# AN INVESTIGATION AND RESEARCH INSTITUTE FOR THE PUBLIC WORKS DEPARTMENT.

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## *Object of the Paper.*

The object of this paper is to supplement the paper presented to the Congress by Mr. C. A. Colyer in 1915, and to

(1) draw attention to developments in research lines in India and other countries, as evidenced by the literature available ;

(2) indicate the advantages that have been, and are likely to be, realised, by the existing research institutes in India ;

(3) indicate the desirability, if not necessity, for a research institute for the P. W. D. in India, if the ideals set forth in the report on Indian constitutional reforms, are to be realised.

## *Recent Proposals in the matter of Scientific Investigation.*

It is understood that in 1915 a proposal was made by the Punjab Government to the Government of India, for the entertainment of a physicist, to study the question of the flow of water through the soil, and subjects, more particularly connected with the phenomenon of water-logging in the Lower Chenab tract. This proposal is believed to have been well received by Government, but there were apparently difficulties in obtaining a suitable man, on account of the war, while financial restrictions also prevented the proposal from being carried out. In April 1917, a conference of revenue and canal officers considered the general question of water-logging in the Punjab. The letter summing up the proceedings, which was sent to the Punjab Government by the Financial Commissioners, contains the following recommendation:—

"That the comparatively small expenditure involved in the establishment of a Seepage Board, to include a whole-time engineer, as well as a whole-time physicist, to investigate systema-

tically the conditions in each doab, and the possibility of remedial measures, would be fully justified."

In September 1917 a conference of civil and canal officers discussed the question of the more economical use of water for irrigation, and connected subjects, but no recommendations appear to have been made to the Local Government or to the Government of India, on the decisions arrived at at this conference.

*View taken by the Agricultural Department as to the necessity for experimental and research work in the Irrigation Branch of the Punjab.*

In the proceedings of the tenth meeting of the Board of Agriculture in India, held at Poona on the 10th December 1917 and following days, will be found the report of the committee appointed to make recommendations, as to "the necessity for further investigations into the water requirements of crops, and the advisability of laying down lines of investigation for different tracts of India, especially irrigation tracts." Included in the proceedings is an appendix, being a letter from Mr. W. Roberts, Professor of Agriculture, Lyallpur, to the Director of Agriculture and Industries, Punjab, in connection with a proposal for an experimental station at Rodu Koru near Lyallpur. The proceedings end with the following resolution:—"That a special imperial officer, with agricultural experience, with a suitable staff, be appointed to investigate the water requirements of crops, and that an experimental station or stations be selected for this research work by the staff after it has been appointed." This resolution was passed unanimously. The appendix contains definite proposals regarding the scope, the staff required, and the control of the proposed experimental station.

In the special Indian science number of the Agricultural Journal of India, 1918, is an article by Messrs. Roberts and Faulkner, on "Some factors affecting the efficiency in the use of canal water," in which the following statement appears in connection with the work of the Canal Department in the matter of lining channels:—"What is wanted at present is concentration of experiments on one canal, and the setting of the chemical or physical research work on a permanent basis."

*Action taken by the Indian Munitions Board.*

In January 1918, a conference was held in Lahore, under the auspices of the Indian Munitions Board, to consider the question of the organization of chemical research in India.

*Evidences of Activity in other Government Departments.*

The Munitions Board hand-book discloses what Government has undertaken since the beginning of the war, in order to supply material for the prosecution of the war, and in order to reduce importations, while the records of the Forest and Agricultural Departments show what is being done in the field and in their research institutes.

*Activities displayed by the P. W. D. Irrigation Branch.*

In the Punjab, of recent years, departmental, as distinct from individual, activities have mostly taken the form of constituting project divisions, placing a few officers on special duty in connection with the lining of channels, and experimenting with the preparation of materials for their lining. These project divisions would appear to have been constituted rather for executive work than for the prosecution of hydraulic experiments and investigations, and the co-ordination of results.

*Investigation work in Hydraulics in other Countries.*

There is considerable evidence of what has been done in other countries, chiefly America. An important feature of many investigations is the use of large scale models for experimenting with, and a good insight into the style of work done can be gained from the book "The Regulation of Rivers" by Van Ornum, published by the Mc Graw-Hill Book Co., New York. In this book, among other things, a model of the River Weser in Germany is illustrated and described, as it was used for experimental purposes, prior to embarking on the actual training of the river.

In the Journal of Agricultural Research of the Department of Agriculture, Washington, there are given the results of accurately made experiments with models of weirs and notches; while in the memoirs of the Miami District Conservancy, Ohio, are to be found the results of experiments and investigations on the "hydraulic jump" or "standing wave", in which experiments large scale models were used. Scientific investigations would appear to be taken up actively in America, whenever any problem in hydraulics, requires investigation.

*Activities in Research Work in England.*

Experiments with trapezoidal and triangular notches have also been carried out in England.

In No. 6 of Volume LXIV (Saturday, August 10th, 1918) of "Indian Engineering" will be found an article entitled,

"The British National Physical Laboratory" in which reference is made to lectures, given by the Director, where he stated that the institution was intended to perform two important functions, viz.:--

(1). That of a laboratory of industrial research.

(2). That of a national testing institution.

The lecturer laid down the axiom that a laboratory should be equipped with a trained and competent staff, able and experienced, and ready both to attack the technical difficulties met with in applying new discoveries, and to develop ideas which promised future success. The article ends as follows :—" Only a few of the directions in which a central laboratory can be useful were indicated in the lecture, but it may be readily deduced from these what a large scheme of help to industry it might cover if properly extended. With the expected extension of industries, in the near future, and *with the expressed intention of subordinating everything to research*, it can be readily seen how much greater the demands of such a laboratory will be in the future than it was in the past. There is no intention that it should take the place of private research, but as a co-ordinating organization its aid will be valuable."

The use to which the National Physical Laboratory is put by the Council of the Institution of Civil Engineers is given in the "James Forrest" lecture on the "Standardization of Engineering Materials" by Sir John Wolfe Barry, in Vol. CCIV of the Minutes. The following is an extract. "The National Physical Laboratory acts as the Committee's official testing bureau, and, generally speaking, is the ultimate scientific authority in matters concerning mechanical, chemical, metallurgical, and electrical tests. It acts in an advisory capacity in practically all work in which unbiassed experimental data are essential in order to establish the facts underlying the principles involved."

The leading article in "The Builder" No. 3940 Vol. CXV. August 9th 1918 is of interest. An extract from this is as follows :—

"*An Architects' Research Institute*"

We therefore put the definite question to the Royal Institution of Architects, as representing the profession, and the building industry :—" Has not the time arrived for the formation of an Institute of Research, which shall be controlled by, and be representative of, the great and important interests

for which you are jointly responsible ? Such an institute would investigate and report on new materials, and would assist in standardizing existing materials, and thus remove doubts and difficulties with regard to specifications. It would also act as a testing authority. The administration would advise as to how far problems had already been met, and would issue instructions as to the elucidation of problems adopted for solution.

These problems would be passed on to the heads of the technical staff, who would be responsible for the carrying out of the purely technical experiments for which shops of sufficient size would have to be provided. Under the technical experts would be a number of pure scientists, say a chemist, physicist, geologist, and botanist, who would make the necessary laboratory investigations outside the field of technology. Reports, after general approval by the administration, would go to the literary section to be assembled, co-ordinated, printed, and disseminated.'

*The advantages that have been and are likely to be derived from investigation in the existing Research Institutes.*

Evidence of the work of the Forest and the Agricultural Research Institutes, the Indian Institute of Science, and the Esociet Tannin Research Factory C. I., may be found in the following books :—

The Indian Munitions Board Handbook, 1917.

The Agricultural Journal.

The work of the Forest Department, by Troup.

The advantages already derived can be seen, and those likely to be realised readily estimated, from these books.

*Proposals of the Secretary of State for India and the Viceroy of India in connection with maintaining the efficiency of the Public Services, contained in the Report on Indian Constitutional Reforms.*

In chapter XI, Miscellaneous, " The Public Services " the following will be found :—

Para. 323. " Future position of the European Services."

At least so long as the Empire is charged with the defence India, a substantial element of Englishmen must remain, d must be secured in her Government and in her Public rvices. We are making over certain functions to public trol, and in respect of these, English . . . . engineers will be quired to carry out the policy of the Indian ministers.

(*e*). The design of canal works, particularly distributary heads.

(*f*). The economical application of reinforced concrete.

(*g*). The control of silt ; in particular, the prevention of excessive quantities entering a canal at its off-take from the river.

(*h*). The control over the internal distribution of the supply after it has entered a canal.

(*i*). Hydro-electric developments.

(*j*). The coefficients of discharge of weirs and notches, when the effect of velocity of approach has to be taken into account.

(*k*). The effects of falling water, and the design of water-cushions, to absorb the energy developed.

(*l*). The testing of materials of construction.

Investigations into the possibility of making a more extended use of reinforced concrete is particularly necessary, since the development of the cement industry in India removes the former restrictions on its use, and the expected development of the steel industry should obviate the necessity for large importations and, after the war, prices should become moderate.

*The supply of material for the Research Institute.*

The Proceedings of the Punjab Engineering Congress would provide much material for experiments and investigation, and the Department could carry these out with the aid of a research institute. A great variety of subjects have already been discussed at annual meetings of the Congress, but it can hardly be said that in all cases final results have been arrived at. The Congress could be guaranteed to keep up the supply of material for investigation.

*The necessity for a Research Institute.*

In the report on constitutional reforms it is clearly shewn that the intention is to increase the number of Indians in the P. W. D., moreover it is equally clearly laid down that :—

"It will henceforth be accepted as the duty of the European officers to do all that lies in their power to fit Indians to take their places beside them."

Now, owing to the gradual depletion of the European engineer staff, there will probably be a gradually decreasing number of men of special attainments in the ranks of the P.W.D,

The department has had many notable engineers, who have carried much experimental and research work, records of which are to be found in numerous departmental technical pamphlets ; and it has at present many men of special attainments. There has been a steady advance in technical matters since the constitution of the department.

To make up for the expected deficiency in the future, it will be necessary to make provision to keep the department not only up to the existing standard, but also to ensure progress, and the constitution of a research institute should assist in carrying this out

Engineering and hydraulic investigations are mostly made by individual members of the department. There are comparatively few who take advanced positions in such matters. Many have devoted much of their spare time to investigations in some particular line of their own, but other matters of as great, or possibly greater, general utility, are liable to receive but scant attention ; moreover it will probably be conceded that the efforts of the department have not in all cases been carried to a final conclusion, and that but few of its members have time to carry out thoroughly the co-ordination of results, which, however, is very necessary.

*The Constitution of a Research Institute.*

Under the head *View taken by the Agricultural Department, as to the necessity for experimental and research work*, reference has been made to the proposals for an experimental station at Rodu Koru, near Lyallpur. In the proposals put before the Director of Agriculture and Industries, a list of ten problems to be investigated will be found. These include a few of the problems in which canal engineers are the more particularly interested. There would seem to be no reason why the scope of these proposals should not be extended, in order to include hydraulic and engineering problems requiring investigation. The staff proposed includes two engineers, and this number could be increased to suit requirements.

Under the head "*Control*" recommendations regarding the engineer establishment to be employed are given, it being fully recognised that such engineers, chosen for the staff, should remain and should not be liable to transfer back to the Irrigation Department.

*The effect on the Punjab Engineering Congress if research work be more vigourously taken up.*

If the P. W. D. would take up all the various technical matter, introduced at the annual meetings of the Congress, and would arrange for the carrying out of experiments, where necessary, and for the co-ordination of the final results, there would be a great incentive to members, not only to put forward papers for discussion, but also themselves to take a more active part in research work, but such work could best be done by the staff of an institute such as is proposed.

In conclusion the author desires to acknowledge his indebtedeness to Mr. T. R. J. Ward, C. I. E., M. V. O. late a vice-president of this Congress, for the assistance given by him in bringing to the author's notice much of the literature referred to in the paper.

## DISCUSSION.

MR. F. W. CARNE, introducing his paper, briefly mentioned some of the principal investigations which had been carried out by canal officers with reference to controlling silt; the introduction of regulating and distributing devices; the form of falls; and in other directions.

MR. H. J. MAYNARD, Financial Commissioner, Punjab, thought that the facts given by Mr. Carne might be supplemented in a few particulars. As a result of the recommendation made in 1917 for the establishment of a Seepage Board, Government had established a Drainage Board, including officers of the Irrigation, Agricultural, and Sanitary Departments, as well as officers of general administrative experience, which would investigate and advise on problems of drainage and water-logging, and ultimately hoped to have funds at its disposal to execute works or give grants-in-aid towards their execution. This body would no doubt avail itself of the results of the researches now being made at Lyallpur by one of its members, but it had no research organ. The proposed experimental station or irrigation farm, at Rodukoru, or elsewhere near Lyallpur, would test times and intensities of irrigation, in their results upon agriculture, on a field scale, with a view to conclusions regarding economy in the use of canal water, and the speaker was informed that the lining of channels, as a means of preventing percolation and the waste of water, was to be tested on a very large scale in connection with the Bhakra Dam Project. The Agricultural Department was testing, in a tank experiment at Lyallpur, the accuracy of the discharges given by a particular form of module.

In these and in many other problems of importance to irrigation, or arising by reason of irrigation, enquiry was, and had long been, perpetually in progress, but the questions for decision were whether it was systematic; and whether it was co-ordinated; and finally whether the results were collated and applied. Every canal was a vast but unorganized laboratory, and the impression which he had received from irrigation officers, when mixed problems of irrigation and general administration had been under discussion, was that the affirmative with which these questions could be answered was a qualified one. Gaps were sometimes left in the verification of hypotheses; work was sometimes duplicated; lessons of practical experience were missed or forgotten; and questions were decided by traditional rule of thumb, or upon personal convictions, which might

or might not be shared by successors, for lack of machinery to systematize enquiry. All this required supplementing with laboratory investigations and the results recorded in a form which would command attention.

The work of the Irrigation Branch had reached a stage at which further developments depended upon the systematisation and application of research by the aid of a research branch of the department ; *e.g.*, irrigation could not be developed to the maximum, until water-logging and waste had been dealt with—two sides of an identical problem—this could not be done, until the laws were finally determined by which water travelled when it was in the soil, and how soil travelled when it was in water. Such a research branch would naturally not limit itself to irrigation questions, when qnestions of interest in other lines of Public Works Department work required solution.

MR. W. S. DORMAN said that the subject had been ably ventilated some years ago by Mr. Colyer ; and he did not think there was very much more to be said. Research was greatly needed in the Buildings and Roads Branch. For instance, the question of road maintenance in the Punjab was becoming very acute. Stone metal was difficult to obtain, its price was mounting up, and the kankar were beds gradually being exhausted. Mr. Lindley had called his attention quite recently to the progress being made with sand-clay roads in America, and he considered that a little research work would result in considerable improvements, as well as saving a good deal of money, on the metalled roads in this country, where, in some cases where traffic was heavy, roads had to be re-surfaced every year. Again, everybody was aware of the damage done to their buildings by saltpetre and white ants, and the cost of making good that damage must, on the aggregate, amount to lakhs of rupees in the year. Colonel Cra'ster, their late President, had started some elaborate experiments, the results of which had been placed before the Congress, but the matter had not been systematically followed up, with the result that the profession as a whole had not benefited, but went on in the same old blundering way.

Other instances could be cited, and he was personally satisfied that until research was more definitely encouraged the work of the department would continue to suffer.

MR. R. M. MAC GREGOR supported the proposal. He thought it was the most important of all the matters discussed by the Congress, because it covered all others. It seemed to

him, speaking from the point of view of the Irrigation Branch, that most of the matters discussed by the Congress could be more thoroughly and satisfactorily investigated by an official body like the proposed technical section, than by what was after all only an unofficial debating society. He pointed out that whereas the engineers of the Buildings and Roads Branch of the P. W. D., and of the Indian railways had to deal with problems which had already been solved in other parts of the world, this was not so with the Irrigation Branch, which had to solve its own problems, and build up its own science and literature. To do this would be the function of the proposed section. It would also serve a useful purpose by producing a quarterly publication containing not only the results of its important investigations, but short notes on points, which though of interest, did not provide material for a paper to be read before the Congress. He thought that the first duty of such a technical section would be to collect and analyze existing information, of which a mass existed in many offices in the Province. The result would show the gaps in their knowledge and indicate the lines of future investigation. He might add that a section, such as was now proposed, had actually been started in 1911 by Mr. Gordon, Chief Engineer, but had for some reason been abolished by his successor. This was the second time that the proposal had been before the Congress, and he thought they should appeal to Government to give effect to it.

MR. C. A. COLYER was gratified to notice that Mr. Carne had very forcibly brought out in his paper the extension and amplification of what he, with a certain amount of hesitation, had brought before the Congress in 1915. Being somewhat junior he had a great deal of hesitation in putting forward so big a question. Some speakers thought that he had then offered it as an original idea, but, as he had pointed out in his paper, there were several departments, institutes, etc., of the kind in various countries in the world, and there had been such an organization even in their own department. A reference to the discussion on his paper in 1915 would show that the idea was then ably supported by such men as Mr. Gibb, Lala Radhika Narayan, Mr. Carne, Rai Bahadur Bishambar Nath, Mr. Wadley, Mr. Dorman, and Colonel Cra'ster, all practical engineers, whose support of this idea should have been of very great weight. His object in writing that paper, was to lay a personal idea before the Congress, in order to form a nucleus for the opinions of men much more qualified than himself,

and, by bringing the matter forward, to put the scheme into definite practical expression. Mr. Carne, after four years, had again brought up the question, and his seniority gave force to its importance. Discussing the matter with engineers, he had during the last three or four years observed an extraodinary unanimity of opinion on the matter ; ninety per cent. of their men said " we want it ; we must have it, as we cannot give our whole time or a sufficient portion of it to thoroughly investigate various important subjects."

Collection, collation, co-ordination, and dissemination, were all wanted. There was a vast number of records, on every conceivable subject, spreading over the whole period during which the Public Works Department had existed in India, and this contained a vast amount of information, which if collected, collated, and disseminated, would help them forward immensely. Somebody had remarked about this " What was everybody's job was nobody's job ". Everybody—at any rate a large number of them—wished to have this thing ; but there did not seem to be any chance of getting it unless some means could be found of giving it definite expression, and asking Government, in an official or non-official manner, whether they—the Punjab Government—would be prepared now to take up this question and help in starting it in some small way. The speaker hoped they would obtain some more definite information, as to the means and channels by which they could get these ideas advanced in a more permanent and a larger way than at present.

MR. F. W. WOODS said that he was opposed to the suggestions, which he regarded as impracticable. He was all in favour of scientific research, but he did not think that the proposals in the paper under discussion would facilitate such research.

Scientific research did not begin and end with the creation of a new department of State, the appointment of new officials, or the creation of new jobs. The Irrigation Branch was in itself an existing department of scientific research. It had produced good results in the past and would continue to do so in the future. Mr. MacGregor had said that a research institute would be more useful than this Congress, but on behalf of the Congress, he was not prepared to agree to that idea. It was better to have the whole body of members of the Congress interesting themselves in practical research and discussion, than to have them relying on the studies of a few professors in a college. He did not deny that a scientific research institute

might have its uses, especially in connection with agricultural problems, but he did not think it was needed, or was the most suitable agency for the study of problems in canal engineering. Mr. Carne, in his supplementary remarks, had referred to many objects of scientific study, such as irrigation modules, syphons, canal linings, &c., but, as a matter of fact, all these matters had been usefully studied in the past by canal engineers, and he felt that it was better for each Executive Engineer or Sub-Divisional Officer to carry on practical research in the course of his ordinary duties, than for these officers to get into the habit of thinking that scientific research was not their business, but that of a few selected *pandits* in a central college.

This idea of establishing a research institute was nebulous, and based on a certain degree of a misapprehension. In this respect it was on a par with the proposal made some years ago byMr. Barnes of the Agricultural College at Lyallpur, that an expert physicist should be attached to his staff for the study of hydraulic problems. The people who made such proposals did not understand what could be accomplished thereby, and did not even know what had been done in the past in the direction of research. Reference had been made to what was being done in other countries, and especially in America, in the way of establishing scientific research institutes, but he was not aware that the Punjab could be taught anything, at any rate in canal irrigation science, by any other country in the world. He believed that, so far as irrigation canal engineers were concerned, it was better for them to continue scientific research in connection with their ordinary everyday duties, as had been done in the past by engineers of eminence like Dyas, Anderson, Beresford, Kennedy and many others, than to leave the higher activities of engineering science to a few professors, who could hardly be expected to be in touch with the practical problems of engineering, in the field, the river, or the canal.

MR. F. H. BURKITT pointed out that the average engineer was not trained for research and his duties did not leave him adequate time for experiments. In America, where the value of research work to the country was recognised, it was carried on in a central institute, while in India, for want of co-ordination, much experimenting was duplicated and much was left undone or incomplete.

MR. E. S. LINDLEY pointed out that within the last few years Mr. Woods had himself presented three important

papers to the Congress. In 1917 he issued a note on the dimensions of regime channels, based on the observations that he had made very many years before, but in the interval, the whole Triple Canal Project had been constructed without regard to the dimensions that he had since shewn to be best. This meant a waste of lakhs of rupees that would have been avoided if the results of Mr. Woods's studies could have been worked up and presented more promptly.

MR. J. B. VESUGAR remarked that a laboratory did not mean a circle of hoary professors playing about with test tubes and bottles, and instanced the National Physical Laboratory. In supporting the proposal, he felt that a research section would save endless waste of money now spent through incorrect design. Referring to Mr. Wallace's paper on reinforced concrete, it seemed to him that no observations of any sort had been taken. For such work instruments were required, and if there was a reseach institute these instruments would always be available. A laboratory would help to eliminate the factor of safety, which was really a polite name for the factor of ignorance, but such a laboratory should be for the whole of India and should cover the interests of all classes of engineers.

SIRDAR BAHADUR LAHNA SINGH advocated the early establishment of a research institute, as giving engineers an opportunity of at least seeing some experiments, and thus having a chance of learning more. An irrigation engineer was not merely concerned with the distribution of water, he was also concerned with the products of the country, and in most cases was more closely in touch with the people than any other civil officer. It would, therefore, be beneficial both to canal and other engineers if an institution were established in a suitable place. A government engineer did not find it possible to carry on research unless his superiors were in sympathy with his object, and he, therefore, asked that some facilities should be granted for the purpose, as he believed that an institution of the kind would be of general assistance.

MR. K. G. MITCHELL regretted that the constitution of the Congress did not apparently provide any means by which the meeting could record its opinion on Mr. Carne's proposal, which did not involve any debatable scientific theory, and urged the author in closing the discussion to put his proposals in the form of a resolution, which the chairman might or might not rule out of order. He disagreed with the Hon'ble Mr. Woods that a research institute would discourage individual investiga-

tion, rather the reverse. They were all apparently agreed that what was wanted was not so much a laboratory as a bureau where the results of research could be examined. He felt that the reception accorded in the past to the result of private investigation had depended largely on their relation to the past theories of the chief engineers for the time being, but results published on the authority of the bureau would carry weight and even chief engineers could not absolutely ignore them.

The proposed bureau, therefore, in addition to inaugurating and conducting such research as its resources permitted, would distinctly encourage the private investigator and should be strongly supported.

MR. C. B. BARRIE, the chairman, remarked that he would like to say a few words from the railway engineer's point of view. The Railway Department at one time had a technical section in India, which called for papers from engineers ; published them; and issued them free of cost to all officers above the rank of an assistant engineer. This section was started some twenty-five or thirty years ago, and had issued about 180 papers. A few years ago it was abolished, but he was glad to observe that the Chief Engineer with the Railway Board had lately revived it. Many valuable papers were published, and among them one by Sir Francis Spring, entitled " River Training and Control ", which had become a classic, and which would be much appreciated by the irrigation engineers present. It was a type of paper that could not be produced by a research institute.

The other day he was talking with Mr. Bagley about the proposed reorganization of the Thomason College at Roorkee, and agreed with his opinion that the attempt to convert it into a research college was unwise. The primary object was to train engineers, not chemists or physicists. So in their life's work it should be borne in mind that they were engineers first and foremost. With regard to the proposal made by Mr. Carne to form a research institute, he considered that engineering difficulties and problems should be solved by the engineer on the spot himself and not by the application of rules and formulæ manufactured by research students in a laboratory. Speaking from the railway engineers' point of view he felt the need for the collection and dissemination of information already in their records and files, rather than for research into questions which had no practical bearing at the moment.

Mr. Woods had referred to the fact that the establishment of a research institute would discourage the members of the profession from tackling their difficulties in the proper spirit of the engineer. As a concrete instance of this he would mention that at one time the work of calculation in connection with girder work was done by the executive engineer ; but as his ordinary work became heavier, it was found advisable to appoint a bridge engineer to do all this. Most large railways now had a bridge engineer, and the result was that any problems of this nature were referred to that official. The bridge engineer was necessary, but the fact was that difficulties, which would have been solved by the engineer on the spot, were too often passed on to him.

MR. M. S. DHODY noted that the proposal for a research institute was natural in the evolution of the Congress, but it remained to be seen how it would actually work. There was no doubt that officers had less spare time now than they had in the past. Was it a fair supposition that any one who had a new idea would entrust it to an institute, and then wait for results and the pronouncement of the institute ? Would the institute officer be equally enthusiastic about the matter, or would he have to be constantly referring for advice to the originator of the idea ? Again, would an originator like to place his pet theories before an outsider ? Would Kennedy or Gibb have placed their module ideas before an institute. If it were a question of getting things analyzed in a laboratory, it would be different, but when the idea was a problem that had to be evolved at each stage, and altered or modified many times, it could only be properly managed by the originator. It would be more useful to be given the facilities for observation and experiment at suitable places, than to have to make over one's ideas (that were sometimes crude at the start) to another. For such work the Congress was the best place to give an exposition, and get criticisms and side lights, and then to go back to work on it. Should there be further need and confidence for work, the matter could be taken up officially and facilities demanded.

MR. F. W. CARNE, in replying, said that Mr. Woods appeared to think that it was proposed to stock a research institute with professors, who would not be of the least use for the prosecution of investigations, such as were enumerated in the paper, under the head of subjects for investigation, but such was not the case. The author would point out that the Punjab P. W. D. had a technical section, but that section did not under-

take the investigation of hydraulic problems, so what was wanted was an extension of that section for investigation into matters incompletely dealt with by members of the Punjab Engineering Congress or others, and for the collation and dissemination of results.

It would consist of engineers, who would be employed on the investigation of hydraulic problems, and, who, when *it* was necessary, would go out on to the canals, and carry out the investigations there which could not be carried out inside the institution. The proposals put forward in the paper were in connection with the difficulty experienced, by canal officers in particular, in finding time to carry out experiments and investigations in a complete manner, or to do justice to their work of research, and to provide them with the necessary facilities and assistance.

The author regretted the absence of Mr. Faulkner of the Agricultural Department, who, he understood, had been invited by the committee to enter into the discussion on the paper in connection with a paper of his own on somewhat similar lines which he had offered to the committee. Finally the author thanked those who had joined in the discussion, which shewed that the matter was of some interest to members.