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The fritz engineering laboratory - the present research role and the new facilities now being added, Address to Kiwanis Club of Bethlehem, (September 1953)

W.J. Eney

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Address of Professor W. J. Eney Before Kiwanis Club
Thursday, September 10, and
Mercer County Chapter
New Jersey Society of Professional Engineers
Wednesday, October 7, 1953

THE FRITZ ENGINEERING LABORATORY - ITS PRESENT RESEARCH ROLE
AND THE NEW FACILITIES NOW BEING ADDED

Forty-five years ago, in the Spring of 1909, Mr. John Fritz, then eighty-seven years old, and one of the original Trustees of Lehigh University, said to President Henry S. Drinker:

"I want to tell you something. In my will I have left Lehigh University a certain sum of money, to be expended in your discretion. I now intend to revoke that bequest. Yes, I'm going to revoke that bequest, and instead of leaving money for you to spend after I am gone, I'm going to have the fun of spending it with you and Charley Taylor. I have long watched the careers of a number of Lehigh graduates, and I have been impressed by the value of the training they have received at Lehigh. But you need an up-to-date engineering laboratory and I intend to build one for you."

Mr. Fritz then set about to design the laboratory, and it is recorded in his autobiography that he personally selected much of the equipment and supervised its erection whenever he could be on the campus. Also, with great foresight, he provided a modest endowment which has helped keep the laboratory operating.
Fitted with what was then the world's largest vertical testing machine, capable of testing tension and compression specimens 20 ft. in length and of 800,000-lb. capacity, the laboratory for many years fulfilled John Fritz's dream. Not only did John Fritz's gift help expand our knowledge of the properties of engineering materials and the behavior of structures, and enable engineers to design safer structures with more economical use of materials, but it has helped in the training of at least three groups of engineering and research personnel. First, those who go into industry to carry on research programs for their new employers; second, those who, as young civil engineers with the latest knowledge of structures or hydraulics, after further professional experience, conceive and design our bridges, buildings, and dams; and third, those who build on this training and carry on as teachers and research investigators at Lehigh and other institutions.

Each group of men who worked and taught at the laboratory have added to its reputation until today we serve not only the industries of the Lehigh Valley, but of all parts of the nation.

Typical of these research projects are those just completed in the laboratory. Slides 1 and 2 show large concrete airplane hangars. Similar hangars are made of structural steel. Slide 3 shows a steel model which was tested in Fritz Laboratory by Dr. Thürlimann to check the design procedures for the actual hangar.
Slide 4 shows a prestressed concrete beam which was recently tested by the speaker and his associates in such a way as to lend confidence in their safe use in a highway bridge. Fig. 5 shows a steel girder that has been twisted, and Fig. 6 shows a steel building frame that was loaded to destruction under the direction of Dr. Lynn S. Beedle and F. W. Schutz. Fig. 7 shows the teeming of open hearth steel from a ladle into ingot molds. Fig. 8 shows one of three models designed and tested by Dr. Knudsen to obtain a lighter and stronger ladle so the same crane could handle a heavier pay load.

The layman, looking in admiration at the great steel structures, the long bridges, the skeletons of the skyscrapers, does not realize how limited has been the opportunity for the civil engineer to verify his stress calculations and choice of the steel section used in those structures. He hears, often, how the automobile and the aircraft manufacturer tests and re-tests his products, strengthening the weak parts and removing material from the overly strong parts, until he approaches the ideal design. Many engineers EVEN lose sight of the fact that the bridge designer can often test his structure only by the performance it renders. It is a tribute to these designers that so few structures fail to give satisfactory service.

Today we see larger and larger structures being undertaken, and there is a growing conviction among engineers that the large components of these structures should be tested.
In all probability, such tests will reveal that in many cases smaller members can be used. This is important, not only because of the direct saving in material, but because as the bridge becomes heavier, the span becomes limited as the strength of the material is used in just supporting itself. Little strength remains to resist the wind storm or carry the highway and railroad traffic. Likewise, in the building, if excessive steel is used in the framework, the foundation loads are increased and the usefulness of the building is impaired or its construction made more difficult.

Heretofore the greatest handicap to large scale testing has been the lack of such facilities as laboratory floor space, especially space for complete bridges and buildings, and a large capacity testing machine. A bold plan for a new laboratory with facilities that would again make Fritz Laboratory the best in the world was projected, and now, as all of you know, is to be accomplished with the cooperation of the Bethlehem Steel Company.

Ground was broken for this addition to Lehigh's Fritz Laboratory on June sixth. This building is shown in Slide 9. Recently the building plans have been revised to include a four-story unit to replace the present south leanto so as to house all of the departmental laboratories now in other buildings. Here will be housed the world's largest testing machine, its capacity will be 5,000,000 lb., and tension and compression
members 40 ft. in length can be tested. With the flexure platform - a concrete mat 4 ft. 6 in. thick and 26 ft. wide - railroad and building trusses in excess of 110 ft. in length can be tested. Some idea of the size of this platform can be had by picturing a diesel engine, box car, and gondola all lined up on the platform with room ahead for the engineer and behind for the flagman.

This machine, which is shown in slide , has now been designed and the specifications prepared, and is being built by the Baldwin-Lima-Hamilton Corporation at Eddystone, Pennsylvania, near Chester, Pennsylvania.

This slide, Fig. 10, shows the main testing auditorium from just inside the west door seen in the last slide. The flexure slab is represented by the black band extending on each side of the testing machine. This bay is 50 ft. wide, 75 ft. high, and 130 ft. long. An overhead crane with 20 and 5-ton crane hooks will serve this testing auditorium. The black band on the left represents another new feature - a 68-ft. long dynamic testing bed which I shall describe more fully later. Notice the two testing and storage balconies at the rear and the observation aisles on the right. The structural steel columns are to be left exposed as we plan to attach jacks and other equipment to pull horizontally against structures set up in the building.
Slide 11 is a plan view of the first floor. The entire laboratory floor will be a test floor in which special anchorages are embedded so that at each of these points shown as squares, x's, or circles, uplift forces up to 100,000 lb. can be applied. The test bay extends under the seven-story auxiliary laboratories and office area. You will gain some idea of the size of the machine from the slides which I shall show of other machines of like capacity but smaller size, which have been built for the Federal Government. Later we shall demonstrate with the model, the operation of this machine.

This slide, Fig. 12, shows the artist's view of the machine which will reach 56 ft. 10 in. from the laboratory floor upward, and requires a pit beneath the floor 17 ft. 6 in. deep. Notice that the machine is fitted with an elevating platform which can be positioned at any point in its height. The design of the foundation was a major problem, but has been solved by the simplest possible design which embodies some 4,200,000 lb. of concrete, which, together with 800,000 lb. of steel in the machine itself, anchors it against the capacity load of 5,000,000 lb.

Some idea of the foundation may be gained from this next slide, Fig. 13. Several plans were studied in the attempt to eliminate the thick concrete weight at the bottom of this pit, but none proved as satisfactory as the presently projected design.
This next slide, Fig. 14, shows a 5,000,000-lb. machine erected at the Bureau of Reclamation, Denver, which has no flexure bed and is 8 ft. shorter than Lehigh's machine. Towards the bottom of this machine will be noticed the sensitive head, which is shown in the next slide, Fig. 15, being lowered into position. This unit weighs 61 tons.

This next slide, Fig. 16, which shows an erection view of this machine, illustrates the long 16-in. diameter screws on which this sensitive head moves.

The next slide, Fig. 17, shows a tensile specimen being pulled apart on this machine, and slide 18 shows a large concrete cylinder which has just been crushed.

Some idea of the large structural joints which can be tested at Lehigh can be obtained from this next slide, Fig. 19, which shows such a test on a 5,000,000-lb. machine at the University of Illinois.

You may well wonder how accurate is the machine in its measurements of the force.

On the lowest dial a weight of 20 lb. is indicated, although the manufacturer will only guarantee an absolute accuracy of 40 lb. On the highest dial range each division will represent 5000 lb. with a guaranteed accuracy at capacity of plus or minus 25,000 lb. It is perhaps a slight exaggeration to say that the force required to crush an egg can be measured, or, if when the full load is on the machine, should a man press upon the sensitive head, a movement of the dial will be noted.
Another very important part of the laboratory equipment will be a dynamic test bed. Buried beneath the floor, the foundation of this bed could be as shown in this next slide, Fig. 20.

Clamped to this bed, above the floor, can be tested frames such as are shown in the next slide, Fig. 21. Shown in Fig. 22 is a concrete and steel beam which is receiving a dynamic load at the rate of 240 loads per minute. Fig. 23 shows another test which can be made.

Pulsators and other control equipment used with the dynamic test bed are shown in this next slide, Fig. 24. No equipment of this kind is made in the United States, and will have to be built especially for the laboratory in Switzerland.

Returning to the 5,000,000-lb. testing machine.

this next slide, Fig. 25, shows schematically the operation of the machine. Before I use the model to illustrate this operation, let me point out a few features on this slide.

Structurally, the machine consists of two closed frames. The fixed frame consists of the two 55-ton columns, the upper horizontal frames weighing 10 tons, and the main table weighing 65 tons. The second frame is moveable, and
consists of the two 16-in. diameter screws, 64 ft. long, the sensitive crosshead weighing 61 tons, and the hydraulic jack casting weighing 50 tons. The moveable frame is forced downward when oil is introduced between the piston, which is fixed to the main table, and the jack casting. A tension crosshead weighing 30 tons, is attached to one of the several points on the column and can be positioned by rotating the screws until the sensitive head picks up the weight of the tension crosshead.

INSERT DESCRIPTION OF MACHINE OPERATION

Forty-five years ago John Fritz may have selected the laboratory equipment with but little help from his associates. This new addition is the result of the efforts of many men. We hope that when these facilities are ready at the end of a two-year construction period you will visit our laboratory and observe the test programs at first hand.

We who are privileged to carry out these plans look to the future with confidence and pride in the services the Department of Civil Engineering and Mechanics of Lehigh University shall be able to give the industries of the Valley, and in continuing our training of young men.

Time does not permit me to describe in detail the several smaller laboratories that are housed in this building or the many new instruments that will complete the facilities. I have only tried to mention the more spectacular aspects of this addition.
## List of Slides Used In
### Address of Professor W. J. Enye Bethlehem Kiwanis Club

**Thursday, September 10, 1953**

1. Concrete Airplane Hangar  &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&n