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THESIS

COMPARISON OF THE HELTZEL DEFORMED STEEL AND DEFORMED STEEL-CAP JOINTS IN CONCRETE PAVEMENTS

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1931

Strophomena *truncata*

Tuber. 1842. 1843.

Julia's first week was good.

John L. Jones Clerk of Court

COMPARISON OF THE HELTZEL, DEFORMED STEEL AND
DEFORMED STEEL-CAP JOINTS IN CONCRETE PAVEMENTS

A Thesis Submitted to the Faculty
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by
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THESIS

Comparison of the Heltzel, Deformed Steel, and Deformed
Steel - Cap Joints in Concrete Pavements.

The concrete road is becoming more and more the undisputed leader of our good road systems, not only in national and state systems, but, in many instances, in counties. It seems to be a material which is adaptable to the needs not only for states in warmer climates, but, when properly designed, can withstand the great changes in temperature which exist in some of the northern states.

Concrete, like most other materials, expands and contracts with these changes in temperature and, therefore, this expansion and contraction must be taken care of in some manner. The present method of taking care of this movement of the concrete slab is to use joints which divide the pavement into sections. These joints can be classified as either Transverse joints or Longitudinal joints depending on the direction they take in relation to the concrete slab. The Transverse joint is placed cross wise to the length of the pavement, while the Longitudinal joint is placed in a lengthwise direction and put in the concrete to localize longitudinal cracking. This cracking of the concrete longitudinally can be caused either by frost action in the sub-grade or by warping of the concrete slab. The Transverse joint is placed in the concrete to take care of the expansion of the slab and the transverse cracking.

There are many kinds of joints on the market that have met with varying grades of success. The three kinds of joints which have been most used in the construction of concrete pavements are: The Heltzel Joint, the deformed steel joint, and

the deformed steel-cap joint.

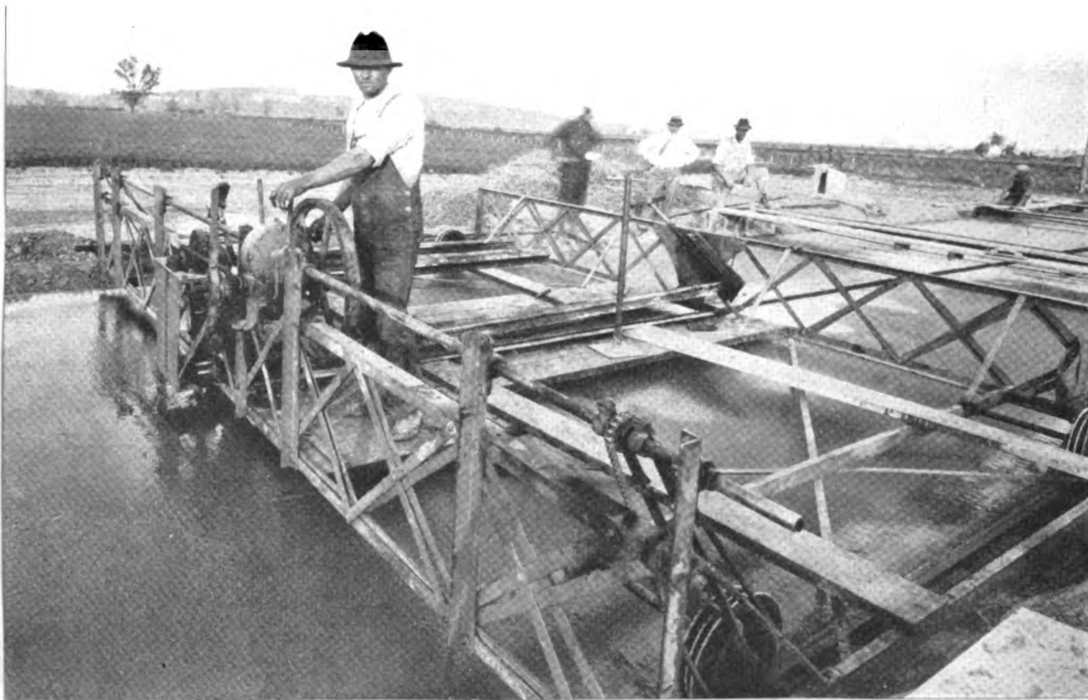
The Heltzel joint machine used in constructing the Heltzel joint is manufactured by the Heltzel Steel Form and Iron Company of Warren, Ohio, and is patented. The joint is made by a cutting tool carried along by a framework which rests directly on the forms, and as the machine moves along under its own power, a groove is cut in the concrete exactly at the center line. A metal plate is placed in the groove after which the pavement is belted and edged. This cutting takes place directly behind the finishing machine and while the concrete is in a plastic condition. The metal plate is allowed to stay in the concrete until the initial setting starts, then it is removed by men working from a bridge which rests on the forms. After the metal plate is removed, the groove left in the concrete is finished by hand-floats and trowels until no ridges remain, thereby leaving a crease in the concrete about two inches in depth and one quarter of an inch wide, extending the entire length of the pavement. When this operation is completed, the pavement presents the appearance of two slabs of concrete each one half the width of the pavement. This groove, which is termed a "dummy joint", is filled with hot or cold tar poured into it from a tar bucket fitted with a spout which will fit into the groove. Hot tar has been the accepted material for filling the joint until recently when the cold tar method seems to have gained favor, principally because the hot tar does not fill the groove as well, especially if water gets into the joint either by sprinkling or rain. Contact of the hot tar with the water creates a boiling action which throws the tar out of the joint

and leaves unsightly black spots along the joint. The cold tar filler does not do this and is therefore gaining preference as a joint filler.

The Heltzel machine is adapted for cutting longitudinal joints only, therefore some other method must be used in making the transverse joints. As it is common practice to make the transverse joint the expansion joint, it must be cut the full depth of the pavement. To do this the wooden or metal bulkhead is generally used and the expansion material fitted to one side of the bulkhead. After the concrete beyond the bulkhead is placed, it can be removed and the expansion material left in place. In cases where the intermediate contraction joints are desirable, the "dummy joint" could be cut from a bridge supported by the forms and the joint finished by hand work and later filled with tar, as in the case of the longitudinal joint. However, this necessitates considerable hand work which is costly. The maintenance cost of this kind of joint is very small, for all that is necessary is to fill the joint once or twice a year with tar. The Heltzel joint machine, if properly operated on straight line of forms held rigidly, makes a fairly straight line down the middle of the pavement. If the joint is properly filled with tar it presents a strip or dividing line which has a tendency to keep the traffic in its own particular lane.

There are, however, some objections to the Heltzel joint, in the opinion of the writer, which can be eliminated by the use of other types of joints. The joint machine is patented and is therefore costly. The "dummy joint" only cuts the pavement a small distance down from the surface, generally two inches and the rest is left in place, leaving considerable

supposition relative to what direction the continuation of this crack will take when it finally does crack through to the subgrade. The concrete might crack straight down, a condition that is desirable, but more than likely it will crack on a slantwise direction, a condition which might lead to weakening of the slab and by frost action under the slab would tend to force one side up on the other, creating a weakened joint and a rough, unsightly road surface.



View showing Heltzel Joint machine in operation on concrete pavement.



View showing joint finisher edging the slab.



Two views showing joint made by the Heltzel machine and filled with tar.

Note irregular edges due to boiling action of the tar.

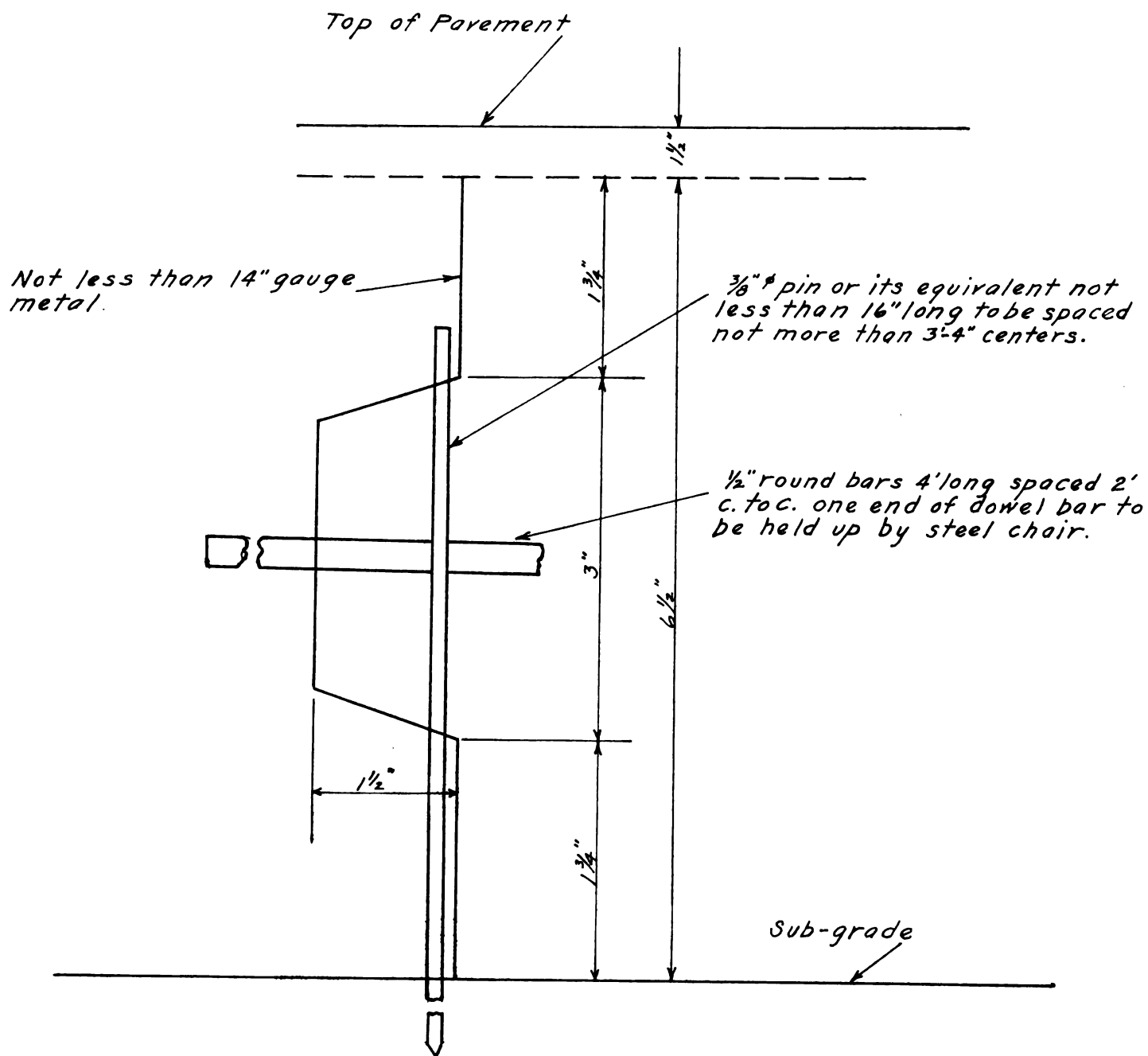
The deformed steel joint consists of a deformed metal plate whose upper edge, when placed in concrete, comes within one half inch of the surface of the pavement. By this method the pavement is divided into two slabs at the center line and this division extends from the bottom of the slab to within one half inch of the top. The concrete covering the top of the steel joint soon cracks through leaving a crack which follows the line of the steel plate the length of the road. The two slabs so created are tied together by bars which are bonded in both slabs and run directly thru the metal joint at distances of from two to four feet apart. This joint can be placed in position and held there by specially designed spikes which are driven through a hole in the joint and into the soil. This can be done by one man directly after the mixer has passed along, thereby causing no delay. But some mixers are so designed that the skip has a groove in the bottom of sufficient height so that the center line steel can be placed ahead of the mixer and will not be disturbed by the mixer passing over it, if properly placed. This method seems to be preferable because there is no possible chance for delay in laying the concrete due to slowness of the man placing the steel. The alignment is generally obtained by a metal or wooden arm which extends from the inside edge of the form to the exact center of the slab and holds the steel plate in position while it is being spiked to the ground. The height of the plate is found by stretching a line from the form line out to the center with a line level fastened to it and measuring the required height from this line. A wooden or metal arm with a level attached can be used with equal success.

The joint can be used both in longitudinal and transverse joint construction, but the general method is to use it as a longitudinal joint and use the expansion material for the transverse joint as is done when the Heltzel joint is used. It can, however, be used in transverse joint construction merely by having the steel plate cut to the desired crown or by cutting the plate into sections and fastening them together with clips and then approximating the crown of the pavement in this manner, but the joint must be kept one half inch below the surface of the pavement as when used for the longitudinal joint. This joint is adapted for fast work as it does not require any attention after being placed, but if the metal joint is not placed exactly in alignment, it will tend to make a very unsightly joint line when the pavement has gone through one or two seasons of varying temperature and the joint crack has widened above the joint steel. It may also cause failure of the surface at the joint due to the steel being placed too low. If the steel is much lower than one half inch below the surface, the crack which is bound to come above the joint may take a zig-zag course, causing breaking of the joint edge. This causes an unsightly joint which in time, if not properly maintained, will cause considerable damage.

The joint is easily maintained when properly constructed. The crack above the joint is generally small and can easily be filled with tar or a standard joint filler.



Two views showing alignment of Deformed Steel Joint.
Note crack is very irregular and makes an unsightly
center line.



Metal Construction of Deformed Steel Joint

The deformed steel-cap joint consists of the same shaped metal plate as that used in the deformed steel joint and has, in addition, a metal cap which fits directly over the metal plate with its surface at the same elevation as the concrete. The cap is made of steel and reinforced by a steel bar running the length of each section acting as a stiffener. These caps are removable and can be used many times or until they are either worn out or damaged due to the action of the screed board on them. The metal plate can be placed ahead of the mixer providing the skip is so constructed as to permit it.

The contractor should have from three hundred to four hundred lineal feet of the metal cap on hand for his joints. The strips of caps should be from fifteen to twenty feet in length for the most economical handling.

The cap is placed on the metal plate just ahead of the mixer and as soon as the concrete is finished, belted and allowed to set until it is stiff enough to hold its form, the cap can be removed and the groove thus made can be finished with a finishing tool of three quarter inch radius. In this manner, a joint is formed which is not only straight with the road line, but the metal plate edge is exposed leaving nothing to chance as to the relative direction the joint crack must take through the concrete slab.

The transverse joint is usually made by cutting the metal plate to the crown of the pavement and fitting the cap to the plate, or the plate can be cut into sections and joined by clips in such a manner as to approximate the crown of the pavement with the cap fitted to it. The cap, in both cases, must be bent to the desired crown of the pavement.

This system divides the pavement into two slabs at the center line as in the other cases, but the division extends the full depth of the pavement. The two slabs, as in the case of the deformed steel joint, are joined together by bars running through the metal plate spaced from two to four feet apart. The metal plate is placed and held in position in exactly the same manner as in the case of the deformed steel joint. This joint takes more time to place because the cap has to be placed and removed and the groove made and edged, but it is usually located at a more nearly uniform depth below the surface of the pavement, for a person can see at all times just how low the cap is and can adjust it accordingly. The joint also can be better aligned for the distance from the cap to the form can be checked at any time and the alignment altered if necessary, thereby insuring a straight joint line.

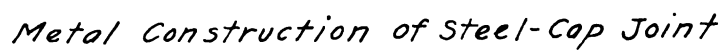
If the joint is to be used as a transverse joint, it can be set very rapidly if a frame is made which will allow the center line steel to be placed in it and clamped in place and the cap put in position. This frame consists of a cast iron strip about three inches wide and one inch in thickness and long enough to extend well over each form. This strip of iron has five slots cut through it from bottom to top and is large enough to allow iron hooks to run through these openings. The hooks must be of sufficient length to fasten to the bottom of the steel joint and extend upward through the frame projecting beyond about three inches. These hooks have an opening in them close to the top placed in such a manner that an iron pin can be driven through sufficiently to tighten the vertical hook thereby holding the steel joint in place. The frame can

then be set on the forms extending from one to the other and as soon as the concrete is poured, the frame can be unclamped and removed, leaving the plate and cap in position. After the concrete has set sufficiently, the cap can be removed by means of a bridge placed from one form to the other and the groove can then be treated the same as in the case of the longitudinal joint.



Two views showing straight alignment obtained by the use
of the Deformed Steel-Cap Joint.

Note absence of unsightly line of tar used as joint filler



Metal Construction of Steel-Cap Joint

The groove in the concrete, upon removal of the cap, should be filled with tar or some standard joint filler as soon as possible and before the dirt cover is placed on the concrete, otherwise the filler can not be placed until the cover has been removed and the joint swept or blown clear of the dirt.

There are advantages and disadvantages encountered in using any one of the above types of joints mentioned, but in the writer's opinion, the deformed steel-cap joint seems to give the best results as far as construction is concerned and presents the neatest appearance to a person traveling over the road looking for perfection in engineering design. Although this type of joint may require a little more time and labor in construction than the deformed steel joint, it does not need as much as the Heltzel joint and seems to be the joint which leaves as little as possible to guess work.

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