THE DUKE ENGINEER

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DEAN HALL'S PAGE

Engineering Graduates of Duke University will take time out from intensive defense activities all over the country for their annual Reunion at Asbury Building on that "Day of Days", Saturday, November 15, the day of the Duke-Carolina game.

For years Duke Engineers have, upon graduation, been stepping into positions with Engineering firms all over the country. Today the vast majority of these Alumni find themselves engaged in some phase of design, construction, or production of materials vital to national defense. Ships, camps, power systems, highways, machines, radios airports, pipelines-all of the physical requirements of national defense are within the scope of their activities.

Meetings, held annually since the Engineering Alumni Association was first formed as a branch of the general Alumni Association four years ago, have been notably successful.

Last year through the efforts of the Engineering Alumni over 50 high school seniors from schools throughout North Carolina were brought as guests of the Alumni and Engineering College to see the Engineer's Show which was presented in March. So favorably impressed were these boys with all they saw-the laboratories, student body, and Engineering faculty - that today a large number of them are in the freshman class of the College of Engineering.

This year the Alumni will find many changes. The new Aero Building will have been completed, and the equipment of all the departments of the College considerably augmented. Two new members have joined the faculty. But perhaps most significant of all is the record enrollment of over 100 freshmen, bringing the number of students enrolled in Engineering to 273.

It is a busy year for the College, the University, and the Alumni, but on November 15, regular tasks will be forgotten for a few hours as the Engineering Alumni gather to see old familiar smiles, to renew old friendships, and to "Beat Carolina".

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The Duke Engineer cordially solicits personals pertaining to any activity of the Engineering Alumni. This material will be printed for the benefit of all in future issues of the publication and should be submitted to the Duke Engineer in care of Dean Hall's office.

THE WILBUR CROSS PARKWAY

BY JOHN MURPHY
SENIOR C.E.

The Wilbur Cross Parkway, located in the state of Connecticut, is a continuation of the well-known Merrit Parkway, which is considered one of the best and most beautiful highways in America. During the past summer it was my privilege to work on this highway, first as An engineer's aid, and later as an inspector of box culverts.

The plans for this highway called for four lanes of concrete pavement each eleven ft. wide, and the highway was flanked 12ft. by shoulders. The last two specifications are set by the government for all federal-aid roads. The maximum allowable grade was three percent, and slopes on the sides were one and one - half to one, with one to six slopes on rock cuts. In order to eliminate the possibility of having buildings erected too close to the road, the state bought the right-of-way one hundred & fifty feet on either side. Every curve whose degree of curvature exceeded forty - five minutes was super-elevated,but no curves were spiraled. At present only half of the road is being built, the other half to be completed as soon as funds are available.

By the end of the summer, fifteen miles of the road had been graded and were ready for sufacing. This section of the road runs south from the Massachusettes state line to a point just beyond Stafford Springs, Conn. It avoids the town completely, thus eliminating many intersections. Because of the roughness of the countryside, it was very difficult to hold to the grade specifications in this section of the state. At some places, fills nearly eghty feet high and one-half to one mile long had to be made. In the fifteen miles completed there were eleven rock cuts.

The contract for the surfacing of five miles of this section was let early in the summer, and our crew was sent out on the job the first of June. It was our job to set the fine grade or concrete stakes for the contractor. These stakes are usually set fifteen feet from the edge of the pavement. In this case, however, the resident engineer and the contractor decided that it would be better to put the stakes six feet from the edge, in order to make it easier for the grade foreman to make elevations from them. We set the stakes six feet from the proposed edge of the pavement, took elevations on the top of each one, and computed the cut and fill every fifty feet. All places where super-elevated curves were to be made, we marked the cut and fill for each edge of the pavement on the stake. On the tangents we marked only the grade that was nearest the stake. letting the grade foreman mentally add the nine-hundredths of a foot for the crown in the center. This crown remained in the road throghout the entire lenght of the super-elevated curves, since it would have been too expensive to change the template on the concrete vibrating machines for each curve.

The surfacing went along smoothly---until the first rock cut was encountered. Here difficulty was experienced in driving the concrete form pins. The specifications had called for twenty-four inches of sub-base in these rock cuts to take care of drainage under the concrete. This is somewhat more gravel than is usually called for, but it was considered necessary because the ground was full of springs. It was found that the contractor who took this grading job had not held to these specifications. In some places we found rock only two inches down. The chief inspector immediately shut down the mixer and ordered the rock blown out. For this delay, the surfacing contractor charged the state eighteen hundred dollars, in addition to what it cost him to take out the necessary rock. The state was forced to pay for this, since the final survey on the grading had been completed, and the job of grading contractor had been accepted. As a result of this error, the state inspector who had charge of this portion of the road lost his job, while the grading contractor made a good deal of money from rock that he had never taken out. Nevertheless, this will go down on his record as a black mark and will make it hard for him to secure a big job in the state again; for jobs are let not only to the lowest bidder, but also to the man with the best record.

One of the biggest problems on this section of the job was the matter of drainage, In every cut there were encountered springs which kept the soil very wet even though most of it was gravel. To remedy this, so-called "rubble drains" were put in along the shoulders of the road in sections of cut. These drains were in the form of bituminous-coated corrugated metal pipe, six inches in diameter, with holes of one-half inch diameter, with holes of one-half inch diameter drilled in the top. They were placed four feet beneath the surface and covered for the first two feet with nut-sized crushed stone and the remaining two feet with gravel.

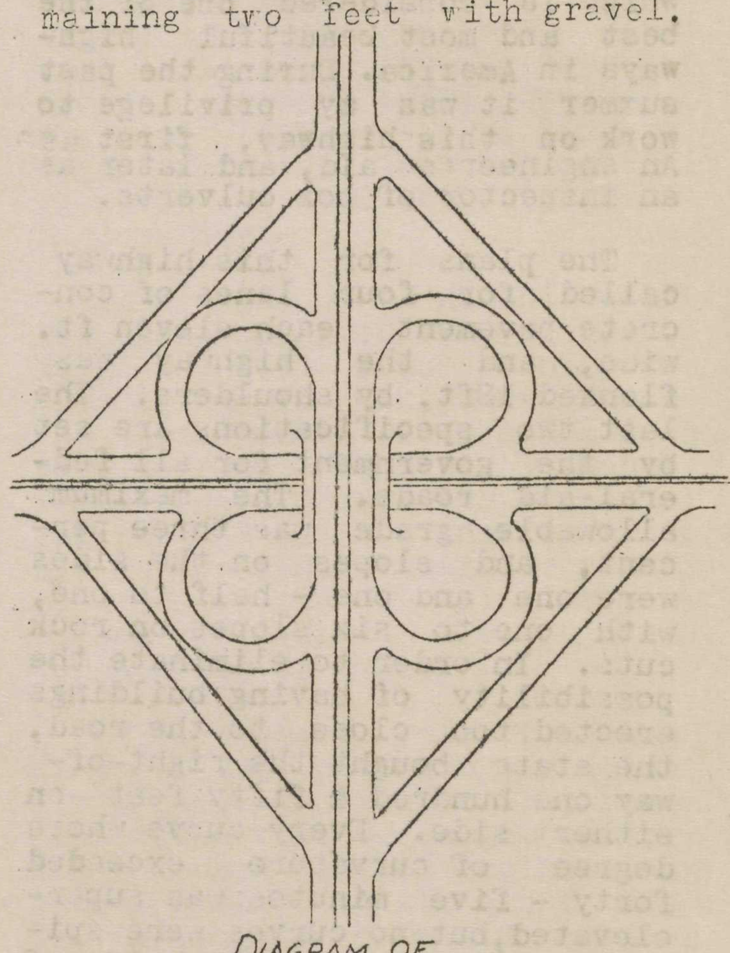

DIAGRAM OF A CLOVERLEAF INTERSECTION.

The pipes drained into swamps or into nearby streams. This type of drainage was new to the state, and replaced the open ditch type with very satisfactory results.

In the course of the job several streams had to be cros-

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STRENGTH ANALYSIS OF INDETERMINATE STRUCTURES

BY ARTHUR ALPERT
C.E. - CLASS '41

Model analysis is rapidly becoming a decisive influence in design work. Modern complicated machined parts and statically in determinate structural members defy classical methods of analysis for stress determination.

Airplane design depends wholly upon wind tunnel tests of model or full scale planes. The performance, aerodynamic cleaness, and structural safety are all determined in high speed tunnels, whose wind speed can approximate the velocity of sound. Airfoil bracing once approximated truss design, but advancement in the aeronautical industry brought changes, and now the wing structure is indeterminate to a high order, and must be tested by model analysis for safety and economy.

The Golden Gate Bridge in San Francisco waa reproduced in a fairly large model, and weights hung at various joints and reaction points. Deflection measurements and stresses thus obtained checked closely the original design which was based on proved empirical formulae and practical experience. Because of this model investigation, however, the structure could be erected with a certainty as to its stability.

The Westchester C ounty Park Commission in New York made ex tensive use of the Beggs Deformeter and Photo-elastic methods of stress analysis. Models of the rigid-frame bridges designed to overpass the highways were investigated by these methods before construction was started. These rigid-frames were highly indeterminate, and methods have not been mathematically fully sy stematised to handle the design of this type of structure.

This frame analysis carried on by Professor George E. Beggs of Princeton University is essentially the same as is used in the Duke University structural design department. Deformeter analysis deals with the principles of underlying the determination of the reactions for a statically inderteminate structure fixed at the footings, by measuring relative displacements in a flat model of the structure. Arbitrarily imposed displacements at reaction points of the model are accomplished by means of deformeter gages capable of producing very small deflections with an accuracy of 1-40,000th of an inch, and the corresponding displacements at the point of assumed loading are measured by a micrometer microscope. Through simple calculations in which the measured deflection is multiplied by the load and divided by a constant calibration factor for the plugs the thrust, shear, and bending moment may be obtained at any reaction point.

My personal research has dealt mainly with photo-elastic stress analysis. In theory this method seems very simple, but I have found it to be, as is most research, very exasperating at times. The polishing and cutting of a plastic model takes about eight hours of painstaking work, as it must be accurate to micrometer readings. Models, when cut are good for only about 72 hours due to the hardening of the edges of the plastic material. This necessitates photographing the model under desired conditions, and developing the plate for permanent record. Photo-elastic technique and equipment are now such that stress determination by this method has become a practical tool for the design enigneer. The cost of apparatus and model making has been reduced to a point where a formerly expensive scientific instument has now become a thoroughly practical tool for economical use in industry. Apparatus may be installed for about $550, and a complete analysis including pictures may be made for less than $10. This cost may be reduced by the use of a little ingenuity in building a loading frame. The one in use at Duke Universsity was made at a very low cost by the students. The main members are 3 in. steel channels, welded together and slotted for mounting the model. The straining bar rests on a knife edge, and the model is supported on Bakelite mounts. The whole frame has horizontal movement, and the model and the loading bar have vertical movement, thus, the whole set - up can be moved for convenience during the test.

Elastic theory is naturally based upon the assumption of perfect elasticity. Model material is very nearly perfectly elastic, and therefore very close agreement is found with the stresses as determined mathematically. Most engineering materials, however, are not perfectly elastic, and therefore, departures are found from the stress determined by experimental or mathematical elastic theory, from that obtained in the piece itself. In some cases the departure is considerable. However, it always reduces the stress, and therefore the elastic figure lies on the safe side.

The loading of the model cannot be exactly simulated, but according to Saint-Venants principle which states that at a distance remote from the application of the load, the stress distribution is independent of the method of application, the designer is justified in producing an equivalent load on the model.

It is a fact that most failures begin at a point on a boundry, either an external one an internal one, such as a hole. Some authorities even maintain that failure never begins within a body. The stress on a boundry of a photo-elastic model is easily obtained, while stresses within the body can be found only by skillful manipulation and a great deal of time. Therefore, in commercial practice, the stress is located along the boundry, and design is made accordingly.

One should look at analysis means to an end, the design of the structure. Accordingly, analysis should be simplified to the greatedt possible extent, so that the engineer can devote a continually increasing percentage of his time to design. This fact explains the popularity of the modern analysis by means of scale models. In the near future I predict even a greater and more widespread use of the basic model tests and the discovery of simpler and more efficient methods to obtain stress distribution.

A.S.M.E. FIELD TRIP TO PITTSBURGH

BY ELMO ROPER
M.E. SENIOR.

On Thursday October 23, 1941, 36 student members of the A.S.M.E. and one faculty member, Mr. Theiss, left Durham for a combined field trip- Pitt game excursion to Pittsburgh and vicinity. At 9:00 A.M. on Friday, four groups of nine men, each furnished with a well-informed guide, began a tour of the Weirton Steel Company's Plant in Weirton, W.VA.

The first part of the morning was spent watching the coking ovens in operation where approximately 3,000 tons of coal are reduced to coke each day, and the coking time for each oven is about 14 hours. The gases which are driven off from the coal as it cokes are collected and used to heat the blast and open hearth furnaces.

The blast furnace was almost ready to be tapped when the group arrived, the slag having already been tapped off. An average of 5 taps per day is usually maintained, and from 160 to 180 tons of iron is obtained each tap. At the present time only one blast furnace is in operation, but a second one is now under construction. The foundation for this furnace is a huge block containing 42,000 cubic yards of concrete, and it is 26 feet high.

The steel from the blast furnace is carried to the Bessemer converter for purification. From the convertor the steel is carried in ladles to the ingot molds.

The open hearth process as used at Weirton utilizes 12 open hearth furnaces. Furnace #12 is the largest of its type in the world and produces 350 gross tons of steel each day. The open hearth furnaces are charged with scrap iron and steel, and the refined steel is tapped off periodically into ladles to be poured into ingot moulds. The hot ingots are then placed in the soaking pits to acquire a uniform temperature throughout, and in the blooming mill rolled into slabs. From the blooming mill the slabs go to either the structural shapes department or to the strip steel department for further rolling.

The H.J.Heinz Company provided a very interesting inspection trip for Friday afternoon. The highlight of the tour was the sound of the "Blue and White" as played on the organ in the theater of the plant as the group passed through it. The onion peeling department, in which about 40 women do nothing but peel onions all day long, provided much amusement. Of course, samples of about 6 of the 57 varieties were served at the end of the tour.

The Cathedral of Learning on the U. of Pittsburgh campus was quite a sight in the eyes of most of the members of the group and investigation revealed that it is 565 ft. high and contains 42 stories - over twice as high as the Duke Chapel.

The final item of particular interest was the Penn. Turnpike (super highway), which extends

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WHY PAY E.S.G.A. DUES?

BY LARRY DARLING
PRESIDENT OF E.S.G.A.

"Why should I pay my dues, I don't dance?", is a phrase heard a hundred times each semester by the treasurer of the E.S.G.A. I shall try to explain in a few words why each member of the College of Engineering should be willing to part with twelve bits to assist the E.S.G.A. treasury.

It is admitted by those who like to dance that the Engineer's Ball in itself is worth the one-fifty, but I want to talk to you fellows who are not faithful followere of the Terpsichorean Art.

In the first place, many of the benefits that a student derives from the Student Government are intangible, but some are not. The recreation room was renovated and furnished through the efforts of the council some years ago. $50.00 from the treasury of the present council, plus $50.00 more presented to us by Mr. Tyree will be put into further improvement of this room as soon as building materials are available.

Some money has already been spent for the DUKE ENGINEER, the Engineers' Glee Club, intramural activities, the homecoming float and other projects. Perhaps you don't participate in any of these activities, but you must agree that you are proud to be an Engineer when you see your classmates have "done the job the way the Engineers do it".

The council is a go-between for the students and other campus groups. Through the efforts of the council the driveway was paved, the gym room is being kept open on Sundays, and it also had a hand in getting that new drinking fountain for you fellows in Epworth, and the council makes arrangements for the Engineer's Sing which is given each semester.

A Thanksgiving Day dinner-dance, more football open houses, picnics, and smokers are being planned for the future if the funds are available. The council spends many hours of its time, both individually and collectively to accomplish these things.

Even in the face of the above facts you may say that you don't think that we need a Student Government Association anyway. A few of the fellows think that the council just snoops around and trys to get the boys into trouble. I'll admit that many times, on the surface, this seems to be true, but fellows who have been on the council in other years, will tell you that in almost 100% of the cases the council has been less severe than the administration would have been had it been necessary to send the Chiefs over here and take charge of the matter. I can think of specific cases where the administration had definitely decided to suspend boys from school, but reconsidered on the recommendation of the council. Some day you may be one of these boys on the spot, and perhaps you will be glad that there is a council of your friends to go to bat for you if you deserve it.

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NEWS:
OF THE PROFESSORS AND SOCIETIES

Professor Seeley of the Electrical Engineering Department took a position in the Naval Ordnance Laboratory. His specific job was to build and test submarine detection devices. Professor Seeley felt very much at home at his job there because a number of Duke engineers were working in Washington. Professor Reed, Wyatt Strickland, graduate engineers Bill Drew, Walter Smith, and Mort Serrell were working in the same yard. For the past few years, Professor Seeley has been working for the Duke Power Company, but he felt it was his duty to aid the government at a time when help is needed.

Professor Otto Meier offered his services to the government and wa temporarily appointed as an electrical engineer with the United States Engineering Office of the War Department. He was stationed at the Army air base in Charlotte acting as a consulting engineer. Professor Meier's work consisted of electrical layout and design.

Mr. Vail spent his summer working for General Electric Company at Pittsfield, Mass. His work concerned the designing of distribution transformers. Orders were filled for R.C.A., The Graybar Electric Co., Perry Mann Electric Co., and the army and Navy.

Mr. Kraybill worked with the General Railway Signal Co., where he built and tested copper oxide rectifiers, for use in operating signals along the railroad lines. Als he experimented with radio communication to bring the engineer and the control tower into closer contact.

Professor Bird was busy the past summer with his numerous activities in the C. E. world. For the first three weeks after the close of school, he trained a group of the engineers in surveying. The remaining part of the summer he pursued his duties as president of the North Carolina Section of the A.S.C.E.

Mr. Watson spent much of his time testing soils. At the close of school he went to Langley Field, Va., to study the composition of the soil there. The purpose of this study was to ascertain whether or not the soil was stable enough to support the heavy loads of landing aircraft under various weather conditions.

After three weeks there, he left for the Gov't soils testing lab at Vicksburg, Miss., where he studied and duplicated samples of soil for use in scale models of gov't projects proposed to control erosion.

Mr. Williams spent the summer as a design engineer with the U. S. Army. His task was to assist in the design of roads, railway siding systems, airport runways, and setup an Air Corps gasoline system for a basic flying school at Sumter, S.C. This air base will be used for the training of pilots for the Army Air Corps under the defense program, and when completed will be one of the principal training bases for the Air Corps, covering 3000 acres.

Jerry Hoffer: The son of a watchmaker in Camden, South Carolins, Hoffer got his first training in his Father's shop where he assembled watch mechanisms. In Camden, Hoffer received both his elementary and high school education. His interest in aeronautics grew with him; in high school his courses were pointed toward a career in aeronautics.

After graduating from high school, Hoffer enrolled as a freshman at the University of South Carolina. Hoffer admits that while at South Carolina that first year, he attained an excellence in scholarship which he was never able to repeat at the Georgia School of Technology. Hoffer transferred to Georgia Tech in order to take a course in Aeronautical Engineering. While an undergraduate at Georgia Tech, Hoffer found time to indulge in his favorite hobby of photography, especially color photography, He worked as a photographer for the "Blueprint" the Georgia Tech annual, just as he had done on the S.C. annual; and in his senior year he was made photography editor. Also Hoffer helped found and was co-editor of the "Georgia Tech Engineer, "which is a magazine similar to this publication. Hoffer was made a member of Pi Delta Epsilon, honorary journalistic fraternity, and also a member of Beta Kappa, national social fraternity.

He received his degree of Bachelor of Science in Aeronautical Engineering in 1939, after three years at Tech. That summer he worked for Glenn L. Martin Company at its Baltimore plant, both in the engineering department and the factory. However, he won a teachers assistantship at Georgia Tech and returned there that fall to teach in the wind tunnel laboratory and the airplane structures lab. In the summer of 1940, Hoffer took a working course in the engineering department and in the shops both at Chicago and Cheyenne, Wyoming. That winter he was again at Georgia Tech, but this time as a full time teacher in the Drawing and Mechanics department. At this time he started writing his thesis, and last June he received his Master Degree in Aeronautical Engineering.

Hoffer came to Durham this summer and spent most of the time trying to get the new Aeronautics Laboratory completed and designing the new wind tunnel. At the moment, Hoffer is spending much of his spare time in Chapel Hill learning to fly.

Professor R. E. Lewis: Professor Lewis believes that even the freshmen should have recreation, and thus his theory that the Drawing room should be locked when he is not there. This effectively stops more ambitious frosh from putting in overtime.

Born in Nebraska, Professor Lewis received his B.S. degree in Mechanical Engineering at the University of Iowa in 1929. Two years later, after writing a qualifying thesis on the fatigue of non-ferrous metals, he received his M.S. degree at the University of Illinois, where he worked as a graduate research assistant. He first started teaching at Texas Tech in Lubba, Texas, where he taught Mechanical Engineering. After two years, he transferred to Southern Methodist University. In the four years preceeding his coming to Duke, he taught Drawing and Mechanics at Georgia Tech.

News of the Societies:

A.S.M.E.: The organization that some refer to as being "dead" still has a little kick in it. In three meetings, the society has acquired 27 new members, organized an inspection trip to Pittsburgh, shown a film very much in line with the times, and has arranged for Professor A.G. Christie to be here on Wednesday November 12. Professor Christie, past president of the American Society of Mechanical Engineers, will speak on the power project for Los Sngeles.

Town Boy's: Stringing along with Southgate are the fellows in 119. They're the town boys in the "Town Boys' Room," furnished by the E.S.G.A. The town buys surely go for the privilege of the room, and it helps them to become better acquainted with the fellows in the "Shack." There are sixteen Durham freshmen this year.

The Town Boys held their first get-together Friday night, November 7, in the form of a Square Dance at Camp Sacarusa. This was the first of a series of coming socials.

A.S.C.E: The Duke Student Chapter of the A.S.C.E. has begun an active year with two meetings and one inspection trip. The meetings featured a talk by Professor Watson on the opportunities of the civil engineering profession and an interesting group of slides on steel construction. On October 14th a contingent of C.E.'s went to Greensboro to inspect the terminus of the new pipe line from Baton Touge to Greensboro. The Chicago Bridge and Iron Company is constructing seventeen gasoline and oil storage tanks at this end of the line.

E.E.'s: Professor Seeley has received the first copy of his latest textbook, Introduction to Operational Calculus. Professor Seeley wrote this book because there was no other book suitable for teaching this course to undergraduates. In former years, the students had to write their own texts and in so doing helped in the organization of the book.

On Friday, November 7, the E.E.'s went to Raleigh to attend an A.I.E.E. section meeting. One of the principal speakers was Russell Ramson, who spoke on "Noteworthy Accomplishments of Former Student Members of the North Carolina Section." He is a native of Charlotte N.C., and he is a graduate of Duke University in the Class of 1931, with a degree of B.S. in E.E. Following gadduation he was associated with General Electric Co., in Test Department and Radio Consulting Department. In September of 1934, he returned to Duke as an instructor in Electrical Engineering. In May, 1939, he accepted a position with the Clark Controller Co. in charge of Electronic Developments. In August of that year he was made Director of Research and Development of the Clark Controller Company, and its subsidiary companies. In 1940 he was elected a Director of the company.

On November 12th the E.E.'s will make an inspection trip to the plant of the Durham Herald-Sun.

This year the E.E.'s are not counting the days 'til Xmas., they are counting the days 'til the first of December. On this day they plan to leave for New Orleans, where, besides seeing the town they hope to find time to attend the A.I.E.E. student convention.

Wilbur Cross P'k'w'y'(con't)

sed.. Two of these streams were crossed with ordinary reinforced concrete bridges.. However, at the other streams, the surface of the highway was above the water level.. This would have necessitated high abutments with long wing walls to hold back the fill and to protect it from washing out.. The cost of such a construction was far greater than conditions warrented., hence another means of crossing these streams was sought..The solution to this problem was found in large box culverts. With these structures there was no necessity of digging down beyond the stream bed for a foundation: the culvert simply rested on a wide slab of concrete one foot thick. This thickness was decided upon a fter a consideration of the soils present, the quality of the fill above the culvert,and acount of traffic anticipated.. Of course, culverts such as these could not take a very la rge stream, but in one instance a width of thirty feet was bridged by using a triple span culvert.. This type of construction cut the cost to nearly one-third of what it would have been if a bridge were built under the same conditions.

My observations on this job led me to at least one definite conclusion: even though elaborate roads such as the Wilbur Cross Parkway and the Pennsylvania Turnpike are being built with what some people would have us think is no regard to cost, money is still the largest item with which the engineer has to deal. I believe that it is not simply what the engineer ca n do but what he can do with the money he has available, that measures his ability.

Pitt Trip (con't)

from Pittsburgh to Harrisburg approximately. Out of 160 miles of road, 110 are straightaway, and the maximum grade at any point is 3%, while the sharpest curve is 6 degrees.. There are 7 tunnels on the road with a total length of 6.7 miles.. The following materials were used to construct the road: 392,000 tons of cement, 700,000 tons of sand, 1,000,000 tons of crushed stone, and 35,000 tons of steel.. Approximately 16,500 men were employed to build the road from Oct.. 27,1938 until Oct. 1,1940. The total cost of $70,000,000 is being paid for by the toll charged - a penny a mile.. The largest cut on the road is called "Little Panama" - in fact it is the largest and deepest man-made cut in the United Sta tes, being 153 feet deep About 1,3000,000 cubic yards of earth were removed with 700,000 pounds of explosives. The most wonderful feature of the road is the 70 mile speed limit.

E.S.C.A. DUES (Cont.):

The council cannot function the way it should and wants to without cold cash. To date only about half of the fellows have paid their dues. If you are one of the majority who intends to pay "sometime before the dance" I urge you to do so <u>now</u> so that we can plan our budget and do before the semester is over.

If you honestly believe that these things the E.S.C.A. does and wants to do are not worthy of your support, I am certain that you have a warped sense of proportions and a misguided sense of values.

L.W. DARLING
PRESIDENT, E.S.C.A.