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it could have been made universal in its application by the
simple expedient of adding one step between the first and
second as plotted, thus permitting the use of any stress de-
sired. Thus, while the commonly used formula gives as re-
sults only the permissible load per square inch of metal, it is seen how easily additional steps may be added to make the completed diagram cover all applications of the original formula to problems commonly met in engineering work, and once the diagram has been constructed the solution of any problem is but the work of a few seconds.
In Figs. 8 and 9 is shown the application of diagrams to

another type of solutions, -that of simple proportions as in- volved in the design of a line of machinery of a given type.
The usual method in such a case is to build and perfect one size and then proportion others from this.
Two views of what is commonly known as a clam- shell bucket are shown in Fig. 8. With this class of machinery the rating is generally given in terms of cubic yards capacity, and it is evident that an equation for any linear dimension in terms of the rating will involve the cube foot of the capacity of the given size.
Assuming that the three- fourths yard size has been built experimentally and perfected, the problem becomes one of securing rational variations in proportions for other sizes. By referring to Fig. 9 the method used will be seen. Here the ordinate used is the rating in cubic yards, and the as-scissas are the linear dimensions in inches. With all dimen-

sions of the three-fourths yard size known, the horizontal locations of these points are plotted on the three- fourths yard ordinate.
Now, as explained at the beginning of this paper, a line representing an expression in which the ordinate is involved to any degree as the one- third, or cube root, will make an angle with the axis of ordinates, the tangent of which will be the exponent of the power or one-third. Take any dimen-sion then, as E, the height closed, and draw a line through the plotted point, making an angle with the vertical, the tangent of which is one-third, and this line will then give, by its intersections, the lengths of all other sizes. Lines parallel to the first one drawn through the other points plotted, give, in a similar manner, the dimensions of other parts, and although only a few are shown here, it is evident that the principle can be extended indefinitely to cover practically all linear dimensions.
The weight of such a machine should rationally vary about as the capacity. For the heaviest materials to be handled this proves true, and the 45 deg. line marked Weight Heavy would indicate the variations on this basis. For lighter ma-terial it is possible to reduce the weight per unit of capacity in the larger sizes, and this is shown by the line marked Weight Light. The reason for the break in direction of the weight lines for small sizes is that when a certain size is reached the minimum sections are used, and below this the reduction in weight is small.

Desplaines Valley Railway The Chicago & North- Western Railway is at present showing activity on three large construction jobs in and near Chicago. A review of its work for several years would seem to show that these and other recent construction jobs are parts of a comprehensive terminal plan, a plan the main

features of which were doubtless worked out years in ad- vance of the construction.
Track elevation of main lines is compulsory in the city limits, and still none of the old main lines within a mile of the depot were elevated, and permanent run offs have been made. Reason for this is now seen in the magnificent new passenger terminal with tracks laid on entirely new right-of- way, and providing for the practical abandonment of the old tracks at city grade, for passenger traffic. The new tracks afford much larger facilities than could have been obtained on the old right- of-way. The location of the new tracks and terminal will do away with a Chicago River bridge and with the delays so common on account of the bridge being opened to allow the passage of river boats.
It is thus seen that the Wells Street bridge recently erected was really a temporary construction to tide the railway over until the new terminal would be completed; probably this is the reason that only a two- track bridge was erected, where the traffic demands would certainly seem to require a four-track bridge.

The addition of an annex for suburban traffic, which was made to the Wells Street station several years ago, was also a temporary construction, made to accommodate only the immediate needs of traffic. The track layout, the interlock-ing plants and, in fact, the whole equipment of this station has not been kept up to modern high standards, and con-gestion has some times been the result. These conditions would only be allowed to exist in temporary construction, or structures soon to be partially or wholly abandoned. Formerly the company had their Galena Division pas-senger coach yard at Ada Street, extending westward, and south of the main lines. In 1903 a new and modern coach yard was constructed at Western Avenue. The old coach yard, which would doubtless have soon been too small, was disposed of. The location of the new terminal tracks at Ada Street is north of the old main lines, and comes into them at Noble Street. With this new layout a back- up move-ment would have been necessary to get into the old Ada Street yard. A run into the Western Avenue coach yard is
made without back-up movements, from either the old or the
new track layout.
In the spring of 1906 work was started on third and fourth
tracks between Melrose Park and Elmhurst, and later on in
the summer a large yard was constructed at Proviso, which

is situated between those two towns. Trackage for handling MILWAUKEE

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NORTH LEG OFY MAIN LINE

Profile of Desplaines Valley Railway. Highway APG 130 °Mighway It 24'P.G 385

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SCALE OF MILES /2 0

Territory Map, Desplaines Valley Railway.

Branch

Desplaines River.

plaines Valley & North-Western Railway, now under way.
This line is practically a cut- off from the Wisconsin and Milwaukee Divisions to the Galena Division. It is to be
a freight road and will divert west- bound freight coming
from the north and northwest entirely from terminal terri-tory and from the regions of greatest suburban passenger train congestion. That advantage will amount to much in dollars and cents, but will also mean much toward ease of train operation and elimination of delays, both to passen-ger and freight traffic.

At the Proviso yard there are wye track connections with the B. & O. Chicago Terminal Railroad. This is a belt rail-way, and much freight will be transferred here for local delivery, and for transfer to other roads. Ample trackage is provided and transfer movements will not interfere with main line traffic. This yard is in two parts, situated north and south of the main lines, and connection is made with the Terminal Railway from both sides. The Terminal Rail-way crosses above the North-Western at this point, and the wye tracks are rather long in order to get up to the higher level of the Terminal's tracks. The combination of the new Desplaines Valley Railway and the Proviso yard in direct connection with this " belt" railway will give high efficiency in the delivery of local freight, and in the transfer of freight to other railways, while at the same time it will relieve the busiest portions of the railway and of the city of much freight traffic.

a large freight business was installed, much larger than the amount of business done there since that time would seem to warrant. From this latter fact we conclude that a large in-

crease of freight traffic was to be expected from a new source. At the present time additions are being made to
the Proviso yards and the plans include a new roundhouse and machine shops.
The reason for the extensive construction at Proviso has been partially made clear by the construction of the Des-

Through freight coming from either the Wisconsin or Mil-waukee Divisions and bound for the west (or vice versa) will be diverted over a shorter route, and a route which will be negotiated at a faster rate on account of low gradient, few curves and these of light curvature, much lighter traffic and no "superior" passenger trains, and fewer interlocking plants. The old route from Desplaines to Elmhurst was across the Mayfair cut-off to 40th Street yard, and then out the Galena

Filling - in a Temporary Trestle. Temporary Span Over C. M. & St. R. Ry.

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Abutments and Piers for Desplaines River Bridge, North Section.

Division. The distance between Mayfair and Elmhurst by
this route is over 25 miles, while the new route will be about
12 miles. The distance from the junction with the Milwaukee
Division to Elmhurst will be about 20 miles on the new line; this will also be a big saving in distance.
With the completion of the work now under construction in Chicago, the terminal capacity for passenger trains will be amply increased, and not only that, but the diverting of freight traffic will greatly relieve the down-town section.

Construction Features of the Desplaines Valley Railway.
A location survey for the Desplaines Valley Railway was

run several years ago, but nothing was done in the way of construction. In 1909 a re- location was made and construc-

The feature of the work in the south section is the over-head railway crossing of the C., M. & St. P. Ry. There is to be a two-span bridge at this point, one span a truss with 131 - foot opening, the other a girder with about 88- foot open-

ing The grade leading up to this bridge is 0.3 per cent on either side and the total fill from cut to cut will be four miles
long and contain 900,000 cu. yards. This fill is 32 feet high in some places. In the south section there are to be four highway subways, and in the north section the plans call for four subways and two overhead bridges for highways. The new line is to be double track of 90-lb. rail A. R. A. section. The ties are of hemlock treated with creosote at the large and up- to-date C. & N.-W. creosoting plant at Escanaba, Michigan. The maximum gradient is 0.3 per cent, and the maximum curvature is 2 degrees. On the main tracks there is only one curve which will have the maximum of 2 degrees, the rest are all of lighter curvature. Exclusive of wye tracks there are only four curves on the line. On the wye tracks a curvature as high as 8 degrees has been used.
The method used in construction was to first lay a tem-porary track along the edge of the right- of- way, beginning at both ends of the line. A through connection of this track was not possible without putting in a grade crossing over the C., M. & St. P. By using this temporary track, work on the temporary pile bridges, on concrete culverts, etc..

Trestle Over Side Tracks, South of Span Crossing Milwaukee Main Tracks.
tion work started in 1910. The work was started with a rush, but later was held up and little was accomplished in that year.
This line will connect with the Milwaukee Division near Blodgett and with the Galena Division at Elmhurst, crossing the Wisconsin Division just north of Desplaines. Wye track connections are designed for each junction. The part of the line between the Milwaukee and Wisconsin Divisions is des-ignated the north section, during the construction, and that between the Wisconsin and Galena Divisions is called the south section. The railway company is now constructing the south section. All of the work is company work, except the fencing, some of which was contracted.
There are to be two overhead railway crossings on the completed line, both of these to be over the Chicago & Mil-waukee Railway. One of these overhead crossings is in the south and the other is in the north section. There are also two railway crossings at grade, the lines crossed being the Wisconsin Division of the North-Western, and the other the Minneapolis, St. Paul & Sault Ste. Marie Ry. Both of these are double track lines. The grade crossings will be quite close together, and just north of the present crossing of the M., St. P. & S. Ste. M. Ry. and C. & N.-W. Ry., Wis-consin Division. It is evident that a great deal of money is being spent in order to eliminate railway grade cross-ings wherever possible and also to a lesser extent highway grade crossings.

Sink Hole, Showing Flowing of the Earth.

could be started all along the line. One track was then started by the track gangs, on its correct center line, and this construction was handled so as to interfere as little as possible with the other work. Where the fills were to be low, or where the track was to run through cuts already graded, this track was made permanent, the filling hauled in and the track raised to grade. Where, the fill was to be high, and the track would have to be lifted many times, a temporary track of second hand steel and cedar ties was used. Where the fill was very high, as approaching the C., M. & St. P. crossing, a temporary trestle was constructed. Two such trestles were used in the south section. The structure ap-

Temporary Trestle, Showing Bracing.

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proaching the crossing is over 30 feet high, and is made of rather small piles, 5 in a bent. The structure was made safe by bracing every fourth bent with second-hand 8x16- in. stringer timbers. These trestles are to be filled in as rapidly as possible, and as they will not have to carry the track very long, and will be buried and left in the embankment, they were made as light and cheap as was consistent with safety. There is one long span in the temporary trestle structures, this being directly over the Milwaukee railway main tracks. A second- hand through girder span was used, theopening being about 30 or 35 feet. The ends of this girder are support-ed on bents consisting of a double row of closely driven piles.

Reinforced Concrete Arch Culvert, with Temporary Trestle Above.

The placing of this span was accomplished without delay to traffic on the Milwaukee.
The track on center has been laid clear through

and partially raised. It is intended to raise this track to grade and build the fills for the second track
from the first. Wherever practicable the unloading of filling has been done by a dirt plow and Lidgerwood unloader. A great deal of black stripping from a quarry is being handled in bottom dump coal cars; the latter are used advantageously for filling in trestles. The Lidgerwood and side plow can be used to great advantage in building the grade for the second track, in connection with a first class bull dozer or

Temporary Water Tank.
gravel spreader which is on the work. The cars unloaded by the dirt plow are swing side gondolas, with the ends re-moved, fitted with sheet iron aprons to close the gaps be-tween cars.
On the south section there are two reinforced concrete culverts. They are of attractive design and have been neatly constructed.

One large sink hole has been encountered, and it is said that the track over it has been raised and reraised a total of over 100 feet. On one side of the track the earth is oozing up and flowing outward, and the earth has humped up 10 or 15 feet close to the foot of the slope.
There is illustrated herein an unusual type of water tank. It is square and was designed and erected entirely by the company construction forces with ordinary lumber. This tank is now furnishing the construction locomotives with water.
There are a number of places where interlocking is to be installed. The junction with the Galena Division is close to an interlocking plant, which handles the turnouts onto third and fourth main lines. The junction with the Wisconsin Division is close to the present interlocking for the M., St. P. & S. Ste. M. Ry. crossing with the Wisconsin Division. The crossing of the Desplaines Valley Railway and the M., St. P. & S. Ste. M. Ry. will require protection, as will also the junction with the Milwaukee Division at Bensonville. It is likely that the entire line will be fitted with automatic block signals.
With the exception of the fills for eliminating grade cross-ings, the grading work is not heavy, as the country is in general quite level. The low gradient used will allow the operation of heavy tonnage freight trains. The location and construction of this line are similar to and in a class with the high grade of the Chicago, Milwaukee & State Line built in 1906.

MT. UNION TIE-TREATING PLANT, PENNSYL-VANIA R. R.
The Pennsylvania Railroad Company, in awarding a con-tract for the erection at Mt. Union, Pa., of a "one- cylinder" plant for the treatment of timber by any standard process, has taken the initial step toward the preservative treatment of its cross- ties and other timbers. In connection with this plant, two creosote storage tanks of 500,000 gallons capacity each are to be erected at Greenwich Point, Pennsylvania. These tanks will have a combined capacity sufficient to re-ceive a full tank steamer cargo of oil. The treating plant will have a capacity of from 1,500 to 2,000 ties a day, if day and night shifts of hands are worked. This will give an annual output of about 500,000 ties.
Mt. Union was selected as the site for the first plant be-cause it is near the center of a tie producing region, and. in addition, is a convenient receiving and shipping point. The plant is to be located on a comparatively level tract of company land comprising about 50 acres, directly north of the new line. Connections from the tie yard and loading platform to the old main line-now a freight yard-will be made by a track under the new stone arch bridge over the Juniata River at this point. ( The narrow- guage East Broad Top Railroad also will have connections with the yard.) During 1907, 840,000 hardwood ties were obtained along the Middle Division of the Pennsylvania Railroad, while the Eastern Pennsylvania Division of which the Middle Division is a part, produced 1,250,000 ties. Eliminating the white oak and chestnut, which do not take treatment readily, and in-cluding the miscellaneous hardwoods, such as beech, maple, and birch, which, if treated, make excellent ties, the terri-tory tributary to Mt. Union should produce enough ties to supply a one-cylinder plant for many years to come. Other plants, if built, will probably be located at Tidewater points tributary to the larger supplies of treatable Southern woods, such as gum, mixed oak, and shortleaf and loblolly pines. The Mt. Union tie yard will occupy an area of about 17 acres. There will be six tracks about 1,500 feet long, and 73 feet apart. There will be ample space for adding other tracks as they are needed. The capacity of the yard will be from 450,000 to 600,000 ties, depending on the height to