, both by military and civil engineers, when they undertook any new works of magnitude, from the want of properly-qualified subordinate agents, to assist in carrying out the details of the work, as well as from the want of practical contractors, and the paucity of skilled labour. Under these circumstances an engineer had great difficulty in commencing his work. When Mr. Greaves first went out to India, he had to construct the lathes, the piling-machines, furnaces, and generally all the appliances for the work he had to execute,—those which were on the spot being of the rudest construction. It was of paramount importance that young men, before going out to India, should make themselves thoroughly acquainted with all the details of their profession, to enable them to meet these exigencies.

With reference to the embankments of the River Damooda, he recollected that during the time of his residence in Bengal, there was a discussion as to the propriety of these banks being maintained. One Commission recommended that they should be removed, whilst another Commission reported in favour of their being retained. The question was really a difficult one to determine; but in his opinion, it was wrong to condemn the principle altogether, and he doubted whether it would be advisable to sweep away the embankments entirely. The bed of the river had been gradually raised considerably above its natural level, and in proportion as this went on, the liability of inundating the surrounding country was increased, during the period of excessive floods, when the banks were overtopped. The Damooda River was peculiarly subject to the violent floods that had been described, which came down with a head of several feet of water resembling the “Bore” on the Severn. Before the construction of the East Indian Railway, the country coals were brought to Calcutta in barges, which were loaded whilst lying dry, and were brought down by successive freshes, or floods, each taking the barges 20 or 30 miles, and perhaps it was only the third flood which carried them into the tidal waters. These violent torrents were most trying, and it was not until engineers had gained considerable local experience, that they could plan the most suitable works.

There were remains of works to be found in Bengal, which showed, that the ancient rulers of the country were not unmindful

of the advantages of good roads. There were the remains of a road called the "Peepul putter ka Seran," lined with peepul-trees on each side, and which reached 1,000 miles from Juggernath to Delhi. It bore the evidences of an extremely well-made road, though not metalled, and was often from 60 feet to 70 feet broad; it was principally on embankment, in low ground, but with a small proportion of cutting. It was bridged in several places, the piers being 12 feet or 14 feet thick, and the water-ways very narrow. Enormous tanks 30 feet and 40 feet deep, from three-quarters of a mile to a mile in length, and about three furlongs wide, also existed. These tanks had been allowed to fall into a dilapidated state, and in some places, rice and other produce was growing at the bottom. Although he did not wish to be considered an apologist of the present system of government in India, he thought there were at all times difficulties in the way of carrying on works of a public nature. It was a habit to talk a great deal about civilization, but that meant many things; and applied to India, as a place for public and engineering works, it meant an export trade. Unless an export trade could be insured, he did not see the object in creating a multitude of railways, or navigable canals, or other facilities of that character. The main object, hitherto, had been military communication; and the nature of the country for agricultural purposes was such, that during the rainy season, when the ground was wet and soft, there was nothing to be carried, whilst in the dry season the country was an open plain, with a good hard surface, and the produce could be carried in any direction without fear of damage by trespass. Looking to the great natural resources of the country, and its capabilities for carrying on a large export trade, the making of roads, and the opening up of the means of communication, became matters of the highest consideration; and as the requirement arose, no doubt the means would be provided. He thought this was an answer to much of the criticism that had been indulged in, with regard to the want of public roads in India.

Mr. SIBLEY thought, that the Author, in his introductory review of the public works executed in Bengal, before it became a British possession, had rather underrated the amount of credit that was due to the previous rulers of the country. In calling attention to the extent of irrigation-canals executed under native rule, praise was withheld, because those works were of direct benefit and convenience to the sovereign; now, although the rulers of those days might not have been actuated by motives of unmixed benevolence, still the cultivator did derive direct and tangible, and, most probably, designed benefit, from the execution of those great works. It would, therefore, be as unjust to deny them merit, as it would be to withhold praise from the British Government, for the

execution of the Grand Trunk Road of Bengal, because the motives which led to its construction were rather military and political, than agricultural and commercial,—rather of benefit to the state than to the cultivator.

With regard to the subject of embanking the rivers to prevent inundation, Mr. Sibley considered that all engineers would agree with the Author, in condemning the system. There was no doubt, that the principle was erroneous, and that it tended to perpetuate and aggravate the evil it was designed to check. These rivers all brought down large quantities of matter in suspension, and this, when confined within the banks, was deposited in the bed, which naturally rose, and then the embankments, or “bunds,” had to be raised accordingly. It was almost impossible to prevent failures occurring in the “bunds,” owing to the burrowing of animals, and to the set of the stream being against particular parts, caused by the shifting nature of the bed. When these failures took place, the whole force of the inundation being confined within, and being directed against, a comparatively small area, great destruction of crops and loss of life necessarily ensued. The evil was further aggravated, by the “bunds” prolonging the submergence of the land, by preventing the flood-waters from returning to the rivers. If there were no “bunds,” the inundation-waters, extending over a much larger area, and rising to a much less height, would be a benefit, instead of an injury to the land; for then, the drainage-channels being opened, the waters, after having deposited the fertilising sediment, would retire, having enriched instead of devastated the land. This was fully exemplified in the valley of the Nile, where the land had risen whilst the bed of the river had remained at its original level. The Government, though now awakened to the evil of the present system, seemed yet hesitating to meet it boldly, by the entire abolition of the “bunds.” He had heard that it was proposed to adopt partial measures, it being intended, he believed, in the case of the Damoodah, to abolish the “bunds” on one bank only, and at first only for a length not exceeding 20 miles. The evil of such a course would be obvious; for besides giving up, in the first instance, the country on the one bank to destruction, the bed of the river and the land on that bank would gradually rise, and ultimately lead to the destruction of the land on the other side.

On the subject of public works generally, all persons must agree with the Author in his regret that while “money to any amount was always procurable for the purposes of war, and might have been as readily obtained for objects of public improvement,” so little had been done during the last century. The one Grand Trunk Road, the Ganges Canal, and the Jumna Canal were the

only public works of importance, for the improvement and development of the resources of the country, which had been constructed during the British rule. In the matter of district roads, practically nothing had been done. In the district with which he was most familiar, the roads were actually in a worse condition than during the period of the native rule; and relatively, comparing roads in Bengal with roads in England a hundred years ago and now, they were then much superior. When he went into Beerbhoom, five years ago, there was not a metalled road to the whole district, except for about three miles out of the Sudder station, or country-town, made for the evening drive of the civil officers. The whole sum, annually expended in that district, was the produce of the letting of the ferry-tolls, amounting to about £400 a-year. These funds were administered by Ferry Fund Committees, consisting of the civil officers and a few outsiders, the majority being Government officials. The magistrate was "ex-officio" secretary, and practically the committee, for he always superintended the works and the expenditure. It was no reflection on these magistrates to say, that they were necessarily ignorant of the art of road-making; and it was, doubtless, as the Author had stated, this absence of professional superintendence, and leaving the expenditure in the hands of the magistrates, which had led to the mistakes, failure, and waste referred to. It had been stated, that one per cent. on the land revenue, was to be set apart, in new settlements, for the purpose of the district-roads; but Mr. Sibley believed that this only applied to the North-West Provinces, and not to Bengal Proper, in which the land was permanently settled. It was said, however, that the produce of the tolls on the Nuddeea River, and of the Circular Canal near Calcutta, were to be devoted to these purposes in Bengal Proper. It was suggested, that these funds, inadequate as they were for their present purposes, should be applied as guarantees for branch lines of railway, and that the feeders to the railways should themselves be railways and not roads; and the practice of the United States was cited in favour of this view. But if Mr. Sibley understood the latter system, it was, in the first instance, simply to extend into each province a trunk line, leaving the feeders to be common roads; and it was only after a lapse of years, when the traffic had been developed, and means became more abundant, that some of the principal of these feeders were converted into railways. The extent of country to be covered in India was so enormous, that to construct feeder lines of railway so as to supersede the necessity of feeder roads, would occupy more than the rest of this century, even if the means could be found. What was most urgently required, for the development of the resources of those parts near to which

the railway would be carried, was the construction of a good system of village-roads. He, therefore, strongly deprecated the diversion of these funds from their legitimate uses; and in place of diverting, or reducing them, he would increase them tenfold. He had remarked rather at length on that subject, as the Government of India appeared to think, that having assisted in the development of railways, by giving a guarantee, they had done all that was to be expected of them. But without roads connecting the small centres of commerce with the railway stations, a railway in India would confer only a small amount of the benefit it otherwise was capable of affording to the country it passed through. There were stations on the East Indian Railway which, for five months of the year, were inaccessible to a loaded cart. He himself, during the last rains, was eight hours in accomplishing 10 miles to a railway station, though only encumbered with a small carpet-bag, and assisted by thirteen men. The Government had, after representations, sent out circulars to the various collectors of districts, inquiring what district roads were necessary for the development of the resources of the country; but, at present, the idea had not got beyond the "paper stage," and showed but little signs of progress. It would tend to impede the settlement of the question, if the opinions of the Author were allowed to pass unchallenged. Relating to this matter, there was a characteristic story current, that in reply to the circular referred to, one collector stated, that no roads were required in his district, as the people there did not use carts, but carried everything in panniers on the backs of bullocks.

The Ganges Canal well deserved all the eulogiums which had been bestowed upon it. It was indeed a noble work, admirably designed and equally well executed; and it was matter for regret, that they could point to so few such public works in India.

On the subject of the railways at present in course of construction, the Author said that, the pecuniary means being abundant, delay "in their completion will only be a proof of want of vigour and of good management." If by delay was meant a longer time in their execution than similar works would require in this country, then he could not agree with the Author. With equal vigour and good management, it might be laid down as a general rule, that railways in India would for some years to come take half as long again in their execution as similar works in England had required. The causes leading to this result were various, but principally three. In the first place, the whole of the materials such as bricks, lime, timber, &c., had to be prepared and collected by the railway officials, instead of being purchased from merchants, for, except in the Presidency towns, there were no such merchants in India, and even there only on a very limited scale. Secondly,

there were the difficulties as regarded the subordinate staff, particularly Inspectors. If they were obtained from England, they had a good deal to learn and unlearn, and further, they were almost practically useless until they had acquired sufficient knowledge of the languages to understand and be understood. On the other hand, if reliance was placed upon what subordinate staff could be obtained in India, they got good general intelligence and knowledge of the languages, but had to teach them their special business. Thirdly, there was the difficulty as to labour, more particularly skilled labour. Owing to the fact, that no public works, except the Grand Trunk Road, had ever been executed in Bengal Proper, the number of skilled artificers was perfectly inadequate to the execution of such extensive works as the railway involved. It was necessary, therefore, first to find, and then to educate the workmen. Further, this being almost the first large work executed in India without a compulsory supply of labour and of materials, the collection of labour was, in the first instance, a source of much difficulty; and it was not until the work-people gained entire confidence, that they would not be ill-treated and would be paid, that they would come in freely and in numbers.

The comparison which had been instituted between the cost of the East Indian as contrasted with the Madras line, could not be admitted as evidence of the advantage of any particular mode of construction, because the mileage cost would, of course, vary with the nature of the country. A better criterion would be afforded by a schedule of the rates at which the various descriptions of work had been executed. An erroneous impression very generally prevailed, that the East Indian line, in Bengal, was a light and easy one to construct. This would be dissipated when he stated, that over a considerable extent, the earthwork averaged 120,000 cubic yards, and the masonry averaged 4,000 cubic yards per mile.

Mr. HAWKSHAW, V.P., remarked, that an opinion had been expressed, that public works could be carried out better in India by means of private enterprise, free from Government control, than under the present system. All, perhaps, would agree in the correctness of this opinion in the abstract; but unless private individuals and English capitalists were willing to embark their money without a guarantee from the Government, he did not see how the system could be altered, or the Government supervision be abandoned. It was clear, if a railway, or other public company obtained a guaranteed interest on their capital, from the East India Company, that the Government would naturally wish to know how that capital was expended. Hence had arisen the supervision which was complained of, and which doubtless created some delay in the prosecution of the works. With respect to the management in this country, the gentleman representing the

Indian Government in these matters, and who was an ex-officio member of the different boards of management, was a most able man, and he wished all directors were as free from introducing irrelevant matters, and as prompt to go straight to the object before them as that gentleman was. The execution of the works was confided to the care of regularly-educated and experienced Civil Engineers, so that there was nothing to complain of on that head ; but the Government supervision in India was sometimes intrusted to gentlemen wanting in practical knowledge of the works in question. He thought more vigour might be infused into the prosecution of railway works in India, if the Indian Government sent to each Presidency, as their representative, an able and experienced man, well acquainted and practically conversant with the system of English railways. Such an officer would be of peculiar value in India, for although Indian officers, civil and military, had always done their duty to the best of their ability, yet some of them had seen little of railways, and were therefore liable to be misled on practical points.

Mr. G. B. BRUCE thought, that no comparison could be made between the cost of the Madras and the Bengal railways, unless all the facts, particulars, and conditions under which each line was constructed were given. He agreed in the remark, that the officers, civil and military, who had acted for the Indian Government in railway matters were influenced by the best and most upright motives ; but what he and others complained of was, their want of knowledge of the subject they had to legislate upon.

Some remarks had been made upon the slow progress of the Indian authorities in the matter of public roads. There were various reasons for this,—one of which had escaped notice. The carriage of materials in Bengal had been stated to be about $1\frac{1}{4}d.$ per ton per mile ; now if goods could be carried at that rate, it was manifest that there was no object, as far as the country people could see, for making roads, and the authorities had been slow in recognizing the necessity for them. At the time of Lord Elphinstone's appointment to the governorship of Madras, that nobleman proposed that a considerable extent of new roads should be constructed. This idea was so much ridiculed, that a certain member of the Council wrote home to England to say, "The silly young nobleman actually talks of making roads!" so great were the prejudices to be overcome, even in the minds of intelligent men. It had been said, that there was no necessity for improved means of communication in India, so long as there was no export trade ; but in periods of famine, which frequently occurred in some districts, the means of communication became of the utmost importance.

He thought that the per centage derived from public works in India was often overstated, from the fact that the expense of

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superintendence was not generally added to the cost of the works. An illustration of the way in which Indian estimates were formed might be gathered from the Paper, in which it was stated that the annual expense of Roorkee College was only £500 a-year. This must be exclusive of the salary of the principal, whose income alone was much more than the sum named. Also with respect to canals and works of irrigation, it might be the case, as stated, that the outlay of 1,000 rupees, for the restoration, probably, of some old works, yielded a return of 500 rupees a-year; but that was not a proper ground on which to found the assertion, that if 1,000 rupees were spent upon a work in India, a return of 50 per cent. would be obtained from the outlay.

General BOILEAU said, before entering on the few remarks which he would offer upon the Paper before the Institution, he begged to express his thanks for the high compliments paid to the officers of the corps to which he had belonged for thirty-seven years, and which, for the last two and a half years of his residence in India, he had the honour of commanding. He could safely say, that there was no body of men in the world who had been actuated, in all that they had done for the Government, by purer motives than had been the corps of Bengal Engineers; and he could also safely say, that they would rejoice to see the time arrive when the execution of public works in India should be transferred to the hands of the Civil Engineers. The military officers had been crippled by the circumstances in which they were placed—which it was not for him now to allude to—in the management of the works. The difficulties had been well and truly detailed in the Paper, and he could only add to the testimony thus given, the experience of his whole official life, that the difficulties of construction were far greater than the small amount and extent of each Indian work would lead any one to suppose. But the difficulties had been overcome, and the works had been completed, which, so far as Government sanction had enabled the officers to apply their talents, he believed had in most cases been useful. It should be recollected, that these works were boons to the community,—that, for the most part, they returned nothing to the Government in the shape of revenue. Every pound laid out by Government was a permanent burden upon the finances of the country; and therefore the acts of the Government in this respect—though he did not in the least degree appear as their apologist—perhaps deserved to be viewed with some little consideration. He hoped the time was not far distant, when the resources of the mighty empire in the East would be more fully developed; and he had no hesitation in saying, that let the time come when it might, public works must then be carried out under the superintendence of Civil Engineers; for they must necessarily be based upon commercial

results, and upon that ground the Government could not undertake them.

He had very little to observe, with reference to the public works of Bengal, which had been so ably treated of in the Paper; but there was one subject in which he felt particularly interested,—that was the construction of foundations in India, by means of wells, which had been practised wherever the soil was of a character to require artificial foundations. This system had been described by Captain (now Colonel Sir Proby) Cautley, in 1839, in a Pamphlet “On the Use of Wells, &c., in Foundations,” and also in a Paper “On Foundations,” by Mr. Boulnois, read before the Institute of British Architects, and he understood that Colonel Goodwyn, B. E. Assoc. Inst. C. E.,¹ and Mr. G. B. Bruce, M. Inst. C. E.,² had previously presented accounts of the same system to this Institution. He might mention, that many valuable reports and other documents relating to the public works of India were published under Government authority, at the Thomason College, in the North-West Provinces, and by Sir John Lawrence at Lahore, as well as in Bengal. Copies of these works could no doubt be obtained by the Institution from the East India Company, and he believed that some of them would be found to be most interesting to the Members.³

With regard to the materials used in the public works of Bengal, he would offer one, or two suggestions. The materials employed by those who preceded him were, for the most part, bricks and mortar. He had found those materials, especially the mortar, not to be sufficiently lasting, and that they involved a very heavy expense for repairs and maintenance. He considered that stone should be substituted for bricks and mortar in large engineering works, and iron for the superstructure of bridges; for, independently of the difficulty of getting good lime in India, the method of preparing the mortar by native contractors was so bad, as frequently, in the course of a few months, to exhibit symptoms of nitrification, and ultimately to become a mass of rubbish. He had himself been able to push a walking-stick through walls which had only been built a few years.

Mr. A. HENDERSON said,—The British public, and particularly those long resident in, or connected with India, ought to be much indebted to the Author for the able manner in which he had brought before the Institution of Civil Engineers, the present position of the public works in the Bengal Presidency; and at the

¹ *Vide* Minutes of Proceedings Inst. C.E., vol. ii., 1842, pp. 63—65.

² *Vide* *ibid.*, vol. xvi., pp. 449—457.

³ Many of these Reports are presented to the Institution by the Honourable the East India Company, through Mr. Juland Danvers.—EDITOR.

same time pointed out, from practical and official experience, the measures necessary for their progressive improvement, which were so essential for the present settlement, and future prosperity, of our Empire in the East. Of these requirements, unquestionably the most important, were more extended and improved means of communication, between the different parts of the empire, both in the interior and on the sea-coasts. To the westward of the Ganges, the system of railways instituted by the perseverance of Sir Macdonald Stephenson, Assoc. Inst. C. E., would afford a trunk line of communication, only requiring feeders by means of the upper branches and minor affluents of the Ganges and Burhampooter. To the eastward, there was but too much reason to fear, from the submerged character of the delta, of the two great rivers, that railways could not be economically constructed, or be profitably worked, so as to compete with the natural facilities afforded by water transport, with the aid of an improved system of steam-tug and tow-boats of the native type, and capable of being navigated by native crews. Even the completion of the most important of the trunk lines of railway to the north-west was dependent upon improved means of water transport, for the conveyance of stores and material from the sea-ports to their destination in the interior.

The Author had adverted to the facilities for river navigation in India ; and had stated that the draught of the vessels should be limited to a maximum of 2 feet. Having visited almost every trading port and river, on the coasts of the Indian and China seas, as well as those on the Islands of Java, Sumatra, Borneo, and the Eastern Archipelago, Mr. Henderson had had excellent opportunities of gaining accurate information, both with regard to the capabilities of the river craft employed by the natives, and also of the conditions under which the navigation of the rivers, deltas, and adjoining sea-coasts could be most advantageously conducted by means of European enterprise. Confining his remarks, in the present instance, to the case of the Bengal rivers, he observed that there were two peculiarities pertaining to them, which called for special adaptations and modifications of the systems in use on the continents of Europe and America. The first of these was that occasioned by the climate, which flooded the rivers at one season of the year, and left them comparatively dry at others. The other was due to the prevailing character of the soil, a soft alluvial plain being the most general, so that the beds of the principal rivers were continually liable to change their direction. Another speciality also, which must be taken into account, was the fact, that European labour in India was scarce and expensive ; and, therefore, the navigation of the vessels designed by Europeans must be adapted to the capabilities, and even to some

extent to the prejudices, of native crews. From the variation in the depth of water available at different seasons of the year, it was obvious, that vessels, specially adapted for one season, would not be the most convenient for use at all times. The character of the rivers themselves, also, varied so much from the shallow upper branches and minor tributaries, to the deep tortuous channels composing the deltas, that vessels adapted to one part of the course would be unfit for others, where the local conditions were different. It was evident, therefore, that the simplest and most effective means of providing for the present requirements of the inland navigation of India, would be to devise some general system of water transport, suitable to all the variations of draft and character of channel.

It appeared to be a prevalent idea, among those engineers and shipbuilders who had considered the question of the river navigation of India, that a light draught of water could only be obtained by increasing the size of the vessel employed. In conformity with this view, several large vessels had already been tried on the Ganges, and that plan had lately been recommended, by the Commission appointed by the East India Company, to the Scinde Railway Company, for navigating the Indus. Mr. Henderson considered, that there was a fallacy in this system, which must inevitably lead to loss and disappointment. In sea-going vessels, where the draught of water was not limited, there might, or might not, be limits to the profitable and safe increase of size. But as he had, on a former occasion, stated his views on this question, he would not now further allude to them. What he wished, at present, to call attention to was, that with vessels intended for river navigation, where the draught of water was necessarily limited to that of the shallowest part of the channel, increase of size was not altogether compatible with a diminution of draught, and with efficient strength and durability of hull. Up to a certain limit, increase of size would be accompanied with an increased capability for cargo; but when that limit was once reached, any extension beyond it was at a sacrifice of draught. Bearing in mind that, while the strength of a beam, or other structure, increased only as the square, the weight increased as the cubes of similar parts, and also the fact, that it was the weight of the vessel which determined the draught, it would be evident, that where the draught was limited, the dimensions of the vessel must likewise be limited. Assuming 2 feet as the maximum draught, it was obvious, a vessel could be built of such a size, that, with the utmost economy of material consistent with strength, it would require that draught of water to float her, even without any cargo.

The inland navigation of India required a vessel of such a form and of such dimensions, that it could be managed by

native crews, and which combined the least draught of water with the greatest capability for dead-weight cargo. After much careful consideration of the subject, he thought, that the exigencies of the Railway Companies, as well as those of the Government and of the commercial community, would be best accommodated by a system of steam-tug and tow-boats, of similar form and dimensions, capable of being used with, or without, steam, as occasion might require, and which could be propelled by the native crew, in the absence of steam power. He had proposed a train of four vessels, to consist of one tug and three similar tow-boats, each 100 feet in length, 15 feet in breadth, and 109 tons burthen; and he exhibited models of such a tug-steamer and tow-boat, as well as of the "Assam" steamer and "Naga" flat, established by him on the Bengal rivers in 1841, for the Assam Company. The powerful steam-tug and smaller tow-boats belonging to that Company were all connected together by a peculiar arrangement of the tug and tow-post, having a radial spar attached to the tow-ropes, which admitted of extension when required. The object of this arrangement was to give play to the balanced rudders, with which the vessels were provided at the bow and at the stern. This system had been proved to be so effective, that a vessel at full speed could be completely turned on her centre in fifteen seconds. He did not mean to assert, that the speed of such a train would be equal to what might be obtained with a large vessel. For certain special purposes, as, for instance, to connect the two links of a railway system, such a vessel might be well adapted; but for the general requirements of the country, in its present condition, it was not so much rapid water-transit that was wanted, as the actual means of transit. Besides, the cost of a train of moderate-sized vessels would be much less than that of a single vessel of the same capability; the working expenses would also be lower, and the smaller vessels could be made more generally useful, as they would not be so cumbersome, could be handled with greater facility, and could be employed in situations where the larger vessel could not be used. To show how loose and uncertain the system of calculation hitherto adopted, with regard to the capability for dead-weight cargo, at light draughts, had been, he had prepared the following Table of the comparative capabilities, and other particulars, of the vessels in use, and proposed for the navigation of the Bengal rivers (see page 535).

In this Table, the first and second columns gave the actual and relative tonnage, and the last column the relative external bulk to the medium height of the deck; from which it appeared that, while the small iron tea-boat was only one-eighth of the tonnage of the steamer proposed for the navigation of the Indus, it was nearly one-sixteenth of the bulk. It also appeared, that the displacement

Tonnage.	Relative Tonnage.	Names of River Steamers, Tugs, and Tow Boats.	Light Water Line.			Load Water Line, Draught 2 Feet.			Load Water Line, Draught 3 Feet.			Relative Load Displacement.			Load Water Line, Draught 4 Feet.			External Bulk to Medium Height of Deck.	Relative Bulk.
			Draught of Water.	Weight of Vessel.	Ratio of external Bulk to Load Weight.	Displacement.	Capacity for Weight Cargo.	Ratio.	Displacement.	Capacity for Weight Cargo.	Ratio.	Displacement.	Capacity for Weight Cargo.	Ratio.	Displacement.	Capacity for Weight Cargo.	Ratio.		
Tons.			Ft. In.	Tons.		Tons.	Tons.		Tons.	Tons.		Tons.	Tons.		Tons.	Tons.		Cubic ft.	
109	2.3	Proposed— "Nautilus" . .	1 2	30	282	58.0	28.0	.48	91.6	61.6	.67	1.93	129.0	.77	99.0	.77		8452	1.82
46½	1.0	Iron Tea Boat . .	1 9	25	185	32.9	7.8	.21	50.5	25.5	.41	1.0	71.0	.46	71.0	.46		4624	1.0
91	1.9	"Naga" Flat . .	1 3	30	241	53.2	23.2	.44	88.6	58.6	.66	1.77	126.0	.76	96.4	.76		7229	1.56
443	9.3	"Assam" Steamer . .	2 6	159	..	..	Nil.	..	200.5	41.5	.27	4.12	293.5	.46	134.5	.46		..	..
733	13.6	"Patna" and "Benares" Steamers . .	2 10	305	..	..	Nil.	..	328.0	23.0	.07	6.26	446.0	.31	140.0	.31		..	..
1748	37.6	"Mirzapore" and "Ghazee-pore" Steamers	2 5	420	..	..	Nil.	..	533.0	113.0	.21	10.5	745.0	.45	325.0	.45		..	..
3741	80.0	Proposed— Indus Steamer for Scinde Railway Company . . .	..	..	..	665.0	..	..	1049.0	..	..	..	..	..	..	..		76,400	16.3

and capability for dead-weight cargo, at light draughts, of such a train as he had described, compared with the larger-sized vessels which had been in use on the Ganges and Burhampooter, was greatly in favour of the smaller vessels; and indeed, that in the system of similar tug and tow-boats, adopted by Government on the Bengal rivers, the minimum draught had been nearer 4 feet than 2 feet. A reference to the Table would show, that not one of the various systems of vessels, which had been in use on the Ganges, had any capability for dead weight at 2 feet, and most of them very little even at 3 feet. On the other hand, each of his trains would have a capability for 91 tons of cargo at 2 feet, 224 tons at 3 feet, and 376 tons at 4 feet.

To exhibit more clearly the merits of the different systems, it might be stated, that, financially, they stood thus:—

The Assam Company expended on the “Assam” steam-tug and the “Naga” flat-boat, which had a capability for dead-weight cargo of 165 tons, at $3\frac{1}{2}$ feet draught of water, £13,738, or at the rate of £83 $\frac{1}{2}$ per ton.

The Ganges Company expended capital amounting to £96,560, or at the rate of £155 $\frac{3}{10}$ per ton, for the “Patna” and “Benares,” which had a capability of 82 tons at $3\frac{1}{2}$ feet draught of water; and at the rate of £130 $\frac{7}{10}$ per ton for the “Mirzapore” and “Ghazee-pore,” which had capability of 219 tons at the same draught.

The train he proposed, with one steam-tug, and three tow-boats, would cost from £6,000 to £8,000, and have a carrying capacity of 200 tons, or at the rate of £35 per ton of capability.

One of the greatest obstacles hitherto encountered, in providing suitable steam-vessels of light draught for the Indian rivers, was the difficulty of determining, with precision, what would be the weight of the vessel and her capability at a given draught of water. To obviate this, he had lately prepared a tabular form, for the essentials required in the determination of these important elements, and had submitted it, along with plans and calculated quantities, to several shipbuilders, for the purpose of obtaining tenders, in which these quantities had been recalculated and inserted in the forms, thus providing the utmost mutual security against the possibility of disappointment hereafter.

These views had been already submitted to the consideration of the East India Company, together with plans and estimates, in order that, as the Government were the parties most interested, they should take the initiative, as private enterprise could scarcely be expected to incur the risk, in a matter of such general public utility. Although private steam-companies were now realizing almost fabulous dividends, it was only a few years ago that they were suffering nearly a dead loss. The establishment of such a system would enable the public works, at present in progress, to be com-

pleted with the utmost expedition ; and as the railway companies would not require the use of these vessels beyond the time it would take to finish the works, the flotilla might then be handed over to Government, to form, what they were very much in want of, the nucleus of a regularly-organized military water-transport service.

With regard to the ports and harbours of India, it was quite true that there had been no progress, except at Kurrachee. He had at different periods, during the last ten years, presented memorials and propositions to the Indian Government, for the improvement of the port of Calcutta, and the construction of wet docks, after having provided a steam ferry-bridge, similar to those now in use at Portsmouth and at Southampton ; but for want of support from Government, this bridge was obliged to be abandoned at a great loss. He had also proposed a plan for the improvement of the harbour at Singapore, which met with a like fate.

Major-General TREMENHEERE remarked, in reply to an inquiry as to the evaporation of water from the canals in India, that this was not of much importance in that country, as the quantity of water at command was enormous. After heavy rains in the upper country the water came down the Ganges Canal almost like a torrent, and at such seasons, the contents of the upper portion of the canal, and the torrent together, were discharged over the waste weir at Ratmoo, alluded to in the Paper. When the torrent subsided, the shutters of the regulating-bridge were raised, and the canal resumed its natural course.

In reference to the question of branch railways, in contradistinction to district roads, he thought it would be evident that, as the main line of the East Indian Railway only skirted the borders of the producing districts, they would be comparatively little benefited by the trunk line, because the whole of the produce would have to be transported some distance to the railway. If the produce of the rich country to the north of the Ganges had to be carried to the railway, in the ordinary native conveyances, at the rate of 2 miles an hour, he did not think the advantages of the railway system would be obtained. What he contended was, that branch railways, following the course of the present markets, and leading the traffic on to the main line, should be constructed as feeders. It was not by the formation of one, or two main trunk lines, that the real interests of India were to be advanced ; but by such an extension of the system, as would facilitate communication between the various markets in the interior, and the ports on the coasts.

Mr. LOCKE, M.P., President, said, in reference to the remarks which had been made, as to the difficulty of carrying on

works in India, from the want of contractors, of skilled labour and, it might be, of practical engineers, it must be borne in mind, that they had had the same circumstances to contend with in this country. There was a time, when there were no experienced engineers, or skilled labour, or practical contractors, like those of the present day. After all, a new country must not expect to start where an old country left off; it must go through many of the same gradations as the old country had done; and for his own part, he believed, that it was rather an advantage than a disadvantage, as it afforded an opportunity for the full development of the skill and ingenuity of the engineer,—and required that exercise of the mind, which could not fail to be beneficial, alike to the individual and to the community generally. The suggestion had been thrown out, that an experienced engineer should be sent from this country, to each of the three presidencies of India, for the purpose of superintending the works there. Mr. Locke saw not the slightest objection to such a course being adopted, and he should be happy to give it all the support he was able, in another place. But it must be borne in mind, that whilst criticisms were being made as to the system pursued in India, there was the Railway Department of the Board of Trade at home exercising a supervision of an analogous character. Again, on the Continent, there was the authority of the officers of the Ponts et Chaussées, and yet, notwithstanding all these things, public works would go on, if there were funds for the purpose. And funds would always be forthcoming for the prosecution of public works in India, or elsewhere, and engineers would be found from some country to carry them out, provided there was a reasonable probability of commercial success. With regard to the remarks which had been made, recommending that the use of bricks and mortar should be discontinued in favour of stone and iron, he did not think that there was any evidence at present to show, either that the bricks were well burnt, or that the mortar was of a proper description. He recollected the time, when there was the same prejudice against bricks, on the part of the officers of the Ponts et Chaussées in France, and stone was universally employed; but now bricks were used in almost all works. Until it was proved, by experiment, that good bricks could not be made in India, he thought they ought not to be condemned. Bricks, if properly manufactured and burnt, made as sound work as stone, and they were the cheapest and readiest materials that could be employed. He had found the great value of bricks, in localities where stone could not be obtained, and therefore he said, let attention be paid to the producing of good bricks, which would often preclude the necessity of sending long distances to procure stone.