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The Wisconsin Engineer

MARCH, 1912

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The Wisconsin Engineer

VOL. XVI MARCH, 1912 No. 6

SOME CONSIDERATIONS ON THE CHOICE OF A PAVEMENT.*

LEONARD S. SMITH,
Associate Professor of Topographical and Geodetic Engineering.

"What is the best pavement" is a question which citizens, city officials and even some engineers are not infrequently guilty of asking, forgetful of the plain fact that such a question admits of no ready or simple answer. As well might it be asked what is the best bridge or the best house to build. It is a most hopeful sign that the past year has seen many papers read at engineering society meetings discussing this question of considerations affecting the choice of a pavement.

It cannot be too emphatically stated that in each case the best structure for a pavement depends upon the particular *service* required of it and also too upon the widely varying local conditions. These modifying factors naturally divide themselves into two general classes. The first of these govern the conditions to which the pavement will be subjected. Chief among these factors are the quality, nature and even the direction of the traffic, the character of the district served by the pavement, the grade of the street and the presence of car tracks.

On the other hand, the second class of factors which may determine the selection have reference to the character of the pavement itself, such as durability, smoothness, noiselessness, slipperiness, cost, etc.

The best pavement for some particular street, then, would be

* Presented at the annual meeting of the Engineering Society of Wisconsin, Feb. 15, 1912.

the one which would give the greatest and most needed service, using the word service in a broad way. The limits of this paper will not allow of a full discussion of this question, but my point can be most clearly explained by giving a few applications of the principle. For example, if the street had a steep grade, all such considerations as smoothness, noiselessness, cost, etc., must needs give way to the single governing quality of non-slipperiness. Again, if the street in question were on a moderate grade in a high class residence district or in the office-building district of a large city, the factors of *smoothness* and *noiselessness* might properly determine the final selection. Such a selection, while involving a very expensive pavement, has repeatedly been shown to fully justify itself by the added value and earning capacity of the property. As a third example, considering the choice of a pavement in a wholesale district, subject to concentrated heavy traffic, the qualities of durability and non-slipperiness would here naturally receive the greatest consideration.

The above statements are so obviously based on common sense that it may seem to some useless to take up valuable time in their presentation. Repeated inspection of the pavements in a score of our largest cities has shown the writer that the choice of pavements has too frequently been left to chance or prejudice. Our growing vision of municipal efficiency discerns a much needed reform in the choice of our pavements, a reform certain of realization.

But while there is great economic need that the best fitted pavement for each particular street should be thoughtfully and carefully chosen, it is at least of equal importance that all such paving improvements should proceed in accordance with some well considered plan,—some comprehensive system for future improvement of the entire city, ward or region. For example, pavement improvements should be so planned as to provide several parallel routes for through traffic. If this be not done, the single route becomes congested and the pavement is prematurely worn out. Again, pavements should be continuous, both for the convenience of traffic and for ease of maintenance.

In the case of country highways, it is necessary to construct disconnected stretches of pavement, but even here it is of prime importance that such construction should proceed in accordance with a systematic plan, so that disconnected stretches may eventually become a part of a complete system. For example, in our own state it would be easy to select a few trunk roads leading from the metropolis of the state to the adjoining cities, and still others connecting the largest city or county seat of each county, as being certain to attract the heaviest traffic. Portions of such trunk roads should be improved with reference to sustaining heavy traffic and also with a view of becoming a part of an intra-state system.

Unhappily, the city paving program is too often determined by the ward politician or the opposition or favor of short-sighted real estate owners. A few cities which have tried this plan of adopting a paving program extending over ten years will soon occupy an enviable position. Our cities cannot do better in this respect than to follow the example of the most successful railroad companies.

While future traffic conditions may render necessary here and there a change in the detail plan, the city is certain to gain largely in the end because of having a carefully prepared plan for all street improvements, including water, sewer and gas as well as pavements.

The charter of many American cities provides that the abutting property owners shall pay for the first pavement, while the city must pay for all repairs and renewals. As might be foreseen, this has resulted in the selection and construction of many cheap and inferior pavements where much more permanant construction would have been justified. But this abuse has not stopped here. Long time bonds have been commonly issued to secure the pavement of such temporary pavements, in many cases falling due twenty-five years or more after such pavement has utterly worn out.

Such a system of financing pavements cannot be characterized as anything short of dishonest. It simply transfers to the backs of our children the burdens we of right should bear ourselves. For the future will doubtless have sufficient burdens and problems of its own without being required to shoulder in addition those of today.

Already legislatures are considering corrective legislation. The writer knows of at least one eastern legislature which in 1910 passed a law prohibiting a city from paying for short life pavements out of the proceeds of any bond sales. This principle of "pay as you go" deserves a wide adoption.

It is worthy of restatement that cheapness does not necessarily mean a cheap price of the pavement when laid; indeed, such a pavement may likely prove the most expensive in the end. The other governing elements which determine the actual cost of a pavement are the annual cost of repairs and the term of life of the pavement. Permanent pavements may properly be paid for out of the proceeds of bond issues payable during the life of the pavement. In such cases the public will eventually have to pay for the following items,—interest on the bonds, cost of repairs, and annual sums for a sinking fund, which by the time the pavement is worn out will pay off the bonds. Such a plan may be shown by the following formula:

$$S + CI + \frac{R}{L} = \text{annual cost},$$

where S = the yearly amount put in the sinking fund
C = first cost of the pavement
I = the rate of interest
L = the life of the pavement in years
R = the total cost of repairs.

Obviously, the cheapest pavement is the one involving the least annual cost. If, for example, a macadam pavement be chosen for a street having a heavy traffic, the last term $\frac{R}{L}$ would be so large as to make such a pavement the most expensive type that could be chosen. This fact is an added illustration of the importance of a wise selection of a pavement for the traffic conditions.

New York state for several years has been making the colossal mistake of issuing many millions of long-time bonds in payment of some form of macadam even on heavy traffic trunk

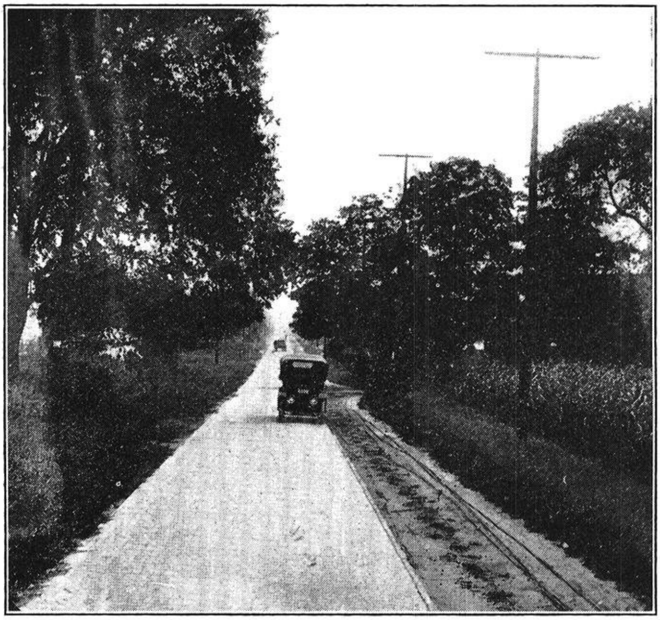

Fig. 1.—*Brick Road, Cayahoga County, O.*

Fig. 2.—*Brick Road at Newman, Ill. One Team Hauling 319 Bu. Corn (19,140 lbs.).*

highways, where they very frequently have failed after a comparatively short term of service. Such is the judgment of well qualified engineers who have had charge of the construction and maintenance of such roads. The seriousness of this situation will not be fully realized until after the officials responsible for this error have passed to their final reward. Other states nearer home have made similar mistakes.

The construction of some form of the macadam road fulfills at a minimum cost all reasonable demands on streets or country highways carrying a moderate traffic, especially if such roads have the added protection of continuous maintenance. This class includes over half of our country roads.

But if such improved highways happen to connect two or more large cities, the unusually heavy traffic which such a road at once attracts results in certain and speedy failure. The advent of automobile and other forms of motor traffic, while it has *lengthened* the life of hard city pavements, has been the chief cause of the *distruction* of macadam roads. The seriousness of this problem of the choice of proper road material is realized when we reflect that the demands made by this new form of motor traffic are certain to greatly increase in the near future. Highway engineers of every land are looking for an adequate remedy, but so far with only partial success. While constructional methods in nearly all other lines of engineering have been satisfactorily perfected and standardized, we find present highway construction on main trunk roads grossly inadequate for even the traffic of today, thereby causing needlessly large charges for maintenance.

It has seemed to the writer that real progress would be made by breaking away entirely from macadam construction on heavy traffic main highways. The improved and more permanant construction best suited to replace the macadam on such roads will here again be largely a local question. Ohio, Indiana and Pennsylvania have taken the first steps toward satisfying the demand for a more permanent construction by building many hundreds of miles of brick pavements laid on a concrete base with a cement grout filler, all supplemented usually by wings of dirt, gravel or macadam. The expense of such a pave-

Fig. 3.—*Warren Road, Ohio. Brick on Concrete Foundation.*

Fig. 4.—*Grand River Road Before Improvement; Tells Its Own Story. Wayne Co., Michigan.*

ment, about $1,000 per foot of width per mile, does not exceed the average price paid by New York state for its wider but short-life macadam roads, while the brick roads, if properly constructed, promise to be in good condition twenty-five years hence. A view of some of these country brick roads is shown in Figs. 1, 2, and 3.

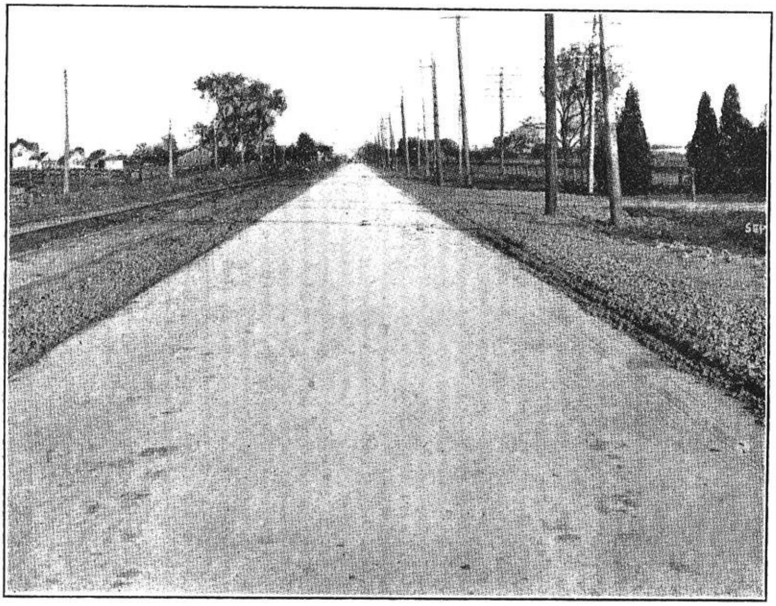

Fig. 5.—*Grand River Road Three Months Later; 16-Foot Wide Concrete; 8 Feet of Gravel on Sides; Total Width, 24 Feet. Cost from $800 to $1,000 Per Foot of Width Per Mile.*

Wayne county, Michigan, has constructed a good many miles of main highways, leading out of Detroit, of rich concrete, seven inches thick, at prices which also compete with eastern macadam, while giving promise of outlasting the latter by many years. See Figs. 4 and 5. Where the proportion of automobile traffic is not too great, a large amount of traffic has generally been economically provided for by some form of the bitulithic construction. It may be that Wisconsin, with her widely distributed rich deposits of good gravel and other road materials can wisely follow one or all of these forms of permanent construction. Few states are more favorably situated for road building than Wisconsin. We are fortunate also in being able to profit by the experiments of our older sister states. These have shown us that there is no one best pavement and no one best way of constructing it under all circumstances.

We now recognize that the selection of road material and the method of incorporating it into a road is in large part a local question; in fact, that highway construction in city and country obeys the same rules of procedure as do all other forms of good engineering.

GOVERNMENT IMPROVEMENT OF THE UPPER MISSISSIPPI RIVER.

J. E. KAULFUSS, '08,
Instructor of Civil Engineering, University of Maine.

The work of improvement, consisting of bank revetments (shore protection, or rip-rap), closing dams, wing dams, and longitudinal dikes are generally constructed of rocks and brush. The proportion of brush to stone employed according to present practice is: for bank revetments, about 1 to 1; for closing dams, 1 of rock to 1½ of brush; for wing dams, 1 of rock to 2 of brush, measured in cubic yards. At the close of the calendar year 1905, there had been built 231.6 miles of dams and 188.6 miles of shore protection, comprising 3,630,234 yards of rock and 5,310,742 of brush, and 1,725,685 of rock and 1,549,525 of brush for dams and shore protection respectively. During the fiscal year of June 30, 1906, there were used 182,735 yards of rock and 275,825 yards of brush on dams and rip-rap.

The expenditures on this work, between Minneapolis and the Missouri River, since the commencement of improvement to June 30, 1906, amounted to $10,252,653.66.

The hills or bluffs along the river are capped with limestone and the rock used for the government work comes from quarries along the river. In some cases the quarries are owned by the government and rock is furnished by day labor. The limestone, crushed to a maximum size of about one-fourth of a cubic foot, is sent down in a skip attached to an endless cable, which skip is emptied on a rock barge. In other cases, rock is furnished by contract. The brush used is very abundant on the islands and lowlands and is furnished under contract. Specifications require that the fascines (or bundles of brush) be made of live willow brush, sufficiently trimmed, compressed and overlapped to form a compact mass 20 feet long and from 12 to 15 inches in diameter, and tied with lath yarn or wire at not more than four foot intervals. The barges made by the

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* In the February issue Mr. Kaulfuss discussed the scope of the improvements, which discussion is here continued with special reference to the construction work.

government for rock and brush are 100 feet long, 20 feet wide and about $4\frac{1}{2}$ high, drawing less than 1.5 feet of water. Rock is piled on the decks to a depth averaging between 1.5 to 1.8 feet, 18 feet wide and 80 feet long, making the cubical contents between 90 and 100 yards per barge. In the measurement of the rock a width of 18 feet (between timberheads) is assumed, two lengths and 30 heights are taken. The brush when piled on the barges overlaps with the tips and is considered 20 feet wide, two lengths (averaging near 80 feet) and 10 heights (averaging from 4 to 8 feet), making about 250 to 500 cubic yards per barge. These barges are towed between the places of loading and use in the work by the ordinary type of river steamboats.

Our fleet consisted of the following: two U. S. steamboats, a dozen or more barges, a building barge, two quarter-boats, a "grass-hopper," skiffs, etc.,—all necessary accessories. The laboring force consisted of about thirty men, the wages being $1.25 per day with "keep." The quarter-boat was about 18x36 feet. On the lower floor were a kitchen, a messroom, a rest room, the time-keeper's office and bunk, and the cook's bed-room. On the upper floor were the bunks for the laborers. The men were furnished with bedding, board and heat. Supplies, including greens and fresh meat as well as fuel, were brought by the steamboats from neighboring towns. The second quarter-boat was a small houseboat for the use of the junior engineer and the superintendent. The building barge was a large boat 120x20 feet, from which the work was directed and controlled. The grass-hopper was a barge of special design used to construct mattresses (or mats) of brush. The skiffs were used to convey the force from the quarter-boat to the building barge, and vice versa.

Bank revetment consists, below the water surface at the time of construction, of a mattress of brush bundles sunk in place by rock; above the low-water mark, of rip-rap 6 to 12 inches thick. The width of the mattress depends upon the depth and stage of the water, but they are usually between 20 and 60 feet. The butts of the bundles are laid downstream. The purpose of the bank revetment is to prevent cutting away of the bank, and can best be defined as being shore protection.

The mattresses are constructed on small flats having inclined ways upon them, which are commonly called "grass-hoppers." The grass-hopper is a small boat, the hull of which is about 2 feet deep, about 18 feet in width and 30 feet in length. On this hull are placed skids running fore and aft, usually 4 or 5 pieces of rounded and planed oak scantling. They are given an angle of about 30 degrees with the horizontal to facilitate launching the mattress, and extend nearly to the water surface. In making a mat (or mattress), the bundles of brush are packed closely and two deep on the hopper and secured at distances of about 10 feet by pairs of binding poles joined by ties of lath yarn 2 feet apart. When the hopper is full, the mat is ready to be launched. It may be said here that, prior to this or in the meantime, in shore protection work, the bank has been graded by shovel, scraper or by hydraulic means. In launching such a mat (continuous in shore protection), the first one is held in place by ropes to the bank and the hopper slides away under the mat, except the lower portion, to which another section is spliced. In this manner a continuous mattress of brush is constructed along the bank to be protected. Using flexible binding poles, the mat when sunk conforms well with the river bottom. A barge of rock is then towed up to the mat and rocks are cast upon it, causing it to sink from the river toward the shore, the barge being pulled in toward land as the mat sinks. When the proper proportion of rock has been used, rocks are wheeled ashore where a pavement is hand-laid on the graded portion, high enough to prevent washing or scouring. This completes the shore protection in a simple, effective, and economical manner.

Wing dams are constructed to contract the width of the river at low stages for reasons before stated. The German practice demands that these dams shall project outward and inclining a trifle upstream, in straight stretches at 105 to 110 degrees, on concave banks at 100 to 103 degrees, and on convex banks at 90 to 100 degrees, and to so place them that the axes of two opposite dams intersect in mid-channel. The spacing is five-sevenths of the channel width, one-half, and the channel width on the above kinds of shore respectively. The government has followed the above ideas in general, but exceptions are frequent due to economic and other considerations. While the heights to which the dams are built are also variable, the usual practice is to build them to four feet above low water. In the construction of wing and closing dams, a mattress containing a single layer of brush bundles, bound with three sets of binding

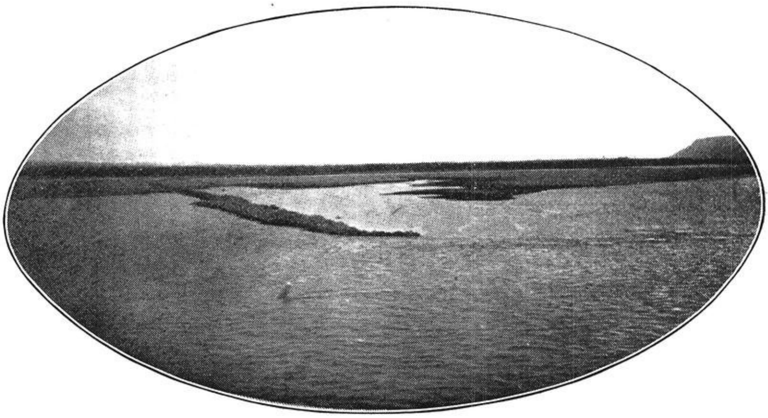

FIG. 1.—*Showing Deposits Below Wing Dam.*

poles, is first sunk the entire length of the dam to prevent scour during construction and to serve as an apron for the overflow. This is covered with a layer of rock from 6 to 18 inches thick. The dam proper is built from 10 to 15 feet farther upstream and rests on the tips of the apron bundles. The bank is rip-rapped for some distance above and below the shore end of the dam to prevent scouring around the end. Then double mats are placed in layers and sunk with rock for a building barge length, when the outfit is moved outward another length by means of two or three lines attached to the shore and to one or more anchors or anchor mats placed upstream. The building barge is held in place just above the tips of the brush in the dam, the barge of brush butts up against it on its upstream side, while the barge of rock is held about 20 feet below the building barge and parallel to it. The grass-hopper can be moved between the two. Each layer of mats is placed two feet farther up the river and all are placed in line by range poles on shore. When the dam has progressed so that the hopper cannot pass between the building barge and the rock barge, separate bundles are carried across the former and thrown compactly into place to the necessary height, when a final layer of stone is placed upon the brush and finished off by hand to make a good appearance. The river end of the dam slopes about 1 to 1, and is heavily weighted with rock to prevent being torn away.

The mats are constructed with the fascines laid across the hopper, butts down river. They are usually tied together by three sets of binding poles securely tied by lath yarn at every third bundle. Three-quarter inch lines are attached to the binding pole near the tips, by which lines the mat is held in place from kevels on the building boat. Considerable skill is required to line in and properly sink the mat so that it is not broken in sinking or turned over by the current. The rock is in thickest layers at the butts in order to keep them from rising. When a mat is sunk the lines holding it are removed and the process repeated. The building boats are equipped with several capstans so that they may be manipulated to nearly any position desirable. All barges of material, both rock and brush, are conveniently placed so that they can be floated or pulled to the building barge without requiring the assistance of a steamboat.

The closing dams, which are used to close chutes and side channels, are built similarly to wing dams, but usually contain more rock, while they are also better protected at the shore ends. In some cases where long sloughs are encountered several closing dams are employed so as to reduce the head that would result on but one. This procedure also increases the tendency to deposit sediment in the chutes.

Longitudinal dikes are similar in construction to wing dams, but instead of being approximately at right angles to the current, they extend nearly parallel to it.

Besides the above construction, there is the work of the snag boats and dredges, which are used to make the channel consistently navigable. But it is not within the scope of this paper to treat with many of these and other subjects concerning river improvement.

The brush and rock dams are simple, efficacious and economical to construct. The bank revetment has for its purpose the

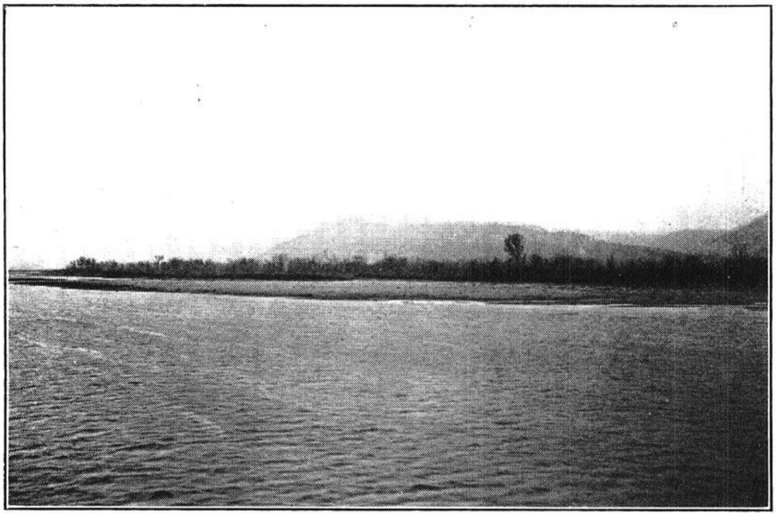

Fig. 2.—*Showing Deposits Between Dams.*

preservation of the river banks. This is an important feature as could be seen from some of the many interesting frolics of the river in changing its course. These closing and wing dams act as places for silt deposit and in a short time are impervious, thus shunting off water into the proper flowing area. A head of several inches is nearly always perceptible between the upper and lower sides of the dams. Often this increases to a few feet and more. One needs only to actually observe the water sweep and rush around the outer end of a wing dam to have proven what an effective factor it is in securing and maintaining a comparatively narrow channel with a comparatively good depth. Also the water coming around the end of a wing dam eddies about in the space between the wing dam, and soon, at low stages, it can be seen that this space has been filled up with sand and silt, which is a much desired condition. This material must be deposited somewhere, and no better place than this can be found. There is every reason to believe that these dams will finally completely confine all water to one channel, which means a navigable stream during the navigable season.

The channel is formed by two smoothly curving lines drawn through the ends of the dams and the shore proper, where the river swings in its meanderings. Diamond boards for day passage, lights for nights, are as guides for straight stretches of channel. These are sufficiently frequent that a straight line from sign to sign lies wholly and well within the channel. On bends or apparently protruding dams there are buoys or floating lights placed so that there be no danger to boats. These lights are operated by the government through fishermen in the neighborhood.

The improvement of the upper Mississippi is perhaps but a small part of the work the government is doing in bettering navigation conditions on its inland waters. While we have not developed this work to such a degree of perfection as some of the foreign countries, since there has not as yet been so great a necessity for it, still a dream of even exceeding the foreign achievements may be shortly realized. Some of the best authorities, notably our own Judge Ray S. Reid, see a wonderful future before the Mississippi; a consistently deep channel, fleets of barges and boats whose style is yet to be developed, wharves and deep harbors at all cities, loading and unloading devices of special design, a wonderful amount of freight transportation and travel, making our Father of the Waters a thoroughfare such as no railroad has ever been or ever will be; such things as these and more do these men see.

At any rate, it may well pay all Wisconsin graduates to watch this development and to take an aggressive interest in it. There is an excellent opening in this work for the contracting business, a large field in this direction with much work to be done, as shown by the figures already given. And even greater, far greater, than the engineering prospects in this matter, are the commercial and business opportunities therein afforded. The center of population will soon be at the Mississippi; the Mississippi valley has untold resources; the cry of "Go West, Go West" may cease and change to one relative to

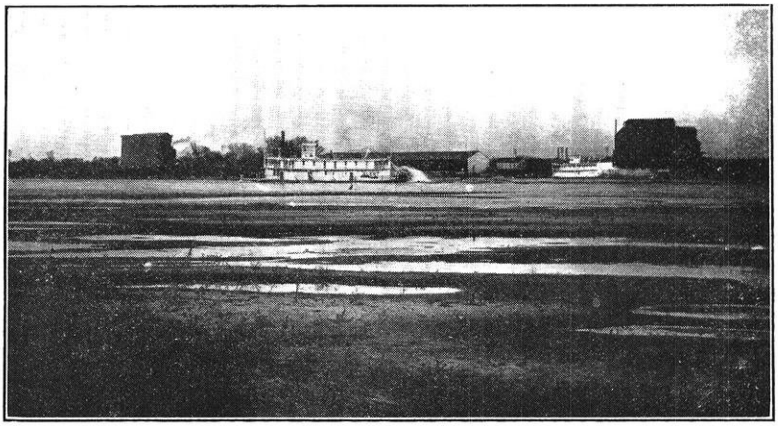

FIG. 3.—*Showing Deposits Between Dams.*

the Mississippi; the events of possible future Canadian reciprocity and the completion of the Panama canal may have wonderful results on river traffic. All in all, too, we may say that, in any event, the effect of water competition on the freight rates will be so beneficial to the public as to make the Mississippi River valley hasten its future, if there is a future for it. It may, too, be devolved upon this generation, our century, to reap the first fruits of this magnificent possibility and this grand probability.

USES OF BITUMENS ON WISCONSIN ROADS.*

H. J. Kuelling, '08; C. E., '11,
County Highway Commissioner, Milwaukee County.

While the good roads movement has a good substantial start in Wisconsin and the outlook for the future is bright indeed, yet the use of bituminous materials on our roads has been limited almost entirely to cities, although there are a few isolated cases of oiled roads and perhaps a few bituminous bound roads.

In considering the uses of bitumens, we must not lose sight of the fact that there are other good road materials that are well worth considering, such as brick, concrete, stone and wood block, but which will not be discussed in this paper. No one doubts the necessity and economy of dust prevention, both from the standpoint of health and pleasure, and the life of the road.

We speak of dustless roads, but to expect such a thing is absolutely useless, for dust is formed not only by the wearing away of the road but also by dirt that is carried on the road and from animal droppings. Still, we can improve upon the present condition of most of our Wisconsin roads. So-called experiments and service tests have been made in many places, sometimes the "cure" being worse than the disease. This has been especially true in rural districts where oils have sometimes been purchased with no knowledge of their ingredients or adaptability for use under existing conditions.

This uncertainty is due to a lack of satisfactory standards, to a lack of men who understand both the make-up or composition of road bitumens and their intelligent use upon the road itself. Then again, too often the layman and not the engineer dictates the quality or kind of materials used. All the blame for our poor and dusty roads should not be placed with the

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* Read before the County Highway Commissioners of Wisconsin, Feb. 13, 1912.

traffic, as often the cause is largely poor construction and poor materials.

During the last few years so much has been written concerning the various bitumens that the layman and many engineers are entirely at sea concerning their proper uses. These questions frequently arise:

What are bitumen, asphalt and tar?

When should we use such materials?

How can we tell what is the proper material to use?

How can we tell the material when we get it?

How should they be applied?

How much should the various treatments and processes cost?

Bitumen:

Perhaps the most used word that is not understood as it should be is the word bitumen. The dictionary definition of bitumen is: "mineral pitch; a black, tarry substance, burning with a bright flame and by extension any one of the natural hydrocarbons, including the hard, solid, brittle varieties called asphalt, the semi-solid maltha and mineral tars, the oily petroleums and even the light napthas."

However, the usual practice is to limit the meaning to those hydrocarbons that are soluble in cold carbon bisulphide, chloroform, turpentine or ether. Bitumen, besides being an ingredient of gas tar, occurs in many natural products in almost all parts of the world and in widely different forms. Free bitumen is found in substances varying in physical properties, from a liquid, as petroleum, to a solid, as glance pitch or as gilsonite. It is found mixed with earthy matter as in asphalt, with silica as in bitumen impregnated sandstone, and with lime as in bituminous limestone. The petroleums of varoius localities contain bitumen in varying amounts, the oils of California and Texas being the richest, the others containing a large per cent of paraffine, which is not desirable in road work. It is the petroleum residue that is used, or what remains after the lighter oils are distilled off.

Bitumens may be divided into two classes: the native, and the artificial, or those found by destructive distillation, of which the tars are the main supply.

Asphalt:

Next in importance perhaps comes asphalt, a word over which there has been considerable disagreement. Mr. Clifford Richardson, a leading authority on asphalts, defines it as follows: "Asphalt is a form of native bitumen. Native bitumen consists of a homogeneous mixture of hydrocarbons and their derivatives, at times of different series, and may be gaseous, liquid, a viscous liquid or a solid. Asphalt is one of the solid forms of native bitumen. It is found occurring in nature in this form, or it may be derived from certain liquid forms, asphaltic petroleums, in which it is contained in solution, by removing the more liquid and volatile components by careful distillation. In a general way asphalt may be said to be a derivative of petroleum as the result of metamorphosis under naturally existing conditions continued during a long period of time. Asphalt does not originate in nature directly as a solid material, but is the result of slow changes which take place under the environment to which certain petroleums are subjected, usually at some depth below the surface."

Tars:

While asphalts and oils are what are commonly called natural bitumens, tars are artificial, that is they never occur free in nature. They are obtained by destructive distillation, *i. e.*, by heating a material beyond the point of decomposition without the access of air. This process results in the formation of coke, permanent gases, ammoniacal liquors and oily distillates or tars.

The tars which are of most interest to us are extremely complex in their chemical combinations, just as the natural bitumens are. Although considerable has been learned concerning both during recent years, there still remains much to be found out.

The question as to when bituminous materials should be used in road construction and maintenance is a difficult one to answer, as there are so many local conditions to be considered.

One often hears the inquiry, "How much motor traffic should a road have before it is treated with a bitumen?" This is an uncertain quantity, for while a given amount of motor traffic may be injurious to one road it may not be very much so to another. Some attention should be paid to whether traffic consists of trucks, light cars or heavy touring cars.

There is no doubt but that there are many districts in Wisconsin that require a macadam road that do not at the present time demand what is commonly called a treatment, for they get so little motor traffic as to be damaged very little. At least they do not demand a more expensive type of road even though a surface treatment may be advisable for other reasons than motor traffic.

Often a cheaper road is more economical in the long run than a more costly bituminous one, the increased maintenance cost of the cheaper being less than the extra first cost of the better road.

Along this line Hubbard (whose book on "Dust Preventatives and Road Binders" is as good as any treatise that has been printed) says:

"For dust prevention only a temporary binder or palliative may be employed, but never with the expectation that it will serve as a permanent binder. On the other hand, the permanent binders, while of great value as dust preventatives so far as the wear of the road is concerned, cannot be expected to serve indefinitely as dust layers. Other considerations which may govern the selection are cost, ease of application, imperviousness, time required before traffic can be admitted to the road after treatment, freedom from harmful and offensive qualities, slipperiness, etc. It should be remembered, however, that no matter how much care and attention is paid to selection, unless the material is properly applied and the road is in proper condition to be treated, satisfactory results will not be obtained. Moreover, the necessity for careful and constant maintenance should never be forgotten if the work is to be put upon the most economical basis possible."

The question of the proper material to use is one that causes considerable thinking on the part of the engineer, especially after he has made a more or less careful study of the tars and asphalts on the market and listened to the praises and criticism of the various salesmen. The type of material to use should be determined by the use to which it is to be put; a mixed macadam requires a different binder than one built by the penetration method, and surface treatments require a still different material. The question as to whether the stone is to be heated or not is one that has a large influence on the chemistry of the binder. To determine intelligently just what bituminous material to use, requires a considerable chemical knowledge of the materials, or at least the ability to interpret the results obtained by some chemist. In my opinion the man who has a knowledge of both the chemistry of bituminous road materials and of their practical use in the construction of the road is rather a scarce article at the present day. Even though enough simple tests can be quite easily made with an outfit costing a few hundred dollars, yet very few engineers attempt to make their own tests. They therefore must depend upon a chemist and it thus requires the combined successful efforts of both to make a good road; and if a poor road results the blame is put by the engineer upon the chemist and by the chemist upon the engineer. The engineer will say that the chemist permitted a poor material to be substituted, and the chemist will say that the engineer did a poor job of constructing.

By all means chemical tests should be made to determine if we are getting the kind and quality of material we are paying for. There is no other way to be sure, just as in the purchase of other materials, as cement or iron. One test is not sufficient any more than one test is enough if a large quantity of cement is being purchased, but samples should be taken regularly and all the necessary tests made upon each.

In comparing the tests of different materials as asphalts and tars it should be remembered that they are two different materials, and similar resuts should not be expected from tests of the two. For instance, an oil with a specific gravity of 1.000 might be satisfactory while a tar of that gravity would be rejected at once.

Where the bituminous material is used as a binder for the stone or slag instead of being placed on the surface of a finished road, two methods are in use, one known as the Penetration Method and the other as the Mixed Method. In the penetration method the stone for the wearing surface is laid upon the foundation course and the binder poured upon it, while in the mixed method the stone and binder are mixed together before being placed upon the road.

As to my idea of the best practice in the penetration method, I quote from a set of specifications I have drawn for some of my own work:

FIRST COURSE OF MACADAM.

1. After the concrete foundation has been placed * * * the first layer of broken stone consisting of 1½″ stone, or stone that will pass through a ring 2½″ in diameter and be retained on a 1″ ring shall be deposited in a uniform layer having a depth of 2½″, after being rolled repeatedly with a ten ton standard roller until compacted to the satisfaction of the engineer. No stone in this course shall be more than 2″ nor less than 1″ long.

2. The depth of stone in this and all other courses must be measured by blocks, the required thickness of said loose stone. These blocks must be placed at frequent intervals amid the loose stone when being spread.

3. The surface when complete must be parallel and conform to the curve of the crown of the finished surface of the roadways as shown on the plans.

BINDER OF FIRST COURSE OF MACADAM.

1. Into the surface layer of large clean crushed stone, free from dirt, made as specified above, shall be evenly poured in a manner satisfactory to the engineer, 1½ gallons to the square yards of bituminous road binder, said binder to be furnished free of charge to the contractor at the dock or other receiving station.

2. Before pouring, this binder shall have been melted and heated to such a temperature as shall be designated by the engineer for the particular binder in use. No binder which has been over-heated or burnt either in the refining or melting shall enter into the roadway. The pouring shall be done only when the surface layer of large stones is bone dry.

SECOND COURSE OF MACADAM.

1. Immediately after the first pouring of binder, as provided above, a sufficient amount of crushed stone of such sizes that all of it will pass a 1″ ring and be held on a ½″ ring and which stone shall be bone dry and heated to a temperature between 200° and 250° F. shall be spread upon the poured layer to fill all of the voids thereof; and the rolling of the surface layer shall be at once begun and continued until the surface is satisfactory to the engineer in charge.

BINDER OF SECOND COURSE OR SEALING COAT.

1. Upon this surface shall then be evenly poured in a manner satisfactory to the engineer ½ gallon to the square yard of the aforementioned bituminous binder, melted and heated as above provided, and upon this shall at once be spread and broomed a thin layer of crushed granite, quartzite, or other material satisfactory to the engineer, all of which shall pass through a ½″ ring and be retained upon a ¼″ ring, this fine material to be bone dry and heated to a temperature between 200° and 250° F. The final rolling shall then be given this surface until it is satisfactory to the engineer. No binder shall be poured except on days satisfactory to the engineer.

DEPTH OF FINISHED PAVEMENT.

1. The bituminous surface of the road shall be 2½″ in thickness and the foundation 5½″ in thickness when complete, and allowance shall be made to this end in the amount of loose materials laid down before rolling them.

MIXING METHODS.

This method is the same as the penetration method up to the application of the second or wearing course of stone. This course is made of fairly well graded stone which has been mixed and coated with the hot binder and applied in a layer about two and one-half inches deep. When the stone is heated a binder of greater consistency can be used than where the stone is not heated, in which case the binder is about the same as in the penetration method. The course is then rolled, sometimes stone chips being spread over the surface if too much trouble is found from the material sticking to the roller. After rolling a seal coat similar to that used in the penetration method is added and screenings added where needed.

A maximum decree of stability is obtained when the mineral aggregate is so graded as to give a minimum of voids, and the only difference between the so-called bitulithic and the common mixed bituminous road is that there is a special effort made in the bitulithic to grade the aggregate. A patent on such a mixture has been granted to Warren Brothers. Because of the increased cost of grading the stone and the necessity for using the full run of the crusher on most road jobs, bitulithic is too expensive for ordinary highway work.

The mixing is done generally by hand, though there is no doubt that where there is much work to be done a machine of some kind would be much more economical. In mixing by hand the material is heated on the job and then mixed in such a way as to coat all the stone thoroughly and still get a good uniform mixture. Such a road should cost about six cents plus the cost of about one and one-half to two gallons per square yard over the cost of an ordinary macadam.

For mechanical mixing there are several mixers on the market, some being very complete, having a place to heat both stone and bitumen and automatically proportion and mix the materials.

COMPARISON OF THE TWO METHODS.

As regards the advantages and disadvantages of the penetration and mixing methods there has been a great deal of discussion.

The advantages of the penetration method are, first and most important, the cheapness of the method, and second, the little investment in apparatus.

The disadvantages are:

1. The uncertainty of obtaining a uniform mixture throughout the wearing surface, because the bitumen is unable to reach many of the smaller voids. The stone may be too cold and result in a poor penetration, dust may stop penetration, or an extra amount of bitumen on the surface may cause trouble by softening in warm weather or peeling off in cold weather.
2. A lack of uniformity in the mineral aggregate affects the distribution of the binder and gives a non-uniform surface.
3. A binder of softer consistency must be used in order to get the material properly to penetrate the layer of stone.

The disadvantages of the mixing method are the greater cost and the more apparatus required for placing. Where large quantities of materials are concerned this disadvantage disappears.

The advantages are:

1. A thorough coating of every particle of stone.
2. The use of less binder.

3. A thoroughly uniform mixture both as regards the aggregate and the bituminous binder.

The question of heating the stone should be given considerable attention, for if it can be done economically it will considerably increase the length of the working season.

For final standards the penetration methods will probably be doomed, for it requires greater care to get uniformity in this way than in the mixing method, and it requires more cement, though the stone is not heated. Furthermore, the contraction of bituminous concrete, after having been put in place while hot and after tamping or rolling, is an advantage of no small importance in getting a solid road.

What is perhaps the most interesting phase of the subject is the question of the extent to which tars and asphalts should be used on our Wisconsin roads outside of the cities, or in other words, in our system of prospective state highways.

I believe that by far the majority of bituminous materials for such roads will be in the form of some surface application. However, some roads near our larger cities and some that carry a large amount of through automobile traffic, and some roads around our main summer resorts, no doubt warrant the use of a binding material.

As regards surface treatments, I do not believe that they should be made on a new macadam, as much better results are obtained if the road is permitted to wear for a season. It therefore appears as if the cost of the treatment could not be included in the first cost of the road, as it undoubtedly rightfully should be. For this reason I believe that arrangements should be made so that if a town or county wishes, they may take two seasons to finish their roads if they desire to add a surface treatment of oil or tar.

As regards the use of bitumens on some of our older roads I would advise caution, for oil will not make a good road out of a poor one. In other words, the road should be put in good shape and allowed to settle before the application of oil or tar.

Many of our old gravel or macadam roads will make a good foundation for a bituminous macadam. They should generally be scarified and rolled before the addition of the new stone to receive the binder. The cost of such work will depend quite a little upon the binder used, which varies from five or six cents per gallon for the cheapest to thirteen or fourteen cents per gallon for the costliest. Before such work is done I believe that the road should be one with a proper alignment and satisfactory grades. As regards the use of oil on earth roads in Wisconsin, I do not think that it will ever be very successful unless there is already a considerable proportion of gravel present in the natural ground, and even then I would be quite doubtful about trying it.

I have been forced to treat the subject only in a most general way, for to go into any great detail regarding the question of bitumens in road work would require a whole volume.

STRENGTH OF GLUED JOINTS.

L. V. Ludy,
Acting Professor of Steam and Gas Engineering.

Several years ago the writer, assisted by Messrs. W. A. Jones and B. T. Jones, senior students in Mechanical Engineering at Purdue University, conducted a series of tests in an effort to secure information on the breaking strength of glued joints as affected by the time of setting and different pressures subjected to the specimen while setting. The original plan contemplated making tensional and shearing tests on different kinds of wood, using different glues, but because of a lack of time only the tensional tests on one kind of wood, with one kind of glue, were completed.

All joints were made of straight-grained clear white pine. The wood was thoroughly seasoned, sawed and planed to one inch square and cut to a length of ten inches. The joint was made by gluing together, end-to-end, two pieces of wood, thus making a specimen twenty inches long with the joint at the middle. The ends of the pieces of wood to be glued together were carefully squared with a patternmaker's saw, and after the glue was applied to the end surface, the pieces were placed together end-to-end and subjected to a definite pressure for the desired length of time while the glue was setting. In order that a uniform pressure on the specimens could be secured, a special form of press was constructed consisting of a steel framework and a system of levers. Its construction was such that three test specimens could be subjected to any predetermined pressure for any desired length of time. The test pieces were placed in the press in a vertical position and as the area of the joints formed by the two pieces was one square inch, the pressure was represented in pounds per square inch and was so recorded. Before tests were made for record, the press was carefully calibrated in order to make sure of the accuracy of the pressure readings. As the work progressed it was found necessary to construct a second press similar to the first, in order to complete the work in the allotted time.

The glue used throughout all the tests was the best quality of hide glue obtainable and was known on the market as amber glue. In order that uniform results might be secured, the greatest of care was exercised in preparing the glue for use, and in its application. In preparing the glue for use a weighed quantity was placed with a known weight of water in an air-tight vessel and set aside for from twelve to fifteen hours. The glue, after soaking, was placed in a double glue pot and heated to a temperature of 170° F. The exact proportions of glue and water used were 40 per cent glue to 60 per cent water. The quantity of water used in mixing the glue was determined by experiment and gave a solution having about the same viscosity as that found in commercial use.

One of the chief difficulties encountered in preparing the specimens was in the matter of applying the glue to the surfaces in as nearly as possible the same manner in all cases. The method employed was to apply, with a brush, a sufficient amount of glue to fill the wood for a distance of from one-sixteenth to one-eighth of an inch from the end, depending on the character of the wood, and after filling the wood to apply a coating to the surfaces. After the application of the glue, the treated ends of the pieces were immediately placed together end-to-end in a vertical position in the press and the desired pressure applied. In this manner, with a little care and experience, very uniform results were secured. Before subjecting the specimens to test, the excess glue, which was forced out from between the surfaces, was carefully cut away so that the strength of the joint would not in any way be affected.

All joints were tested on a 50,000-pound Riehle testing machine, the method employed being that ordinarily used in testing specimens in tension. The test piece was held in the machine by flat jaws or wedges, care being exercised when the specimen was placed in the machine that it was subjected to little or no bending. The length of the test piece was such that any local crushing of the wood caused by the action of the wedges did not affect in any way the joints under test. As the work proceeded it was found that by exercising care in the preparation of the specimens and in their testing that in most cases three tests were sufficient to give a reliable average.

The results obtained are presented in Table I.

TABLE I—*Strength of Joint in Pounds Per Square Inch*

Pressure on joint while setting, in Lbs. per Sq. in.	Time of Setting in Hours				
	2	4	6	8	10
50	440 300 305	775 850 780	1,040 1,160 1,050	1,180 1,200 1,450	1,300 1,210 1,440
Average	348	802	1,083	1,277	1,317
100	215 275 265	320 295 300	500 480 465	610 630 655	845 1,070 950
Average	252	305	482	632	955
200	470 390 420	810 910 1,010	1,275 1,095 1,170	1,470 1,570 1,400	1,810 1,755 ....
Average	427	910	1,180	1,480	1,782
300	145 160 185	535 585 470	820 940 800	1,155 990 810	1,530 1,510 1,620
Average	163	530	853	985	1,553
400	90 130 200	440 460 490	720 750 770	1,100 1,070 960	1,400 1,480 1,420
Average	140	463	743	1,043	1,433
500	80 90 70	910 845	1,130 1,230 1,175	1,160 1,200 1,390	1,300 1,560 1,610
Average	80	878	1,178	1,250	1,490

The effect on the breaking strength of the joint of both the time of setting and the pressure on the joint while setting is clearly shown on Diagrams 1 and 2, which are constructed

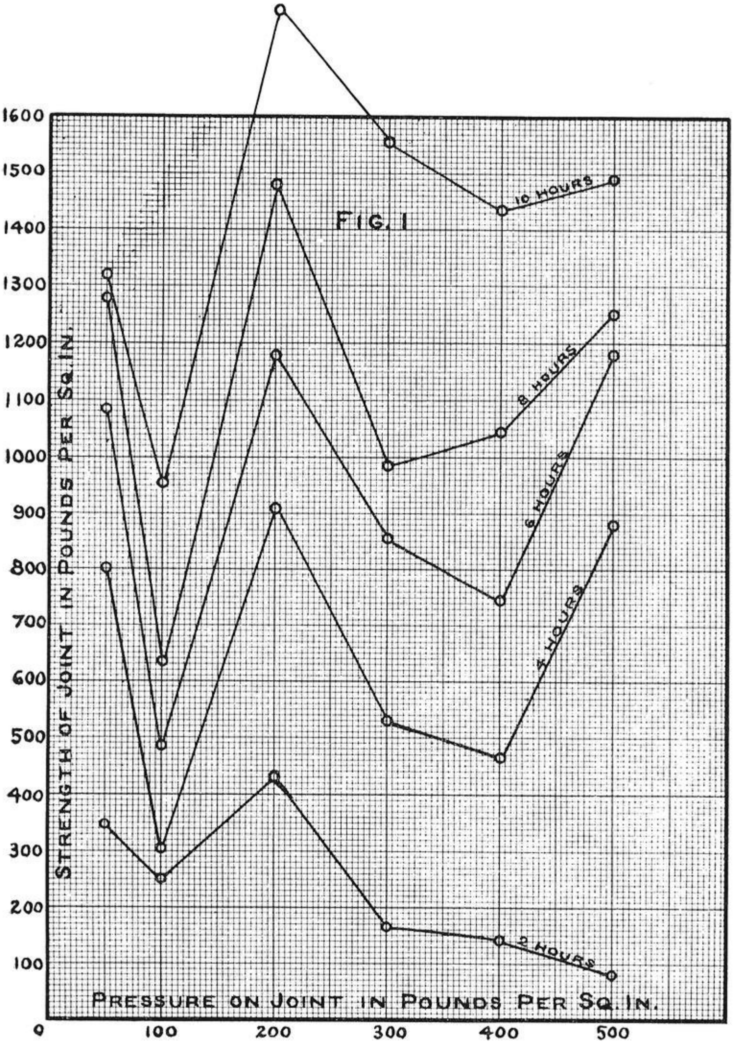

FIG. 1.

from the data given in Table I. A study of the results given in Table I, together with Diagrams 1 and 2, disclose the following facts:

1. The joints having the greatest strength, under all time-setting conditions, were found to be those which were subjected to a pressure of 200 pounds per square inch while setting.

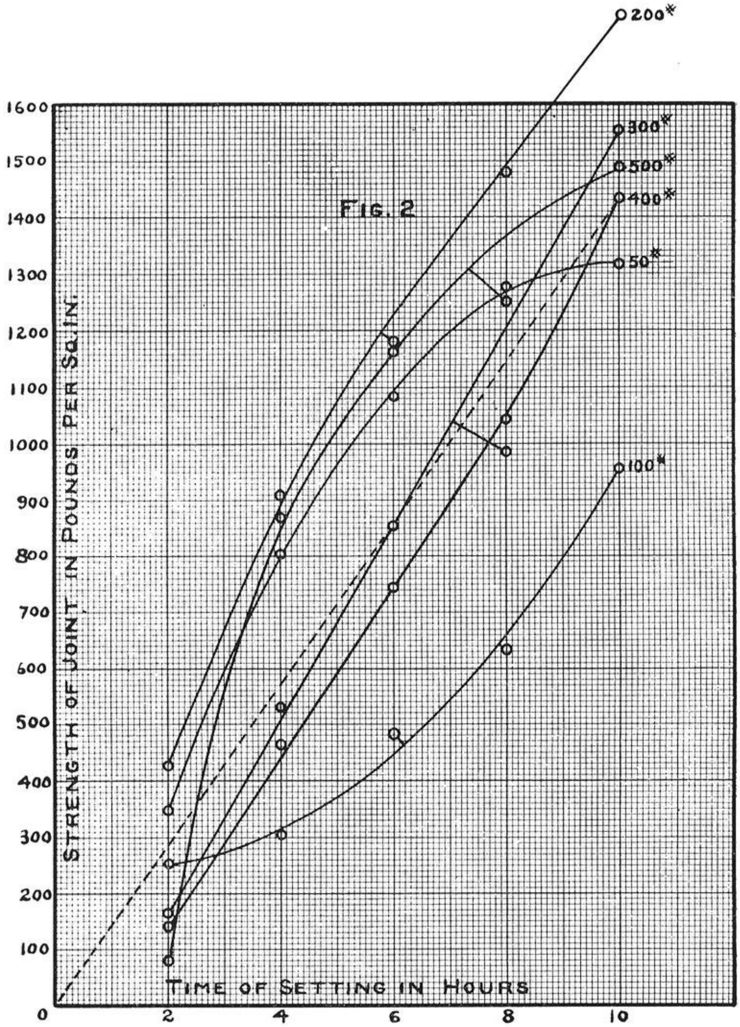

Fig. 2.

2. The joints offering the least resistance to breaking, except those having the lowest time of setting, were those subjected to a pressure of 100 pounds per square inch while setting.

3. The breaking strength of all joints increased with the time of setting, save those having the least setting time.

4. With the exception of those joints having a setting pressure of 50 pounds per square inch, the results indicate that the time of setting was not extended sufficiently to develop the maximum strength of the specimens.

5. With but one exception (at 200 pounds pressure while setting) the results indicate that with the least time of setting (two hours) the breaking strength of the joints decreases as the time of setting increases.

In practice it seldom, if ever, happens that the pressure employed in glue work is known. Under such conditisons the time of setting is the element which controls. To give some information on this phase of the question Table II was prepared.

TABLE II —*Average Strength of Joint in Pounds Per Square Inch*

Pressure on joint while setting, in Lbs. per sq. in.	TIME OF SETTING IN HOURS				
	2	4	6	8	10
50	348	802	1,083	1,277	1,317
100	252	305	482	632	955
200	427	910	1,180	1,480	1,782
300	163	530	853	985	1,553
400	140	463	743	1,043	1,433
500	80	878	1,178	1,250	1,490
Average	235	648	920	1,111	1,422

In this table the averages taken from Table I are arranged with reference to the time of setting. The averages given in Table II, plotted on Diagram 2, gives a straight line which is shown as a broken line extending from the origin. The equation represented this line is,

$$x = \frac{y}{143.3}$$

In which x = the time of setting in hours
and y = the breaking strength of the joint in pounds per square inch.

If the time of setting is known, substitution in the equation should give, within reasonable limits, the breaking strength of the joint in pounds per square inch.

THE ENGINEER AND THE FUTURE.*

E. D. MEIER, New York,
Past President of the American Society of Mechanical Engineers.

If we could plot the progress of engineering in the last century in a plane curve culminating in the present, at the intersection of our axes the future would probably trace a line ascending in a great parabola.

But as we look back we can conceive of no equation which could express the achievements of the past in a single line, no matter how grand its sweep. The three dimensions which limit our knowledge of space are requisite to compass the varied activities of the engineer.

A century ago the distinction between civil and military engineer sufficed, but a few decades ago it became necessary to differentiate in turn the mechanical and the electrical engineer, while quite recently upwards of a hundred specialties were enumerated in the attempt to define the activities of the profession, each of which has its recognized experts. These are developed to fulfil the imperative demands in every art and industry for a greater refinement, precision and certainty as to the quantity and quality of the product.

Slowly but surely the superstitions and traditions which have so long encumbered our social life and hampered our free development, are exposed and annihilated by the altruistic labors of men who give their life to science. These are the high priests of the new dispensation. It is the duty, the glorious privilege of the engineer to receive their discoveries with reverent hands, and apply them to the solution of the practical problems of life.

Both these types of men are essentially modern products of an evolution which counts not by centuries, but by ages. Before the first Cain of the stone age could appropriate the fruits

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of his brother Abel's labor there was a mechanic who fashioned his stone axe as patiently as he had lashed the pole to the curved branch with which Abel ploughed. The lame blacksmith who hammered out the greaves of Achilles and chiseled a whole panorama of barbarous deeds on his bossy shield, stood in such high repute among the war-like Greeks that they voted him a place among that rather disreputable coterie which ruled the small world of the day from Mount Olympus. Some centuries later there were a Democritus, a Bion and a Euclid, who developed geometry. But the clumsy method of numerical notation and the absence of algebra made the application to practical problems almost impossible. And the unfortunate habit of the noblest minds among the ancients to lay more weight on methods of reasoning and theoretical speculations than on the facts on which these should be based, retarded the union of science and practice. Even the inventive genius of Archimedes was hampered by these unfavorable conditions.

Those great road and bridge builders, the Romans, produced military engineers, but theirs were mainly static problems; and even their much vaunted aqueducts show lack of co-operation between science and practice. They were carried over valleys on costly structures inviting diversion or destruction at the hands of the enemy. With their excellent cement and their knowledge that water always seeks its level, their engineers might have built subterranean conduits.

The great engineer of the Renaissance, Leonardo da Vinci, with prophetic prescience conceived in the sixteenth century projects which the nineteenth and twentieth were to carry out in the light of scientific facts entirely unsuspected in his day.

The seventeenth and eighteenth centuries were engulfed by wars predatory and dynastic, and even the fierce upheaval of the French Revolution and the drastic destruction of feudalism by Napoleon left alive modes of thought based on an exaggerated reverence for the philosophy of Greece and Rome.

Early in the nineteenth century the scientific method came into vogue, and henceforth problems were studied and defined before their solution was attempted, and more intellectual labor expended in ascertaining facts than on reasoning about them.

Thus the union between the mechanic and artificer and the student of nature's eternal laws became possible and permanant, and engineering developed from an art into a profession.

The men who spanned the Hellespont for the hosts of Xerxes, those who dug the irrigation canals which made Mesopotamia the granary of the ancient world, those who designed and built the engines with which Alexander battered the walls of Persian strongholds, those who cumulated the puny muscular force of thousands of Egyptian slaves for the herculean task of raising the pyramids, all these men were giants in their day; but now their very names are forgotten. The literature of that day and for long afterward was concerned mainly with kings and conquerors. Jurisprudence and medicine shared in some slight degree the attention and prestige which were almost wholly absorbed by war, and can hence trace their history back to the ancient world. Democritus was one of the few ancients with scientific bias; knowing his surroundings we can understand why he became the "laughing philosopher."

Engineering is the profession of the present, and will dominate the future.

Laws have been made by men ever since the family expanded into the clan or tribe. They naturally reflect the ethical standard of the average mind of the period. Far in advance of them are the precepts laid down by those who founded the great religions of the world. And as we reverently discover and apply natural laws, we find new reasons and supports for these fundamental ethical conceptions.

The engineer then is a devout believer in natural laws. He knows that they are immutable and permit no exceptions. He needs no Supreme Court to define them as reasonable. They are the very foundation of the universe, and reason itself owes its existence to them. Every infraction of them brings its own punishment. The knowledge that every mistake or neglect inevitably results in failure is ingrained in the very fiber of his being. The vile doctrine evolved in the dark ages, "the king can do no wrong," which still causes occasional lapses of justice, has no meaning for the engineer. To tell the truth is not merely laudable and salutary, it is essential and necessary.

To lie is not only wicked, it is ineffectual, absurd and ridiculous.

To men thus trained, the future of the race is to be confided. They are not to be merely learned men; they must possess knowledge. Those fundamental sciences which observe and explain the inter-relation of matter and force, which weigh the distant planets and measure the wave lengths of sound and of light, must be thse absorbing objects of their nightly vigils and their all-satisfying reward.

The savage hated work, and even in those golden periods, praised by romancers masquerading as historians, labor was despised as the doom of the slave. As progress demanded more and higher types of labor, various devices were invented to secure it. From the glass beads and the brass bangles of the Hottentot to their counterparts in polished stone and burnished gold in civilized communities, these devices were effectual; but the highest type of labor has never been purchased by such crude bribes. The enlightened man loves his work and finds in it his supreme incentive.

To a Copernicus or a Newton, a Watt or a Corliss, an Ericsson or a Fritz, an Edison or a Steinmetz, the ransom of a king would seem trival compared with the satisfaction of knowing that he has given to his fellow men an achievement which marks a forward step in the evolution which will finally make us a race of rational beings.

When the ''missing link'' stood erect, walked and essayed articulate speech, this evolution began. The first man had crude but strong desires, and was a strenuous individualist. The predatory instinct was predominant, and the success of the family, the clan, the tribe, and finally the nation, depended on the potent warrior at its head. Laws and customs modified this predatory individualism in each community, but between neighboring communities there still held the rule, that

> "He shall take who has the power,
> And he shall hold who can."

The right of the mailed fist is still occasionally invoked by great nations, even though the individual citizens have been tamed and domesticated.

Commerce, which has in large measure wrested the control of the world from the war lords, has always had as its basic principle the rule, "Buy as cheap as you can, sell as dear as you can."

This has worked fairly well when cargoes of grain, wool, cotton, hemp, etc., were concerned. But where this principle was ruthlessly applied to the great producing industries of the world, where the comfort of the worker, the maintenance of his family, the very existence of his helpless children were in jeopardy, it has caused havoc, bred discontent and fomented revolution. No one who has worked among the contented, intelligent mechanics of a half century ago can view without distress and indignation conditions as they exist today. Labor unionism is a protest, dangerously near a rebellion, but not a cure.

When the commanders of the industrial soldiery wrought in their mist, understood their problems, solved their perplexities, aroused and shared their enthusiam for the quality of the product there grew up an esprit de corps which is now sadly missing.

Without faith in the excellence of the goods produced, without enthusiasm in the work and in the leaders, productive labor becomes mere drudgery. The remedy lies in placing engineers in all the responsible positions in these great industries. Their special training fits them for leadership in this host; and leadership by him who knows, and who sinks himself in his work, always has and always will command that joyous and fervent support from his followers which money cannot buy.

Where nepotism is banished, and ability and perseverance are recognized, there great success is attained. Napoleon's army, the Carnegie Steel Works, the Pennsylvania Railroad, exemplify this. The increasing multitudes of special industries are literally hungering for engineers equipped with character, knowledge and devotion, to become the expert leaders.

Labor wars will cease when such men are given the power to provide that the share in the rewards of industry shall bear just ratio to the service rendered the community. There is a sane middle ground between grasping individualism and utopian socialism.

The forces and materials we employ in our manufactures have long been and still are the subjects of most careful analysis and experimentation, to find their precise load capacity and endurance. The study of the living force and of that highest and most costly material inherent in the workman has but recently begun. But already several promising theories are undergoing exhaustive tests on a large scale. Pyschological study prescribes a humane basis for them all as the condition of success.

The unrest in the modern world has its basis in an underlying sense of injustice. The growing sense of community of interest, the knowledge of our dependence on each other, the ever-expanding humanitarianism, are all founded on scientific facts, and are becoming world movements. They fervently and emphatically answer Cain's question, "Thou art thy brother's keeper."

The engineer is responsible for the vast increase in appliances to meet every demand of that most voracious of living beings, man. The mass of mankind needs to be educated to understand and use them properly. He is in honor bound to supply this education; and as the crude dangers and fears of the earlier centuries vanished, so the prejudices and superstitions of the Dark Ages must be swept away.

If our future professional brethren do their duty, and we know they will, the golden rule will be put in practice through the slide rule of the engineer.

The Wisconsin Engineer.

EDITORIAL.

In connection with Colonel E. D. Meier's address, "The Engineer and the Future," which is to be found elsewhere in this issue, it is worthy to note that the American Society of Mechanical Engineers has entered the field of social service and has initiated a "forward movement in an effort to bring the engineering profession into a share of the prominence and leadership in public affairs now largely held by lawyers and financiers." Technical design and industry have a significant influence upon our commercial and industrial progress. The society, through its committees, will devise means for betterment of the industries and will cope with problems of municipal and national interest.

* * *

The importance of good roads and streets is generally appreciated, but the factors which make for public highway betterment are not so generally known. In this issue we present the papers of Messrs. Smith and Kuelling, which will acquaint the reader with factors necessary to good roads and streets.

* * *

AN OPEN LETTER.

To the Alumni and Students, Colllege of Engineering, University of Wisconsin, Madison, Wisconsin:

FELLOW ENGINEERS: As a non-resident alumnus of the University of Wisconsin I wish to ask if any co-operative engineering agency or bureau exists at Madison, or elsewhere, which has for its object the placing of U. W. graduates in suitable positions for a commission on a percentage basis. If not, why not? Are not the engineering alumni of the University of Wisconsin numerous enough and influential enough to support such a bureau? 1386 graduates! Owners and executives of manufacturing plants; chief engineers, superintendents, and managers of public service corporations, steam and electric railroads, and powerful construction companies; consulting engineers, private contractors, and hundreds of assistants having influence with employers of technical help! 1386 graduates, and tens of thousands to become graduates; men of affairs in responsible positions of controlling influence in almost every state in the Union; located as far north as Alaska, and as far south as the Argentine Republic; as far east as Russia, and as far west as China,—these enthusiastic supporters of the U. W. colors unable or unwilling to support one engineering bureau? Nonsense!

Teachers' agencies have existed for years, giving proof that the operation of such bureaus is a commercial success. Only last September we read that the stock of a central engineering agency would advance twenty per cent. If a bureau can build up such a profitable business by getting strangers and prospective employees together, how much more profitable the business of getting employers and employees acquainted when these are alumni of the same college of engineering and that of the University of Wisconsin.

I am aware of the record of graduates that is being kept at the Dean's office; and, but for our individual procrastinations, if not omissions, I am confident this would have been more complete and efficient. But we need a system by means of which men out of employment can at once get in touch will all alumni who are in the field for technical help, or who have influence with such employers. Again, alumni may not be in need of employment so much as they may need a change of employment; it is one thing to have a position, and another to have the position where we can work to our best advantage, do the most good in the world, and be the happiest.

From personal experience I know there exists a need, and I believe there will soon exist a demand, that we become better organized for the advancement of our mutual interests. To work out the scheme and carry it into execution is a problem for resident alumni and the present senior class at Madison. Or possibly the Wisconsin Engineering Journal Association could carry it on in connection with the publication of the Engineer, which journal would naturally become a regular medium for advertising positions and candidates. I want to assure the promoters that the bill for the usual registration fee will be honored at once; and the usual commission on a year's salary when I am located in a suitable position, guaranteeing something like a permanency, and paying me a better salary than I am earning in my present position. Are there many real U. W. alumni unwilling to promise as much? Let me recount to them my individual experience illustrating how ignorant we are of each others' wants at the present time: Having been out of permanent employment for some months back, I wrote to a classmate who I thought might be in a position to put me in touch with something. He answered: "I should have been glad to have gotten hold of you last spring when we were scouring the country for men, but did not know you were . . ." I was busy at the time, very busy; but my position was quite temporary, and one I could have severed my connection with on very short notice. With a central bureau at Madison, or Chicago, financially interested in keeping an up-to-date record of the wants of all its registered members, it would not have been necessary for my friend, and even classmate at that, to be "scouring the country for men;" while my own employment might have been continuous during the season.

Not very long ago I had the opportunity myself to recommend a man. No information being pressed on me about the needs of U. W. men, I did the most natural thing: recommended an acquaintance. Though not even possessing a high school education this man was in less than six months drawing a salary of $150 per month. If some deserving fellow alumnus out of a job had the proper qualifications to have filled this position, I didn't know about it.

We get together for commencement anniversaries and celebrations of athletic victories; we get together for class reunions, for social and fraternal banquets; we get together for fun, frolic, and frivolity; now let us get together for something enduring and permanent. One U. W. graduate "scouring the country for men;" another graduate of the same class and in the same city looking around for a job! Inconsistent with U. W. fellowship that.

Respectfully,

JOHN BERG.

NEW YORK CITY, February 1, 1912.

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The Alumni directory to which reference is made in Mr. Berg's letter is the first complete compilation of Alumni of the College of Engineering, as distinct from the five year University Alumni directory, which has been made.

It represents a very large amount of work, and will probably be published biennially, the revisions requiring less labor than the original compilation. The fact that the directory will be maintained practically up to date will render the location of graduates a much easier matter than has been the case in many instances in the past.

It is only fair to note, however, that many men have been put in touch with positions and located in better paying and more satisfactory work. More letters of inquiry regarding men for positions have been received by members of the faculty than they have been able to supply, partly because present addresses of graduates have not always been available, which it is hoped will not be the case now that a system of recording addresses has been established. Much greater assistance could be rendered the alumni if they would keep this office better posted as to their own positions and desires with reference to change of employment.

On some former inquiry cards sent out a question was asked regarding a desired change in position, and the response to these questions was so satisfactory that it will be continued in the information to be asked for in the future.

It seems rather undesirable to place this assistance on the commercial basis of a regular teachers' agency. It will probably be more effective if continued under the present arrangement with the added facilities given by the directory and the information on the inquiry cards, as every member of the faculty is interested in the highest degree in the success of the alumni.

The Wisconsin Engineer furnishes the best possible means of communication with the alumni, particularly as it is now issued eight times per year, giving an opportunity to keep them in touch with affairs in the College and University.

One discouraging feature is the small number of alumni subscriptions to the Engineer, but 150 out of 1,341 living alumni. Every possible effort has been made for many years to increase this subscription, but with little effect; and this excellent medium of talking with the alumni as matters of interest arise is only 11.2 per cent effective.

Any further suggestions along the line of Mr. Berg's letter will be welcomed.

DEPARTMENTAL NOTES.

THE STEAM AND GAS ENGINEERING DEPARTMENT.

An interesting study of the Nordberg compound engine is to be made in the laboratory as thesis research by Messrs. Prochaska and Richter. The present reheating receiver re-evaporates the moisture of the initial steam and the condensation from the high pressure cylinder, and may even superheat the steam before its passage to the low pressure cylinder. This will be replaced by one which will first separate out entirely entrained water and superheat the passing steam to a temperature approaching that of the initial high pressure steam which will be used for heating. Experiments by German engineers seem to indicate a decided gain in economy by the use of this apparatus, and it is hoped that their results will be checked in these experiments. The engine has been overhauled by the mechanician's department and is in good shape for the test.

Messrs. Gillette and Wile are making a study of a kerosene engine to ascertain its economy and efficiency, the influences of varying compression and water carburretion, and the analyses of the exhaust gases. The engine is about ten horse power, and is direct connected to a 110 volt, 7½ KW generator, forming a neat compact unit. The machine was built by the Falk Co. of Milwaukee and is kindly loaned by them for this thesis.

For the past year the Steam and Gas Department has been running a series of tests on the power required to run different types of commercial bearings under varying conditions of speed and load. The apparatus consists of five sections of 2-7/16″ shafting coupled together by flexible leather couplings and direct connected to a shunt motor by means of which the power necessary to drive the shaft is measured. Each section of the shaft has four bearings, two for supporting the shaft and two for applying the load. Conditions are exactly the same as exist in the ordinary line shaft inasmuch as the load is supported by one-half the bearing. The load is applied by means of a system of levers, one end of the system resting on the bearings and the other end on a jack screw placed on a platform scales. The apparatus was built by two of last year's seniors, and the tests are being continued by Messrs. Roth and Gaskell of the present senior class.

An apparatus for measuring air has been installed in the Steam and Gas laboratory during the first semester of 1911–12. The Fort Wayne Electric Co. and the American Blower Co. have kindly furnished the laboratory with a motor driven No. 2½ Sirrocco fan. A Thomas Electric Gas meter (the invention of Prof. C. C. Thomas of the University of Wisconsin) has been installed a short distance from the outlet of the fan, and provides a means of accurately measuring the volume of air delivered by the fan.

At present Messrs. Quast and Strothmann of the senior mechanical class are conducting a series of experiments to determine the losses in a 12″ galvanized iron pipe due to the straight pipe and to bends of varying radii.

A number of tests have been made and others are planned for the near future with the object of calibrating various types of Pitot tubes and some Venturi meters against the Thomas meter. These tests will be conducted by members of the Steam and Gas Engineering Department as research work, and are expected to be of considerable practical value.

THE HYDRAULICS DEPARTMENT.

The Niagara Power Company of Niagara Falls has recently presented the university with a high grade governor for use in the hydraulics department. The company has been changing their system of governors and this one has been discarded. It is an expensive piece of apparatus, and, while of no value in experimental work, will be of great use in illustrating the principles of of governors, and their method of construction. Prof. Mead has been instrumental in obtaining this gift and all the transactions have been carried on through him.

THE JUNIOR CIVIL ENGINEERS' TRIP.

By a recent action of the committee on engineering trips, it was decided that the civil engineers should take two short trips instead of the one long one which has been customary. The first trip will come in the latter part of the junior year and the second in the fall of the senior year.

Plans are at present being made for the first junior trip under this new schedule, and a committee of the faculty will meet in a few weeks to make the final plans. It is expected that the trip will come about the first of April and will include Milwaukee or Chicago, or possibly both. The complete itinerary will be perfected at the coming committee meeting. This trip will be compulsory.

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DANIEL M. GRANT.

Word has just been received that Daniel M. Grant, Min. '11, died at Galena, Illinois, of pneumonia, on Friday, March 1, 1912. Mr. Grant entered the University from West Division High school, Milwaukee, and was graduated from the mining course in June, 1911. After graduation he was employed for several months by the E. J. Longyear Company at Crystal Falls, Michigan, and afterward by the Unity Mine at Galena, Illinois, at which place his untimely death occurred.

ALUMNI NOTES.

J. T. Buser, formerly an instructor in mechanics in the Michigan Agricultural College, is now working for C. B. Stewart, consulting engineer, of Madison. Buser was a graduate of the class of '09.

E. H. Whittaker, '09, is now teaching in the St. Joseph Mo., high school. He taught in the high school at Worthington, Minn., last year.

A number of Wisconsin graduates are holding positions on the Isthmian Canal at Panama, as follows:

Edward Schildhauer, '97, EE., '11, chief electrical and mechanical engineer at Culebra, is in charge of the design and erection of operating machinery.

A. W. Bechlem, '07, electrical engineer, Culebra.

W. R. McCann, ex-'10, assistant engineer, Culebra.

A. T. Sjoblom, '10, draftsman, Culebra.

E. D. Stillwell, '10, electrical engineer, Culebra, is now testing machinery as it is erected.

F. A. Potts, '05, junior engineer, Empire.

R. O. Comer, '08, draftsman, Gatun.

C. H. Feige, '06, chief operator, Gatun Power Plant, Gatun.

O. O. Kuentz, '08, mechanical draftsman, Gorgona.

F. C. Henke, '10, has left his profession as civil engineer and is at present engaged as general secretary of the Y. M. C. A., Washington State College, Pullman, Wash.

S. R. Sheldon of the class of 1894 is professor of Electrical Engineering in the Imperial Polytechnic Institute, Shanghai, China. His address is U. S. P. O. Box 651.

H. E. Brandt, a civil engineer of the class of 1903, has taken up the manufacture of jewelry. Address, 1229 E. 63rd Street, Chicago.

G. W. Brown, '86, C. E. '90, is assistant inspector in charge of the Naval Coal Depot at Tiburon, California.