Development of Building Research in West Pakistan

By
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ROLE OF RESEARCH

Progress in the Building Industry depends on improvements in its many fields of activities like ; planning, development, crafts and their training, production and supply of materials, information, testing and research facilities, etc. There is a role for the application of the methods of scientific research to problems in all these fields of activity. Scientific knowledge and its application can assist in many ways in the field of economic and operational as well as technical research. For instance, modern techniques of soil investigations and foundation engineering can assist the planner to distinguish between land which can be developed at reasonable cost from that which cannot be, can show how best to build economically on sites where soil conditions are unfavourable.

NEED FOR RESEARCH IN WEST PAKISTAN

Scientific investigations of various problems of building research have not yet been started in this country on sound basis. The experience and research work done by others can guide and simulate better buildings, but can rarely, if ever, provide a readymade solution. Only by painstaking efforts can, methods best suited to the time and place be developed.

It is for this reason that advanced countries are continuing their research work on more extensive and highly technical lines and some have advanced to the extent of separating organizations for various fields of building research. Pakistan has only recently made a start in building research and we are way behind others in this particular field. While many of the problems in Pakistan would be similar to those encountered by other countries but there will be some of special interest such as comforts and efficiency in tropical conditions, study of soil stabilization and non-erodable mud plaster, use of indigenous materials particularly gypsum and lime which is available in abundance in this country, utility of industrial wastes etc.

HISTORY OF BUILDING RESEARCH IN WEST PAKISTAN

Until May 1961 the activities of Building Research in this country remained undefined although record is available of the sporadic efforts made

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off and on. Actually the Building Research acvtities have been an offshoot of the defunct West Pakistan Building and Road Research Laboratory, the history of which dates back to the year 1944 when a Soil Stabilization Construction Division was established to work on the soil stabilization of roads. With the migration of trained staff at the time of independence, the Laboratory was downgraded to a Sub-Divisional charge. After independence the scope of work for the Laboratory was not very clear as most of the activities of the Soil Stabilization Sub-Division remained obscure till 1951 when the Laboratory was again brought up to the status of a Division.

Since 1951 the work of the Building and Road Research Laboratory increased and its Divisional status was restored under an Executive Engineer designated as Research Officer. But the main emphasis was towards the testing of aggregates, design of concrete mixes and design of road pavements. Some traces are available of the modest research work done on cement stabilization etc. The work, however, progressed slowly and an Assistant Research Officer was added to the staff in October 1953. Another Assistant Research Officer was taken in staff in March 1954, and the tempo of the work naturally improved.

Two sections namely Building Science and Concrete Section were added to the Laboratory in 1953. From 1953 to 1961 the emphasis in the Laboratory remained primarily on testing of road and building materials due to the pressing demand of the field engineers. Efforts were made, however, to initiate a few building research problems and whatever work was reported in the defunct Building and Road Research Laboratory bulletins.

From the preceding paragraph it is seen that the Building and Road Research Laboratory had done some work on buildings. The progress would have been much better if attention of the Laboratory and its staff had not been diverted to extra-curricular activities. For instance from 1954 to 1960, the Laboratory was in charge of all the protocol duties on behalf of the department and used to conduct opening ceremonies of various projects. At the time of integration in 1955 the Laboratory was made incharge of additions and alteration work in the Civil Secretariat and brick burning operations for the construction work in Lahore. This, however, provided an opportunity to the research staff to have some field experience. The work of plastering Badshahi Mosque walls was also handed over for execution to the Laboratory owing to the special design of plaster involved. This work was successfully accomplished. In addition, the staff and the officers have been deputed at times to various emergent projects like putting up of the exhibition at Lyallpur, supervision of construction of bridges on G.T. Road and of keeping watch over

Lahore Protective Bund during floods etc. These works have been diverting the attention of the Research staff and as such n o planned work was possible.

HOUSING PROBLEM

Housing remains one of the unsolved problems of the country. The importance of housing is only next to food and clothing and is the most essential necessity of life. With the advancement and development in social and economic field, the need for healthy and wholesome living has become more pressing. Yet for several decades, both in respect of quality and quantity of the housing accommodation, no progress has been made in the country as a whole. In fact, the conditions have worsened considerably specially in the urban areas and for low the income groups. The steep rise in land values, extreme shortage of building materials and the ascending cost of construction as a consequence of these and other factors have aggravated the housing difficulties of the people.

The task of housing our millions is a colossal one, both for the urban and rural population and enormous resources will be required to plan and build the housing settlements. A large influx of refugees after partition aggravated further the housing situation as over six million refugees migrated to West Pakistan. According to the First Plan, the refugees' population alone needed as many as 500,000 dwellings in Pakistan which would need many years of house building effort. The Government consequently embarked on big satellite town projects but the problem is very far from any solution. The housing situation has not improved even in the Second Plan period.

EXPENDITURE ON BUILDINGS

The Third Five-Year Plan which has gone into operation from July 1965, provides for an expenditure of about four thousand million rupees to be exclusively spent on the building projects related to Education, Health, Social Welfare, Power, Transport, Works and Communications, etc., both in Private and Public sectors in West Pakistan. This will give an annual expenditure of eight hundred million rupees on building construction in West Pakistan alone. This development programme is the highest since independence and is undoubtedly greater than any previous effort in the entire history of this part of sub-continent. This huge expenditure deserves more careful designing and better planning in the use of land, economical use of expensive building materials so as to reduce waste, and to produce structures and buildings capable of affording a comfortable living and worthy of the amount spent on them. The only way to find an answer to all the problems is to embark on extensive research programme like every country of the world

BUILDING RESEARCH NUCLEUS

The West Pakistan Government set up a small Building Research Nucleus in May 1961 to frame a Scheme for the establishment of Building Research Station in this country. This was necessitated due to the exponential increase in the cost of building construction and the Government ultimately realized the necessity of setting up an institution which would probe into the problem and find out ways and means to reduce the cost of construction by developing new techniques and revising the prevalent specifications and increasing the use of local building materials.

It took a few months in organizing the office and arranging staff as lot of formalities and sanctions had to be obtained. The following terms of reference were assigned to the nucleus :—

(*i*) Scrutinizing the existing specifications and their revision.

(*ii*) Collection of information in respect of similar organizations abroad, and

(*iii*) To prepare a scheme.

The Building Research Nucleus, in addition to the above terms of reference, carried out theoretical studies and analysed a few buildings to pick up some of the expensive items for effecting economy by suggesting different specifications.

In the latter part of January 1962 two Laboratory Sections dealing with building from the defunct Building and Road Research Laboratory were attached to the nucleus and emphasis was shifted from testing to research in these two sections. During the last four years significant achievements have been made.

DEVELOPMENT PACE AND ASSISTANCE BY BUILDING RESEARCH

To raise the standard of living and achieve a certain degree of self-sufficiency, there is lot to be done to develop West Pakistan in achieving the desired targets. During the past, due to the meagre financial resources of the country diverted mainly to shelterless families, it has not been possible so far to attack the housing problem in a systematic manner. The research work carried out by the Building Research can directly reflect on our huge building activity. A small saving can run into an economy of millions of rupees. The work carried out by the Building Research Nucleus has already started showing its effect on the buildings now being constructed. The specification so far framed by the Building Research Nucleus can cut down the cost of construction by at least twenty per cent and with the development of Building Research

Centre, it will be possible to have more economical, functional and more comfortable buildings. Taking a very conservative estimate of economy as ten percent over the whole range of building construction during the Third Plan period, an overall saving of the order of four hundred million rupees can be affected in this period.

ACHIEVEMENTS OF BUILDING RESEARCH

During its short existence of about four years, some useful work has been carried out at the nucleus. The work of this organization has been appreciated locally and recognized abroad. It is not possible to discuss here all the topics under investigation. The achievements of research under a few main headings are given for which the work has been completed and the items developed have gone into practice in the field.

(*i*) New Bricks

The stress analysis of walls of buildings has shown that the bricks remain much under stressed. As for a single storey building, the maximum stress does not go beyond twenty-five pounds per square inch, and for a four-storey building the maximum stress in the brick hardly reaches ninety pounds per square inch. Similarly, the maximum stress developed in a masonry pier of a class 70 loading bridge does not increase beyond one hundred pounds per square inch. The Station has tested a vast range of bricks and has found that even the present-day bricks which are known for their poor quality have a crushing strength of about 1500 pounds per square inch. The factor of safety of bricks is, therefore, abnormally high which evidently calls for reduction to affect economy as other components of the buildings are designed at a much low factor of safety ranging from three to four. The Building Research Station has therefore probed into the various possible combinations of dimensions which would give an economical size compatible with the structural safety of the building. The Station after going deep into the historical background of the size of the bricks has developed a new size of the bricks which has also been now standardized and adopted by the Pakistan Standards Institution. The recommended size is $7\frac{5}{8}'' \times 3\frac{5}{8}'' \times 3\frac{5}{8}''$ which comes to $8'' \times 4'' \times 4''$ with mortar.

This size has more than one advantage. By using the new size, twenty-five percent saving in mortar and ten percent saving in number of bricks is achieved. At the same time, the productivity and progress of the masonry work is increased by at least twenty-five percent. The new brick is $\frac{1}{2}$ lb. lighter than the conventional brick and is easy to handle.

(*ii*) **Zed Tile Roofs**

One of the major and the most expensive items in a building is its roof With the ordinary conventional reinforced concrete slabs the roof costs about Rs. 3.50 per square foot. The cheapest type of improvement in roofing devised by the Building Research Station so far is the manufacture of Zed Tiles which are made out of ordinary 1 : 2 : 4 concrete. The tiles are $2\frac{1}{2}' \times 2\frac{1}{2}'$ in plan and 1'' thick and are made without reinforcement. The process of manufacturing of these tiles is extremely simple and these tiles can be made at site of work even by an unskilled labourer without involving any expensive shuttering or machinery.

(*iii*) **Hollow Roofs**

The major problem in this country is to ward away the summer discomfort during the months of April to September. Roof forms an important component of a building as it receives the highest solar load thus affecting the indoor climatic conditions. For a place like Lahore (31°-30′ North), it has been estimated that direct solar radiation incident on a clear day on roofs varies from 44 to 53% of building during the hot summer months. This high intensity of the solar load is welcome in winter but most undesirable during summer as it correspondingly raises internal temperature of a room.

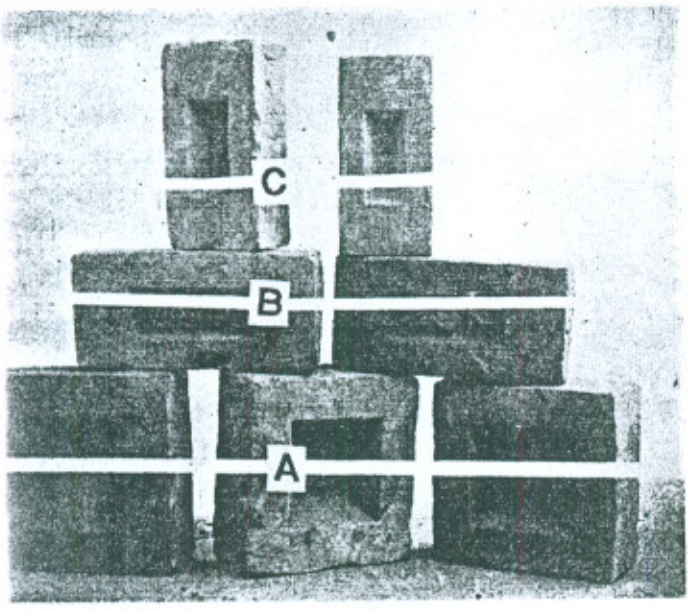
Till about four decades ago, roofs used to commonly consist of wood in this country. These roofs, however, have been replaced due to scarcity of good quality of wood and rapid ingress of the reinforced concrete technology in the Building Industry. The reinforced cement concrete slabs give flat ceilings and are not liable to termite attack but these roofs have a very high value of thermal conductivity which is a source of great thermal discomfort.

The Building Research Station has developed the Hollow Box Slab which will cost almost the same but will provide better living conditions indoor due to the horizontal air cavity which has been introduced in the roof.

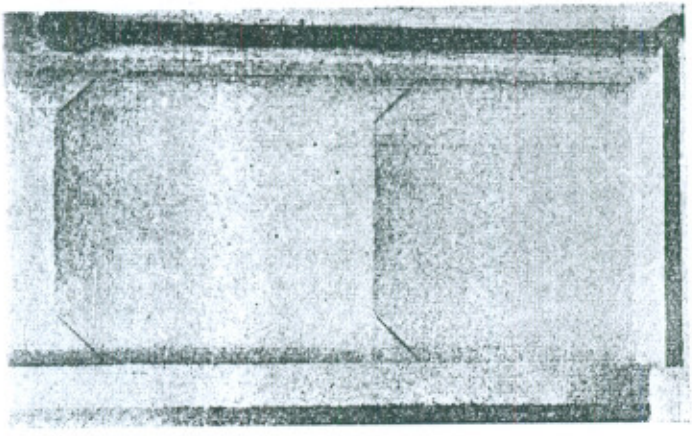
Since the Hollow Box Slab requires greater skill in its construction due to double shuttering involved, the Station has recently modified this roof by replacing its structural slab with Zed Tiles. Both these roofs have been laid in the Building Research Station and can be inspected. These types of Hollow Roofs will provide about 73 to 81% more insulation for almost the same cost and will give flat ceiling underneath. Although the cost of these types of roofs is the same as R.C.C. solid slab, there will be at least 50 percent less demand on steel for these roofs.

(*iv*) **Polythene as a Building Material**

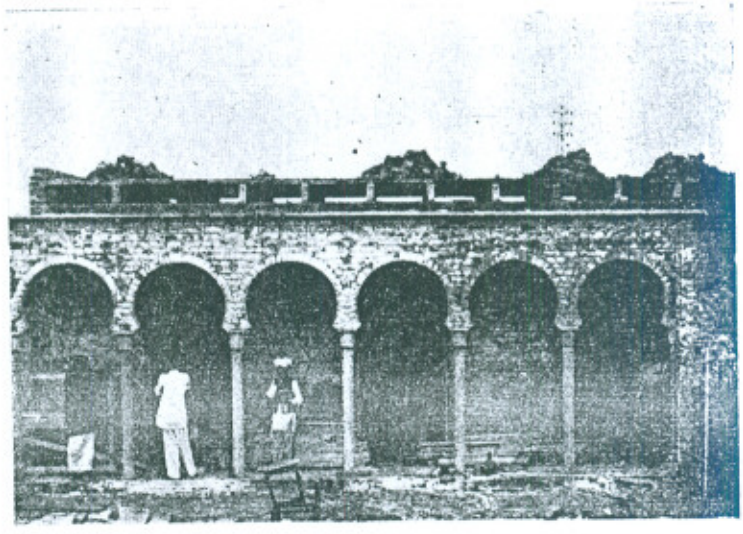
Polythene is a material locally available which has been introduced in the Building Industry by this Research Station. The Station has used this



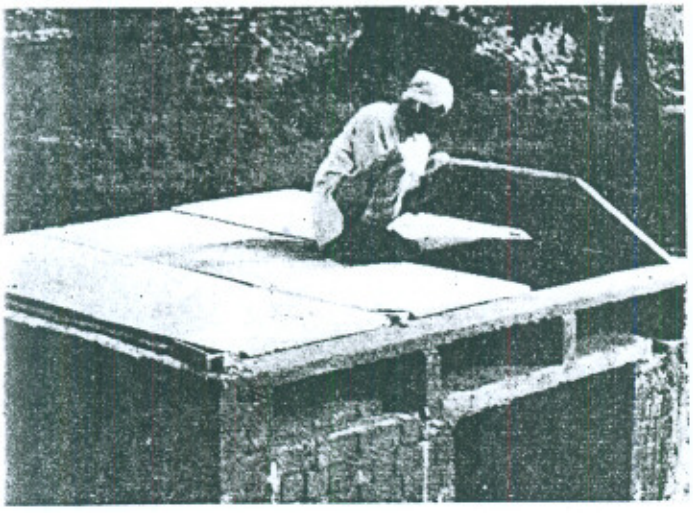
(1) New bricks :
A : Double size brick ($7\frac{5}{8}\times7\frac{5}{8}\times3\frac{5}{8}$ in.)
B : Conventional Brick ($9\times4\frac{1}{2}\times3$ in.)
C : New Brick ($7\frac{5}{8}\times3\frac{5}{8}\times3\frac{5}{8}$ in.)



) Zed Tile Roof :
Panels of Zed Tile laid over battens.



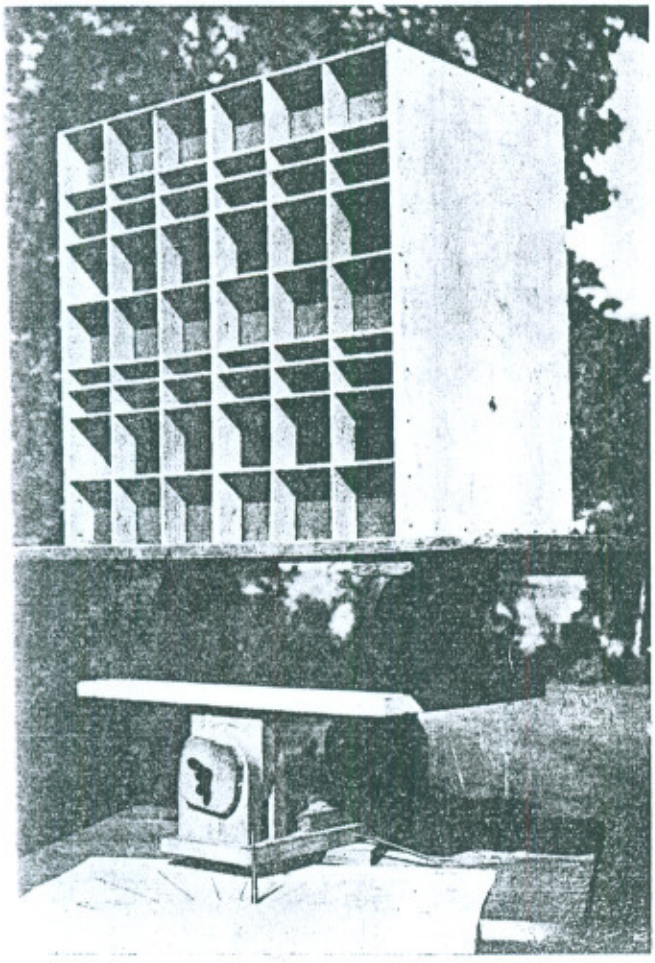
(3) Hollow Box Slab :
A Hollow Box Slab laid over Mohalla Mosque Wahdat Colony, Lahore.



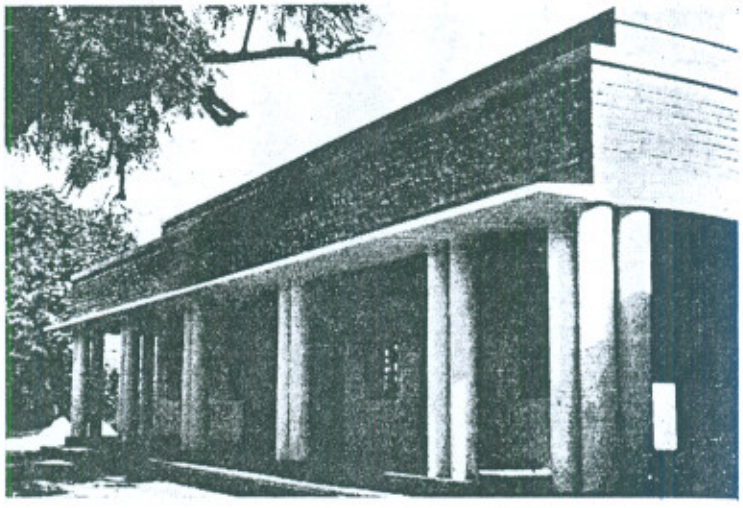
Zed Tile Hollow Roof :
Zed Tile Hollow Roof laid on a room in Building Research Station Lahore.



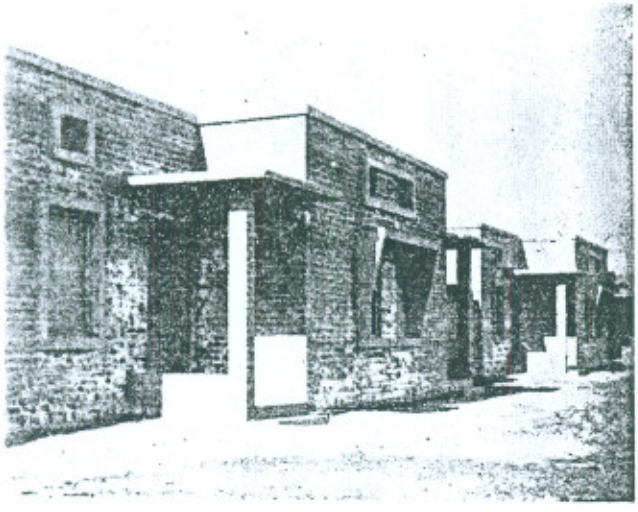
(5) Polythene being laid as a Damp-proof Course in the walls.



(6) Sunshade Table.



(7) Office of Co-operative Development Board, 1-Mozang Road, Lahore, Built with specifications of Building Research Station Lahore.



lony of Quarters built with the specifications of ding Research Station Lahore at Lyallpur.



(9) Shops built with the specifications of Building Research Station Lahore at Thano Bulla Khan.

material as Damp-Proof Course for a roof as well as for the walls. In the demonstration rooms erected in the compound of the Building Research Station, polythene has been effectively used as Damp-Proof Course material and the observations of the last three years indicate that this material has been a success. This material has also been used in the shuttering to get smooth surface. Polythene has also been used for damp proofing over an old all-time leaking roof and the observations of the last three years show satisfactory results.

(*v*) Sunshade Table

A 'Sunshade Table' has been developed in the Building Research Station which can be utilized for studying sunshine and shade pattern of buildings at different latitudes and for different orientations. This table is capable of rotating along the three axis and uses the sun as source of light. This table can take a model of $2\frac{1}{2}'$—$2\frac{1}{2}'$ and can be used for determining the shade pattern of any building for any time at any place on the earth. The table is provided with a shadow chart for the equator and has a standard size pin. The table can be operated by fixing the chart at an angle equal to the latitude of the place and turning the table along different axis to make tip of the shade of pin touch the time for which investigation is desired. One can then observe the shade pattern and determine the placement of louvers etc. on the model of the building under investigation.

WORK IN PROGRESS

In addition to the above new items developed in the Building Research Station, the following items of work are under progress and are at various stages of investigation.

(1) Cavity walls.
(2) Climatological and Solar data.
(3) Setting up of Wind Tunnel.
(4) Production of Lime Hydrate.
(5) Testing of Masonry Mortars.
(6) Testing of adhesion between mortar and bricks.
(7) Testing of non-erodable mud plaster.
(8) Testing of crushed stone aggregate.
(9) Testing of flat arches and study of lintels.
(10) Testing of no-fine concrete.
(11) Thermal Comforts.

ADOPTION OF BUILDING RESEARCH SPECIFICATION

The Building Research Station during its very short existence has developed new specifications with regard to all components of the building. In these recommended specifications the major emphasis has been on the removal of wastage in material and labour. The new specifications are capable of reducing the cost of building construction by at least four rupees per square foot.

The Building Research Station with its very limited resources of man power has been making continuous efforts for the adoption of these specifications so as to effect saving on a national scale. It has so far succeeded in getting an office block of the Cooperative Development Board at 1-Mozang Road, Lahore constructed with new specifications partly. This building was completed about 2½ years back and has an area of 2300 sq. ft. Although the specifications of the Building Research Station have been partly followed in this building, a saving of three rupees per sft. of plinth area was affected. The specifications used in this building are the Zed Tile roof, postfabric system in woodwork, floors etc. This building has now become a living monument of the soundness of the specifications recommended by the Station and should inspire confidence in other Engineers to follow the lead given by the Cooperative Development Board.

The specifications recommended by the Building Research Station have been completely followed for the construction of 16 Nos. residential quarters at Lyallpur.

Cavity wall has been constructed in Mohallah Mosque Wahdat Colony, Lahore. Hollow Box Slab has also been laid in the same mosque. These innovations have been introduced in this building for better thermal comforts.

It is a happy occasion to report that the Building and Road Department has also 10 Nos. quarters at Wahdat Colony Lahore. These specifications have also been used at places like Dera Ismail Khan and Hyderabad, etc.

Although some ingress has been made by these specifications in the Building Industry, it is high time that the Building and Road Department gives serious consideration to the adoption of these specifications on a large scale. Assistance of the Building Research Station will always be available. The saving of four rupees per sft. of plinth area is not at all a mean figure and if these specifications are widely practised all over the country a huge saving in the expenditure can be achieved.

COLLECTION OF RESEARCH LITERATURE

The Building Research Station during the course of its short existence has developed contacts with sister organizations all over the world and has

collected the research literature from UK, USA, Canada, India, Japan, Israel, South Africa, Australia, CIB, and the United Nations.

The useful literature has been bound, titled, marked and arranged for use by the research workers in the Station. A major part of the research literature has been abstracted and cards have been prepared for reference by the research workers. The total number of research papers in hand at the moment comes to over three thousand.

TESTING FACILITIES

The Building Research Station since its formation is putting its major emphasis on research but testing services are being provided to various government and non-government agencies and even private builders. These facilities consist mostly of soil investigations of sites for foundation purposes, design of concrete mixes, testing of bricks, concrete, sand, aggregates etc. The Building Research Station during the last four years has received more than Rs. 70,000 as revenue out of testing charges.

PUBLICATIONS

During the last four years the following publications have also been issued for the benefit of the Building Industry in this country.

(1) Low Cost Housing Studies No. I—Economy in Foundations.
(2) Low Cost Housing Studies No. II—Economy in Wood Work.
(3) Development of New Size of Bricks and their influence on Economy. By Ashfaq Hasan.
(4) Low Cost Housing. By Ashfaq Hasan.
(5) Foundation and Allied Problems in Soil Mechanics. By Mian M. Hanif.
(6) Influence of Parapet Walls on the Ventilation of Roofs. By Mian M. Hanif.
(7) 'Sastee Imarat'. By Ashfaq Hasan, Mian M. Hanif and Modood Ahmed Qureshi.
(8) The Zed Tile Roof. By Ashfaq Hasan and Modood Ahmed Qureshi.
(9) Building Construction. By Ashfaq Hasan.
(10) Polythene as a Building Material. By Ashfaq Hasan.
(11) Economy in Rural Works of West Pakistan. By Ashfaq Hasan.
(12) Some Aspects of Low Cost Housing. By Mian M. Hanif.
(13) Building Research Pavilion at the P.W.D. Centenary Engineering Exhibition. By Mian M. Hanif, Modood Ahmed Qureshi, and Ch. Ghulam Hussain.
(14) Room Sizes for Zed-Tile Roofing. By Ch. Ghulam Hussain and Mian M. Hanif.