THE ELIMINATION OF GRADE CROSSINGS
ON THE NEW YORK, CHICAGO & ST. LOUIS RAILROAD IN
CLEVELAND, OHIO.

By A. J. Himes, Engineer of Grade Elimination.

PRELIMINARY DESCRIPTION.

The New York, Chicago & St. Louis Railroad, commonly called the
"Nickel Plate," traverses the city of Cleveland, with its suburbs, from
Rocky River on the west to Ivanhoe Road on the east, a distance of
16.94 miles.

Its course is intersected by 120 highways, twenty of which either did
not cross at grade when the road was constructed in 1882, or had been
separated from the grade of the railroad prior to 1909. In the latter
year the work, which it is the purpose of this paper to describe, was
undertaken.

Within the above limits, the road is crossed by seventeen double-
track street car lines, only one of which is on private right-of-way.
Eight of these lines were operated at the railroad grade in 1909. Within
the same limits there were five steam railroad crossings, one of which,
the Cleveland & Pittsburgh, was then and still is operated over a grade
crossing. At that time the Nickel Plate operated two main tracks over
10.48 miles of the above distance, and the longest stretch of track with-
out a grade crossing was that extending across the river valley and
eastward. Its length was 3.39 miles.

The Lake Shore & Michigan Southern Railway, which, for several
years, has been engaged in building third and fourth tracks from Buffalo
to Chicago, crosses the Cuyahoga River in Cleveland on a single-track
drawbridge. There is a very large amount of traffic on the river, and
on that account the bridge is kept open for boats except during the act-
ual passage of trains. Because of this very difficult operating condition
which grows rapidly worse as traffic increases, and for other reasons,
the Lake Shore & Michigan Southern Railway has acquired the Cleve-
land Short Line Railway, which was projected as a double-track belt
line through the southerly portion of the city. In planning this road
it was arranged to parallel the Nickel Plate for a distance of 2.4 miles
and to occupy, with it, a common four-track roadbed. Because of the
constantly increasing danger of accidents it was desired to avoid all
grade crossings, and since the Nickel Plate needed a second track through
this common territory, arrangements were made to build an entirely new
roadbed and to eliminate the existing Nickel Plate grade crossings.

The ordinances providing for the construction of the above four-
track roadbed and the elimination of grade crossings in Cleveland were
103
passed by the City Council about January 1, 1909. Half a mile of this four-track roadbed was to lie in the village of East Cleveland, and the ordinance for that portion was passed by the Council of the village of East Cleveland one year later.

Very strong opposition to these ordinances developed among residents of the territory where the road was to be built and particularly among the residents of East Cleveland. This opposition resulted in the final adoption of some very unusual bridge designs, which it was thought by interested persons would make the bridges at the various street crossings less unsightly than the usual steel construction.

The law under which the work was planned provided for the elimination of grade crossings when requested by the municipality, the expense thereof to be borne equally by the railroad and the municipality. In this instance, the crossings were not only to be eliminated, but additional tracks constructed and so the railroads agreed to bear the whole expense. For this purpose deposits were made with the city of Cleveland and the village of East Cleveland sufficient to cover their shares of the expense.

In Cleveland it was arranged that all street work and the highway bridges should be constructed by the city through the City Engineering Department in the usual manner. In East Cleveland all work was done by the railroad company.

Each ordinance required that the work covered therein be completed within two years from the date of its passage. The writer was asked whether that amount of time would be sufficient and he replied that, considering alone the construction work, the time would be ample, but the effect of possible delays not growing directly out of construction was indeterminate.

The ordinances mentioned provided for the elimination of all grade crossings between East Ninety-third Street, Cleveland, and Ivanhoe Road, East Cleveland, a distance of 4.97 miles. Of this distance the four-track roadbed covers 2.4 miles and a double-track roadbed was built the remaining distance.

Some of the larger items of work performed were as follows:

- Excavation ......................... 601,000 cu. yds.
- Embankment ........................ 537,000 cu. yds.
- Concrete .............................. 63,000 cu. yds.
- Steel Bridges ........................ 5,500 tons
- Wooden Trestles, both temporary and permanent...
  ........................................ 7,500 linear feet
- Street Paving ........................ 2.18 miles
- Sewers ................................. 2.76 miles
- Water Pipes ........................... 2.24 miles

Fig. 1 shows the territory within which this work was to be done.

While there existed at the beginning only one main track, there were 10.7 miles of sidings and industrial spurs. The main line was
crossed at grade by three double-track street car lines and by two more such lines, not at grade, but which had to be depressed to agree with the new profile of the railroad.

There were four principal parties concerned in the performance of the work: Cleveland, East Cleveland, the Cleveland Short Line Railway and the Nickel Plate. The operation of the Nickel Plate trains within this territory would be seriously affected by the work of construction, and there was much street traffic to be cared for. These conditions made it advisable to segregate the work from all other affairs of the railroad and a separate department, known as the Department of Grade Elimination, was created for that purpose. The Department was given full control of all maintenance and construction within the territory described, and such control of the operation of trains as might be necessary in handling the work.

The Operating Department showed at all times an interested and willing spirit of co-operation that was much appreciated and the arrangement proved wholly satisfactory.

The Grade Elimination Department was also charged with all designs and estimates for the work and the necessary accounting. The Legal Department was charged with procuring the necessary real estate and the settlement of claims.

The steel bridge work was performed entirely by contract. It was completed about March 1, 1912. Two thousand one hundred cubic yards of concrete were built by contract with the railroad company during the summer of 1909. The bridges at Cornell and Adelbert roads were built by contract under the direction of the city. A few sewers and all street pavements in Cleveland were built by contract. All other work has been done by day labor. The working organization was recruited from the open market, with practically no assistance from the regular railroad organization.

It was realized in the beginning that to prepare plans and specifications for the whole of this work, in a manner that would permit of a definite contract, was practically impossible. The details of the work involved the co-operation of nearly every department of the Nickel Plate, several departments of the Lake Shore & Michigan Southern Railway and numerous departments of the city of Cleveland, of East Cleveland,* the public service corporations in each municipality, the property owners along the line and the various affected industries. Many of these parties could not be induced to study the subject and decide just what they would do until the time arrived to act. The handling of the Nickel Plate trains required an elasticity of control that could not be readily secured under a contract. By retaining full control of the construction work it could be adapted to the operations of other interested parties more readily than if it were placed in the hands of a contractor, and if necessary its completion might be hastened in ways that could not well be written into a contract. The conditions were such that under a contract it would have been practically impossible to escape numerous extra claims from
the contractor. Without a contract, it was possible to start construction work at once, thus avoiding the loss of time necessary for preparing contracts and specifications, receiving bids, entering into a contract and getting a contractor's plant on the ground.

On the other hand, the railroad had neither organization nor plant to handle the work.

It will be noticed on the profile (Fig. 2) that the excavation was entirely in Cleveland, while the embankment to be made was largely in East Cleveland. It has been stated that the East Cleveland ordinance was passed one year later than the Cleveland ordinance. It was not considered practicable to permit the Cleveland work to rest pending the discussion of the East Cleveland ordinance. It was of great importance that the whole Short Line project be completed at the earliest possible date.

In view of these conditions, it was decided to begin grading at once with a company force. A contract was let for about 10,000 cu. yds. of concrete masonry. Another contract was let for the steel railroad bridges in Cleveland, and the city let a few sewer contracts and contracts for two highway bridges.

At the end of the season the company's contractor had built about 2,100 cu. yds. of concrete and one highway bridge was nearly completed; 143,000 cu. yds. of excavation had been made. The progress had been exasperatingly slow.

After much consideration, the company's contract for concrete was canceled.

When the East Cleveland ordinance passed, the decision was made to handle all work possible with a company force, and it was forced ahead rapidly thereafter without regard to either season or weather.

Construction began March 1, 1909. The operation of the Cleveland Short Line Railway began July 1, 1912. The New York, Chicago & St. Louis Railroad was ready for double-track operation within the above territory October 1, 1912.

ORGANIZATION.

The original estimates and designs were prepared by the writer. When the preliminary negotiations were complete and instructions were given to proceed with the work, immediate steps were taken to develop the necessary organization. An office force was employed to handle the designing and estimating. Mr. A. C. Irwin, whose experience included the design of a part of the arches for the Florida East Coast Railway and an instructorship in bridge engineering at Cornell University, was placed in charge. The accounting was of such a nature as to require engineering experience, and it was placed under the supervision of Mr. L. V. Gaylord, of Branford, Conn. Mr. W. A. Miller, Professor of Railway Engineering of the University of the State of Missouri, was engaged to attend to the field engineering. For this purpose he secured a leave of absence from the University for one year, which, with two sum-
mer vacations, made his period of employment about eighteen months. At the expiration of that period he was succeeded by Mr. C. E. Drayer. Mr. J. W. Wilkinson, Division Engineer New York, Chicago & St. Louis Railroad, was in charge of the construction force.

There were employed three general foremen, one each for track work, concrete construction and timber bridges. The track foreman, Mr. Henry Wildis, had served the road for many years as District Supervisor of Track. Mr. John Kopp, bridge foreman, had long been an employee of the Erie Railroad and had worked on the New York, Chicago & St. Louis Railroad as contractor's foreman in the erection of bridges. The concrete foreman, Mr. John R. Bisset, is well-known in the East for his work on the New York canals, in the Hudson River quarries and on the railroads of New York and Pennsylvania.

An assistant yardmaster was employed to handle the traffic. Telephones were installed at intervals along the line and excepting a reduction of speed, the interference with regular trains was very slight.

The organization was not fully planned at the beginning of the work. It was in some respects an evolution, its various stages being the result of developments. Had the information on hand at the beginning of the work been sufficient to permit a proper organization, it could not have been formed at once because of the lack of men. Time was needed to secure the best assistants, and in some instances the organization was arranged to suit the men who were available, rather than wait for men having the exact experience needed. This is one reason why in the tables showing the actual organization and that now recommended the titles used are not those recommended. It was easier at first to call a man an Assistant Engineer and later to use him according to his fitness than to find in each case a man properly qualified for some particular position.

There should have been a Principal Assistant because in the rush of work many important matters could receive but scant attention from the Engineer of Grade Elimination and the interests of the company suffered accordingly.

It was originally intended that the field assistant engineer should report to the Division Engineer, but pressure of work and the experience of the men rendered the course pursued advisable.

The rate of pay for common labor at the beginning was $1.40 per day. In July, 1909, it was raised to $1.50 per day and in April, 1910, it was raised to $1.60. In July, 1912, it was again raised, the final rate being $1.70 per day.

Concrete laborers were paid in general 25 cents more per day than the rate for common laborers. Other workmen received various rates according to their experience and ability.

The labor employed was that found commonly about the city. With a single trifling exception, near the close of the work, no labor was brought from other points. At the beginning labor was very plentiful.
There had been much idleness during the preceding winter and men were eager to work. During the fall of 1912 there was an unusual amount of building in the city and the local contractors paid $2.00 for common labor. This condition resulted in bringing about seventy Greeks from Chicago during the latter part of the year.

The great bulk of the work was performed without a regular force of inspectors. The engineer corps kept an eye on the work while attending to its regular duties, and the writer spent much of his time on the ground.

Work performed through the agency of the city of Cleveland was inspected by city employes. In East Cleveland one or two inspectors employed by that city were always on the ground. All foremen were made to understand fully that only first-class work was desired, and after the first few weeks there was little disposition to sacrifice quality to either speed or lowness of cost.

The maximum force employed at any one time was about 700 men.

The selection of the employes was made with a great deal of care and now that the work is complete, it is recorded with satisfaction that no serious blunders were made and that an unusual degree of harmony and good-will prevailed throughout the work.

PLANT.

The construction equipment used on the work with cost, ownership, rentals and period of service is shown in Table 3. Only cars, locomotives and earth-handling machinery were supplied directly by the railroad. Tools, machinery, materials and supplies were obtained through the Purchasing Agent.

The time of service of each item of equipment was recorded under the proper account and the rental thus made up its share of the final expense.

The method used in establishing rental values for equipment purchased is illustrated by the case of Crane 8, as follows:

Cost of crane delivered and set up ready for service ................................ $6,207.25
Depreciation for one month at 10 per cent. per year ........................ $51.73
Interest for one month at 6 per cent. per year .............................. 31.04
Coal, oil and supplies for one month......................... 28.60
Watchman .................................................. 60.00

$ 171.37

$171.37 expense and depreciation per month, equals $6.59 per day, divided by 26 working days per month, say $7.00 per day.
### TABLE 3—PLANT

<table>
<thead>
<tr>
<th>Ownership</th>
<th>Cost</th>
<th>Length of Service</th>
<th>Rental</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locomotives</td>
<td>N. Y. C. &amp; St. L. R. R.</td>
<td>45 months</td>
<td>$3.40 per hour including engine and train crews</td>
<td></td>
</tr>
<tr>
<td>Unloading Equipment:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ligerwood unloader (60 ton full)</td>
<td>N. Y. C. &amp; St. L. R. R.</td>
<td>5071.56</td>
<td>32 months</td>
<td>$10.00 per day</td>
</tr>
<tr>
<td>Jordan Spreader</td>
<td></td>
<td>3350</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two Plows</td>
<td></td>
<td>No Record</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steam Shovel:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70 ton Bucyrus Shovel</td>
<td>Leased from L. S. &amp; M. S. Ry.</td>
<td>29% months</td>
<td>$11.00 per day</td>
<td>$10.00 for shovel, 50 cents each for cars.</td>
</tr>
<tr>
<td>Two Tool Cars</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locomotive Crane No. 8</td>
<td>N. Y. C. &amp; St. L. R. R.</td>
<td>6207.25</td>
<td>29 months</td>
<td>$7.00 per day</td>
</tr>
<tr>
<td>Locomotive Crane No. 9</td>
<td>N. Y. C. &amp; St. L. R. R.</td>
<td>6517.25</td>
<td>28% months</td>
<td>7.00 per day</td>
</tr>
<tr>
<td>Locomotive Crane No. 10</td>
<td>N. Y. C. &amp; St. L. R. R.</td>
<td>6475</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locomotive Crane fitted with leads for driving pile.</td>
<td>N. Y. C. &amp; St. L. R. R.</td>
<td>206.51</td>
<td>25% months</td>
<td>7.00 per day</td>
</tr>
<tr>
<td>Concrete Mixer No. 1:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. 21 Smith Mixer; 9 HP. O. &amp; S. Vertical Engine, hoisting engine; 20 HP. boiler mounted on flat car and housed; 7-24 cu. ft. side discharge concrete cars; 29 chutes, 600 feet of track, etc., set up and ready for service.</td>
<td>N. Y. C. &amp; St. L. R. R.</td>
<td>3015.65</td>
<td>20% months</td>
<td>$5.00 per day</td>
</tr>
<tr>
<td>Concrete Mixer, No. 2:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. 24 Lakewood Mixer, batch hopper, engine, 20 HP. boiler, Byers hoisting engine, mounted on flat car and housed, 1 24-cu.ft. side discharge hopper car, 225 ft. of track, 25 chutes, etc., set up and ready for service.</td>
<td>N. Y. C. &amp; St. L. R. R.</td>
<td>2314.50</td>
<td>17 months</td>
<td>$5.00 per day</td>
</tr>
<tr>
<td>Concrete Mixer, No. 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leased</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pile Driver</td>
<td>N. Y. C. &amp; St. L. R. R.</td>
<td>2% months</td>
<td>$3.00 per day</td>
<td>$10.00 per day</td>
</tr>
<tr>
<td>Ownership</td>
<td>Cost</td>
<td>Length of Service</td>
<td>Rental</td>
<td>Remarks</td>
</tr>
<tr>
<td>-----------</td>
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<td>---------</td>
</tr>
<tr>
<td>Leased</td>
<td></td>
<td>3 months</td>
<td>$4.00 per day</td>
<td></td>
</tr>
<tr>
<td>Leased</td>
<td></td>
<td>5½ months</td>
<td>$167.50 per month</td>
<td></td>
</tr>
<tr>
<td>N. Y. C. &amp; St. L. R. R.</td>
<td>511.06</td>
<td>18 months</td>
<td>$2.00 per day</td>
<td></td>
</tr>
<tr>
<td>N. Y. C. &amp; St. L. R. R.</td>
<td>1650.00</td>
<td>16 months</td>
<td>$1.50 per day</td>
<td>Does not include cost or rental of car</td>
</tr>
<tr>
<td>N. Y. C. &amp; St. L. R. R.</td>
<td>165.00</td>
<td>14 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N. Y. C. &amp; St. L. R. R.</td>
<td></td>
<td>39½ months</td>
<td>.45 per day</td>
<td>Including repairs</td>
</tr>
</tbody>
</table>

*150 cu. ft. per minute.
GRADING.

The steam shovel was a 70-ton Bucyrus machine, not new, but in excellent condition. The shovel and crew were borrowed from the Lake Shore & Michigan Southern Railway. Mr. Willard Beahan, who has authority over the construction equipment of that road is entitled to credit for the able manner in which he maintained both shovel and crew in the highest condition of efficiency. No more skillful shovel engineer is to be found than the one supplied, and throughout the whole period of 29½ months no time was lost because of any absence or failure on the part of the crew. The shovel was put in the shop each winter for repairs and only 32 hours were lost through breakdowns while in service, an average of about one hour per month. Critics of efficiency in railroad management are invited to take notice.

Much of the material excavated was very hard shale. None of it was blasted except where excavated by hand. In some places it was so hard that teeth of manganese steel were used on the dipper and the progress was very slow.

Blasting was objectionable because of the proximity of dwellings and the frequency of damage claims.

The capacity of the shovel for hard digging is illustrated by Fig. 3, which shows the broken parts of a seven-foot six-inch circular sewer. This sewer was encountered while excavating for the depression of the tracks at East 10th Street, in the middle of the night.* Through some misinformation the sewer was supposed to be about six feet lower, and the shovel coming upon it unexpectedly, was obliged to break its way through or suspend work until the sewer could be removed in some other way. The volume of flow through the sewer was exceedingly small and there was no objection to breaking through. This the steam shovel did successfully in the night, although the sewer was constructed of a first-class quality of concrete reinforced by 1½ in. x ¾ in. flat bars 15 in. center to center placed transversely of the sewer, and five ½ in. round bars in the top of the sewer and parallel with its length.

One of the difficulties encountered in the shovel work is illustrated by Fig. 4. When the shovel started east from Ninety-third Street it worked on a down grade as far as Quincy Avenue. The sewer in Quincy Avenue had already been depressed and afforded the only means of caring for drainage. It was hoped that the shovel would reach the sewer before any unusual runoff occurred, but the flood came when the shovel was still 274 ft. away, and it was necessary to dig a trench 274 ft. long and about 8 ft. deep to drain the cut.

A 2-yd. dipper was used throughout the major portion of the work. A 3½-yd. dipper was used in the borrow pits where there was no hard shale.

*Night work was necessary while crossing the street to shorten the time of interference with street traffic.
Fig. 3—105th Street Sewer.

Fig. 4—Flood in Steam Shovel Cut.
The performance of the shovel varied from 550 cu. yds. to 2,300 cu. yds. per day; the larger quantity approaches its capacity. Below that the output was governed by the disposition of the material. Much of the material handled during the first season was wasted. Spoil banks were small and inconveniently located and the unit cost was high.

Because of the absence of spoil banks within easy team haul and the hardness of the material which could otherwise only be loosened by blasting, the steam shovel was used in excavating for the depression of Quincy Avenue, Cedar Avenue and Mayfield Road. This involved hauling the material in one case over a grade of 2½ per cent. on a 40-degree curve, and on 6 per cent. grades where the curvature was small. In one case the work trains were operated successfully over 40 to 50 ft. of 13 per cent. grade. Box cars invariably uncoupled in passing this grade, but there was no trouble with flat cars.

The locomotives operated on these grades and curves were of the 0-6-0 type with a wheel base of 11 ft.

The shovel worked uphill on grades of 6 per cent. This was especially difficult in hard material, but it was accomplished successfully.

The work in Mayfield Road was especially interesting because of the railroad crossing. The change of grade of the railroad at this point is slight, and in order to depress the street with a shovel the excavation beneath the easterly track was made by hand and a trestle built to carry the track. The cut was extended east of the track far enough to permit the shovel to be pulled clear of another track on the westerly side of the narrow right-of-way. The first running track was at the easterly side of the right-of-way. The shovel approached from the west. After excavating up to the trestle another trestle was partly built under the westerly track, the first trestle torn out, the shovel pulled across the first running track, the westerly trestle completed and traffic turned over the westerly track. The traffic was suspended about two hours to make this change, and the shovel was idle seven hours. (Fig. 5.)

The cost of excavation in Mayfield Road was 58 cents per cu. yd. There were 14,000 cu. yds. of material, mostly shale. The cost includes all track work, but none of the trestle work.

All excavated material was loaded on flat cars with hinged side boards. The average load per car was 11 cu. yds., excavation measurement.

The material was unloaded with plows and a Lidgerwood unloader and afterwards leveled with a Jordan spreader. (Figs. 6 and 7.) The embankments were generally made by jacking up the track as the filling progressed.

An embankment was built in this manner during the coldest months of the winter of 1910-11, an unusually severe winter. The average depth of fill was 13 ft. The total volume was 40,000 cu. yds. The material was mostly clay and generally moist. It would freeze very hard in a few hours. The cost per cu. yd. of labor on the fill was 10 cents, making the total cost $4,000.00. A trestle for use in making the embank-
ment and built to carry standard railway equipment would have cost not less than $9.40 per foot, or a total of $19,552. Assuming that there was use for the stringers and ties after completion of the fill a credit of $3.25 per foot, or a total of $6,760 could have been allowed, making the net cost of the trestle $12,792. This is three times the actual cost of the labor on the fill.

But apart from these considerations, it was necessary to build the embankment as soon as authority was secured to enter upon the land and there was no time to build a trestle.

Four work trains were in service much of the time. Occasionally a fifth train was used. One locomotive was always needed to serve the shovel. In busy times one locomotive was used in spreading the unloaded material and two trains in hauling. One train was generally required to serve the concrete construction.

![Image of a steam shovel in Mayfield Road.]

**Fig. 5—Steam Shovel in Mayfield Road.**

The grading was not all shovel work. Teams were used occasionally both with scrapers and wagons, considerable quantities of earth were handled by hand and more with the cranes. Teams cost 50 cents and 60 cents per hour. They were hard to find and unsteady in their work, and were, of course, used as little as possible.

The cranes were useful in foundation work and in depressing streets. In many cases material from the street was scraped or trucked on rails in skips to the overhead bridge and there hoisted by a crane and dumped behind the abutments. Spoil banks were very scarce, but, if plentiful, any earth deposited thereon would have been wasted while behind the abut-
FIG. 6—LIDGERWOOD UNLOADER.

FIG. 7—JORDAN SPREADER.
ments it was of value. The work of the crane as above was more expensive than a short wagon haul, but where wagons could not reach the embankments, the cranes did good service.

The average cost of prism excavation was 28 cents per cu. yd. This cost does not include any labor on the embankments, after the material was unloaded.

CONCRETE.

Three concrete mixers were used on the job. They were all mounted on cars. Two were equipped with hoisting engines for charging. The third was charged by wheelbarrows moving over the cars, and was used in building the floor slabs and other work where a large output was not required. The manner of operation is illustrated in Figs. 8 and 9. In Fig. 8, the housing was carried over the boiler and the incline proved too steep for economical wheeling. This is the first job undertaken. The method was at once abandoned for that of Fig. 9. At a later date wheeling was again resorted to, but the charging of the mixer was done at a lower elevation and with better results.

Between Lakeview Road and Superior Street, a distance of 2,600 ft., the streets—eight of them—were so close together and the available right-of-way was so narrow that it was thought best to make use of a temporary trestle. The new location of the tracks was such that about two-thirds of the street abutments could be built without interference with traffic on the old line (Fig. 1). It was impossible to get traffic on the upper level and close only two adjacent streets at a time—a provision of the ordinance—without using a trestle. This condition being recognized and the trestle decided upon it was thought best to mix the concrete on the trestle and pour it by chutes into the abutment forms below. If this reason were not sufficient, a further one for so mounting the mixers was that because of the large number of structures and their small average volume much time could be saved in moving the plant. Furthermore, there was no room for derricks, stock piles and stationary plant.

The concrete for many footing courses and small concrete structures was mixed and placed by hand. This was partly because the small yardage made it economical, partly to hasten the work when the mixers were busy and in the case of the footings, when sheeting and bracing were used in the foundations, it was better to get the footings in, part or all of the bracing removed and the forms erected, before bringing the mixer on the work; otherwise it would stand idle a part of the time and thus reduce the volume of concrete placed per month below the rate necessary to keep up with the schedule.

The maximum output of one mixer per day of 20 hours was 200 cu. yds.

The average output of one mixer per month for 11 months was 1,345 cu. yds.

The drum of a new Smith one-half-yard mixer was worn out in mixing: 20,752 cu. yds.
IN CLEVELAND, OHIO.

**Fig. 8—Serving Mixer with Wheelbarrows.**

**Fig. 9—Serving Mixer with Cars.**
All structures were divided into sections in such a way as to preclude cracks from expansion and settlement, and each section was poured complete in one run; or at any rate, such was the intention and the failures were few. This required extra gangs and considerable night work. The men, as a rule, did not like to work at night, but they seemed to appreciate the necessity and to take an interest in the success of the work. The utmost harmony prevailed and it was very rare that a section once started, failed of completion through lack of men. It did happen occasionally that because of the failure of a work train to serve the mixer or because of a sudden storm, a section was left incomplete. In these cases no water has ever seeped through the masonry on the resulting seams, but the attempts at concealment in finishing the concrete were not wholly successful. The color of the patchwork, when used, to remedy defects along the seams, was not always the same as that of the original concrete.

The concrete was generally mixed quite wet. This was necessary in order to have it flow well in the chutes, and to insure a dense watertight product without tamping. It was aimed to draw the surplus water off from the concrete at the rear of the masonry and thus avoid a deposit of laitance on the face of the structure. In this respect the success was very good, but it might have been better.

The labor employed was wholly unskilled and it was very hard for the foremen to teach the men just what was required.

The concrete work was carried on continuously the year around. In freezing weather, the water and sand were heated and salt water (a saturated solution) was used when there was to be no steel in contact with the concrete. In but one instance was there any sign of a failure. This case was in a section of a retaining wall that was placed by hand. The final conclusion as to the cause was that salt had been thrown in the mortar without being first dissolved in water. Has anyone else had such an experience?

The concrete was generally mixed in the proportion 1:3:6. In bridge floors and reinforced work it was made 1:2:4.

Where the mixer car was obliged to stand upon the ground towers were frequently used for elevating the wet concrete to a point where it might be distributed by gravity. In some cases this method was very economical. At Euclid Avenue, after railroad traffic had been turned over the bridge, there was so much traffic above and below and so little available space that no other method seemed at all comparable in either economy or speed (Fig. 10).

Wooden chutes were made two feet wide and 8 in. to 10 in. deep. With planed boards the preferable slope is four in. per foot. Slopes of two in. per foot were used at times, but a man was then required to keep the chutes clear. A slope of six in. per foot will cause the ingredients to separate and requires the use of baffles to retard the motion.

Iron chutes were made 20 in. wide and eight in. deep. The maximum slope used was four in. per foot, the minimum slope two in. per foot.
The slope is, of course, dependent upon the amount of water in the concrete.

Great pains were taken to remove all form marks and other defects from the surfaces of the masonry. The cheapest method and one that proved generally pleasing was to bush-hammer the surfaces. Such work was done at a cost of 4 cents per sq. ft. Other surfaces were rubbed smooth with carborundum bricks at a cost varying from 4 cents to 10 cents per sq. ft. No concrete surface can be made to retain a good appearance unless all laitance be thoroughly removed. Its deposition on the surface may be prevented by proper care in filling the forms.

**Fig. 10—Concrete Chute, Euclid Avenue Bridge.**

Little difficulty was experienced in making repairs or correcting defects. Surfaces to be patched were carefully cleaned and then soaked with water. The mortar was applied in comparatively thin layers by throwing on forcibly with a trowel, each layer being permitted in turn to harden. Such work has gone through three winters without sign of failure.

Iron trowels were never used in finishing the surface. Very smooth surfaces were secured with carborundum. Rough, sandy surfaces, resembling Cleveland sandstone were secured by rubbing with wooden floats while the concrete was still green. This is an excellent finish and can be done at a cost less than bush-hammering if there are no surface defects to be removed.
ELIMINATION OF GRADE CROSSINGS

When the aggregate was desired to show, the mortar was brushed away while green with wire brushes. A good finish of the latter sort requires the aggregate to be uniform in size and uniformly placed. It is not easy to secure.

A very beautiful surface may be secured by bush-hammering a concrete made with quartz gravel.

STEEL WORK.

The steel work of the railroad bridges was divided into three separate contracts, the first covering the bridges in Cleveland, the second covering the bridges in East Cleveland, from Lakeview to Superior Street, inclusive, and the third the East Cleveland bridges beyond Superior Street.

The division was made in this manner because when letting the contracts it was not possible to foresee when the bridges, not included, could be erected. For instance, a contract for the Cleveland bridges was made prior to the passage of the East Cleveland ordinance. It seemed unwise to contract for bridges in East Cleveland before the right was secured to erect them.

The bridges were all designed according to the New York Central Lines specifications of 1910. The Cleveland bridges were the first to be constructed under these specifications, and a large part of the writer's work, as member of the New York Central Lines Bridge Committee, was to secure the adoption of a joint specification in order that it might be available for these bridges.

The traffic of the Short Line promised to be as heavy as any in America, while that of the Nickel Plate is lighter. The Nickel Plate is operated wholly independent of the New York Central Lines, but its relations with the latter are so close that to build any portion of the four-track bridges for less than the maximum requirement seemed very shortsighted. Joint specifications seemed the easiest means of securing authority for proper bridges.

The live load in these specifications is Cooper's E-60, with an alternate loading of 144,000 lbs. equally distributed on two axles spaced seven feet center to center.

The unit stresses are tension 18,000 lbs. per sq. in.; compression 16,000—70 l/r, but not to exceed 15,000 lbs.; and the impact I = S/L + 300.

The use of unit stresses somewhat higher than common is in recognition of the apparent impossibility of any material increase of live load without a general reconstruction of all roadway structures.

The bridge floors are of I-beams encased in concrete or bearing a concrete slab above the beams.

Fifteen of the bridges were plate-girders; seven of them were three-hinged arches.

The former Nickel Plate East Boulevard bridge (Fig. 11) was considered a very handsome structure, and the people of East Cleveland in
the hope of beautifying their city demanded the construction of similar arch bridges. To this the Company objected strongly, but it was finally arranged to build such bridges on a few particular streets.

There was no material difference in weight between the plate-girder and arch bridges. There was a considerable difference, however, in the volume of masonry in the foundations. The rock surface was about 12 to 16 ft. below the surface of the streets and the foundations of the arch bridges were designed to carry the arch thrust to the rock. This increased the volume of concrete materially above what was needed for the plate-girder bridges.

No lateral bracing was used in any of the bridges, it being left for the floor slabs to furnish lateral rigidity. Before the construction of the

![Figure 11: Old Boulevard Bridge](image)

floor slabs, temporary wooden stringers were laid on the I-beams to support the track to grade, and the trains caused considerable motion in the arch bridges and the girders having curb supports. In all such cases temporary wooden bracing was used to check the motion.

At Euclid Avenue a combination of long span, sharp skew, curve and heavy loading made it necessary to use curb supports. These were provided in the ordinance. Curb supports were likewise used at Mayfield Road.

A state law makes any ordinance providing for curb supports subject to a referendum vote. Besides the general uncertainty of the outcome of such a vote, it involves much delay and the company would have been glad to avoid the opportunity. At Euclid Avenue, however, there was
Fig. 12—Old Truss Span at Cedar Avenue.

Fig. 13—Cornell Road Bridge.
strong objection to a truss for aesthetic reasons—so-called—and the curb supports were the only alternative.

Fig. 12 shows the old single-track truss span at Cedar Avenue and the Nickel Plate eastbound track over the new bridge. The picture was taken on the day when regular traffic was turned over the new bridge, March 24, 1910.

Fig. 13 shows the bridge at Cornell Road. It is typical of the highway bridges.

At Mayfield Road (Fig. 24) the curb supports were only a matter of economy, but the street was coupled with Euclid Avenue in a separate ordinance so that they could stand or fall together. At the end of the prescribed time, 60 days after the passage of the ordinance, no petition had been filed and no referendum was held.

The old bridges at Cedar Avenue and East Boulevard were dismantled, and all new bridges were erected with derrick cars. All bridge erection was done by contract.

The contracts for the railroad bridges were let and the bridges built without delay of any kind to the general progress.

The steel work of the highway bridges consisted mainly of lattice columns and longitudinal beams, and was wholly encased in concrete.

The division of tonnage between railroad and highway bridges was as follows:

- Railroad bridges ................................ 4,870 tons
- Highway bridges .................................. 630 tons
- Total ............................................. 5,500 tons

**East Boulevard Bridge.**

The original East Boulevard bridge was a three-hinged plate-girder arch with ornamental stone abutments. It was built for two tracks and had a clear span of 57 ft. 4 in. The floor consisted of I-beams with a deck plate to which the rails were fastened directly by clips and bolts. It was designed by C. F. Schweinfurth, Architect, and was regarded as typical of what a park bridge should be (Fig. 11).

The revised grade of the railroad contemplated a lowering of the Nickel Plate track over the boulevard 6.39 ft. The grades of the two roads separate just east of Cedar Avenue, the Nickel Plate descending sharply to the westward on a five-tenths grade, and the Short Line ascending westward on a three-tenths grade. The effect of this divergence at the boulevard is to produce a difference in the elevation of grade lines of 3.72 ft.

The city ordinance provided for a plate-girder bridge with concrete abutments, but when the time came to detail the work the park department entered a protest. It desired that the bridge be rebuilt on lines exactly similar to those of the former bridge. This it was impossible to do, a fact, which, after careful study, was reluctantly admitted. A stone arch was then proposed with abutments similar to those of the old
bridge. This was impracticable because of insufficient space from top of rail to soffit on the Nickel Plate side. The negotiations continued a whole year without results. It was finally proposed by Mr. Hoffman, Chief Engineer of the Board of Public Service, that a composite bridge be built, that a reinforced concrete arch be built for the Short Line tracks where there was plenty of room, and that a plate-girder be used for the Nickel Plate tracks. The present bridge is the outcome of that suggestion. It was designed to meet the requirement that it have something of the appearance of the old structure except that the arch should be concrete instead of steel. To carry out the idea as well as possible the writer offered to surround the plate-girder with a parapet and false soffit, so as to present the appearance of a simple arch structure and to face it with a matrix of red granite from Picton Island in the St. Lawrence River. Later it was decided to color the mortar with iron oxide, not a fortunate proceeding, for the color is much inferior to that of the granite. The granite is now exposed in the rough panels and along the moldings, pilasters and bases where it is bush-hammered. The smooth surfaces are weathering gradually and after a time the difference of color will be less pronounced.

The mechanical design of the structure is interesting. The arch is solid and perfect in condition save a fine vertical crack in the parapet over the haunches. This is a shrinkage crack and it occurred soon after construction. Its position could have been predetermined by a joint.

The whole arch was formed continuously without any intermission night or day, and has thus far been wholly impervious to water; no waterproofing was used.

Because of the deflection and vibration of the plate-girder a longitudinal joint was constructed along the face of the arch and adjacent to the plate-girder to avoid cracking. The joint was filled with oakum and an asphalt mixture, but it will not stay in place. The motion of the steel span causes it to work upward out of the joint.

The false soffit under the plate-girder is divided into three sections. The center is a part of the concrete floor slab. Ten ft. 8 in. each side of the center is a transverse joint. From the joint to the springing line the soffit is a sheet of mortar 3 in. thick plastered on woven wire. The wire is supported by a frame work of light channels. Provision is made for motion at the transverse joints. The concrete parapet or face of the false arch is separated from the concrete floor slab by a vertical joint. These joints have thus far prevented injury to the concrete by the vibrations from passing trains.

EUCLID AVENUE BRIDGE.

At Euclid Avenue the tracks cross the street on a four-degree curve, the tangent making an angle of 37 degrees 29 minutes with the center line of the street. The street was depressed 3 ft. 6 in., and the railroad grade elevated 14 ft. 4 in. This street was made a controlling point in the grade line, the prime object being to avoid as far as possible any ob-
struction to the view along the avenue. In this respect the result is quite satisfactory as may be seen in Fig. 14.

Preliminary studies indicated that a plate-girder bridge with curb supports was the only feasible design. Sketches were made for trusses spanning the whole street, but they were objected to as unsightly. The clear span measured on the skew is 140 ft. 3 in. Because of the curve...
it was necessary to space the girders 19 ft. center to center. The heavy live load and the enormous dead load together with the lateral clearance needed because of the curve, made the use of curb supports imperative.

Solid shale rock was found 27 ft. below the old street surface. It was overlaid with water-bearing sand, the depth of water varying with the season, but being generally about six ft. A concrete pier was constructed under each of the girders on the curb line, 10 piers in all. The inside piers are 6½ by 6 ft. in plan, and carry an estimated maximum load of 17 tons per sq. ft. The sidewalk spans are so short that the abutments are little more than retaining walls. Their load is trifling, but to insure against settlement which might injure the concrete superstructure they were founded on piles.

The thickness of the floor 3 ft. 6 in., top of rail to underside, was agreed to with the city officials a long time before the passage of the ordinance, before the live load and unit stresses were determined and before the type of bridge had been selected.

When the design of the structure was taken up it was soon found that the depth of floor allowed was very scant. A minimum thickness of ballast of eight inches had been agreed to as necessary to prevent noise and avoid damage to the concrete. The summit of the grade had been located on the bridge so it was not desirable to raise the grade. These conditions are stated in detail, because, although investigations had indicated that waterproofing the floor slabs was in ordinary cases unnecessary, in this case the span was pretty long, there was no fall to take water away from the bridge and cracks in the floor were bound to occur over the curb supports. Had there been sufficient depth of floor available to waterproof the slab and give it a protective covering, such a course might have been followed. As it is, the leakage at the curb line is considerable.

The bridge was constructed without at any time closing the street. One street car track and one side of the roadway were abandoned at a time while depressing the roadway.

The inside girders weighed 79 tons and measured 91 ft. 3½ in. over all. They were placed with a derrick car from above.

The form of the bridge in plan is a rhombus, the diagonals being respectively 83½ ft. and 245½ ft. Some trouble was expected from temperature changes and there was no disappointment. Both ends of the structure were left free on the abutments. The tops of the abutments were finished smooth and well painted with a heavy asphalt paint. The floor slab was then extended over the abutments. There has been a little motion on the top of each abutment; just enough to crack the mortar in the angle between the floor and the abutment face.

The greatest motion has occurred at the extreme apices of the rhombus. At the northerly apex the motion has resulted thus far in a few cracks that are hardly noticeable. At the southerly apex, in February, 1912, a crack appeared in the face of the pilaster, extending from the upper right-hand corner to the lower left-hand corner. An expan-
SION joint had been constructed in the abutment at A and one at B (Fig. 15).

The joint at B did not appear to work. It was naturally assumed that the crack was occasioned by the tendency of the wing walls to part from the head wall in the angle, which is a common occurrence in abutment masonry. To remedy this the wing wall was cut loose from the head wall during the following summer by drilling clear through the abutment at B. The crack in the pilaster was then filled to a depth of two or three inches. In the winter of 1912-13, the crack again opened. Further repairs are now being made. The portion of the pilaster below the bridge seat and between the crack and the joint A has been removed and rebuilt, using reinforcing and dowels in the old concrete. At the bridge seat two grillages made of rails have been placed, one bearing on the other, the rail heads in contact. In this way it has been sought to provide a sliding surface of less resistance, it being thought that the pull of the bridge in cold weather was the cause of the crack.

The portion of concrete removed from the pilaster showed a projection from the face of about one-sixteenth-inch in extreme cold weather.

Another crack, and one which should have been avoided, occurred in the outside columns. The bridge proper is carried by steel columns encased in concrete and resting on concrete piers, carried to the rock foundation as above stated. The concrete facias concealing the bridge rest on the outside columns, but the columns were elongated in cross-section with concrete, that being sufficient to carry the load. In each of the four outside columns the concrete has parted from the steel. The crack is, as yet, barely visible. Now that it has happened, it is clear that steel reinforcing should have bound the concrete under the fascia to the steel column under the girder, even though the composite column does have a solid rock foundation.

BRIDGE FLOORS.

It was required that the railroad bridge floors be relatively noiseless and waterproof. In former years every effort has been put forth to build shallow floors so as to minimize the change of grade. Such floors have always permitted the muddy water to seep through upon people passing below and have operated as drums in accentuating every sound from the passing trains. To overcome these defects the floors were made of I-beams and concrete slabs upon which tracks were laid and ballasted as upon the ground. Such a design requires a greater depth of floor, which means a greater change of grade, and more steel to carry the added weight of concrete. The bridge is therefore more expensive. But in cities where the noise is troublesome, the ballasted floor is a great improvement. Trains passing over such floors are noticed but little more than when passing over the solid ground.

A concrete floor slab can also be made reasonably water-tight. The writer's first experience with concrete was on the Missouri in 1887-88.
Later it was used a little on the New York State Canals, and still later in bridge construction on the Nickel Plate. During this period many experiments had been made and papers written in which it was sought to demonstrate that concrete can be made practically impervious to water, and also that it cannot. Much concrete had been built that was very porous and there had sprung up numerous business enterprises for the manufacture and sale of waterproofing material. Both observation and experience indicated that water-tightness could be secured by either concrete alone or in combination with waterproofing. The requisite seemed to be that the material and workmanship should be the very best. If poor waterproofing were placed over poor concrete, the structure would leak. If the concrete were good, it would hold water, either with or without the waterproofing.

In order to confirm these opinions before construction, an investigation of concrete practice on other roads, and in building work, was undertaken by Mr. G. H. Tinker, Bridge Engineer, New York, Chicago & St. Louis Railroad. Later, as Chairman of the Committee on Masonry of the American Railway Engineering Association, he had exceptional opportunities for continuing the study. The result of this work was in harmony with the above-stated views and the bridge floors were accordingly designed without waterproofing. A paper by Mr. Tinker setting forth briefly the information he has accumulated appeared in Vol. 5, No. 3, of the Journal of the Cleveland Engineering Society. The following extract is quoted therefrom:

"In the bridges recently built in Cleveland by the Nickel Plate no foreign waterproofing substance has been used. An attempt has been made to construct a concrete slab which would be in itself as nearly waterproof as is practicable or desirable to make. This has proved satisfactory. When the Cedar Avenue bridge floor was built, the ends of the bridge were dammed up, the trough so formed was filled with water and allowed to stand for several days. No water whatever came through at any point of the slab. A little water ran through the dam and down over the back wall, and seeped through the joint between the bridge seat and floor slab. At the center bent there is a drainage system provided to carry what water might percolate through at that point down to the
gutters. Through some slight defect in the formation of this drainage some water seeped through there and dampened the concrete, but at no point of the bridge did any water drip."

Especial efforts were made to avoid the entrance of water between the steel and concrete and at points of contraluxure and where cracks might develop from temperature changes. Bevel flashings of steel were riveted to the girder webs and malleable cast flashings were fitted around the stiffeners to cover and seal the edge of the concrete (Fig. 16). This design was very successful. At points of contraluxure over curb supports and at Cedar Avenue over the center columns it was realized that cracks would develop and an attempt was made to forestall their appearance by the construction of joints. The joints were carefully provided with gutters and drainage pipes, and it was hoped that no trouble would be had with the water. The cracks were successfully forestalled, but the drainage was unsuccessful. The channels soon became clogged with cinders and the details of steel work in the cross-girders did not leave
room for a sufficient body of concrete, and in some instances the concrete proved imperfect. So, while the slabs proved generally tight, there has been some leakage at points of contraflexure.

Much reliance had been placed on the use of direct labor and carefully selected foremen, but there came a great rush of work at a critical time and the floors suffered. In East Cleveland at a later date it became necessary to build waterproof joints at the hinges of the arch bridges. This was successfully accomplished in the manner shown in Fig. 17.

The concrete in the floor slabs cost about $12.00 per cu. yd., in place. Now that the bridges are completed and have been two or more winters in service, the conclusions are as follows:

1. Concrete can be made water tight, under low heads, for all practical purposes.
2. The mixing, placing and ingredients of concrete are subject to such a great number and variety of defects that only the keenest attention will secure an impervious structure.
3. Contraflexure, temperature changes and settlements will produce cracks.
4. It is best to forestall cracks with predetermined joints.
5. Joints may be sealed against water if well-designed.

The highway bridges were paved with brick. The gutters have a good fall and the water runs off quickly. On the under side of the bridge floors the concrete is protected from locomotive blasts by cast-iron plates ½ in. thick and 36 in. wide. They weigh 71 lbs. per linear foot, and cost $5.23 per foot in place.

ORNAMENTATION OF BRIDGES.

Both cities insisted that the bridges be of an ornamental character. In Cleveland that idea seemed to mean that the structures must be masked with concrete. Steel was held to be unsightly, but concrete was in high favor. The bridges over East Boulevard and Cedar Avenue were surrounded by park land of considerable beauty. Euclid Avenue is known throughout the world as a magnificent residence street, but that magnificence is now largely a matter of history. Other streets, unfavored by business blocks, and exhibiting a more lavish display of wealth, have wrested its proud eminence and the solicitude for its waning glory is something like the reluctance with which a boy lays aside his copper-toed boots; it is done with a struggle. In this case the bridge is the evidence of the struggle.

In East Cleveland the municipal artist pinned his faith to a steel arch. The Euclid Avenue bridge is shown in Fig. 14. The bridge at East Boulevard (Figs. 19, 20, 21) and the one at Euclid Avenue have been described in detail. The Cedar Avenue bridge (Figs. 22 and 23) was first designed and planned as a type. It is a set of plate-girders masked with concrete. The aim in its design was to secure a pleasing effect
Fig. 18—Arch Bridge at Eddy Road.

Fig. 19—East Boulevard Bridge.
FIG. 20—EAST BOULEVARD BRIDGE.

FIG. 21—EAST BOULEVARD BRIDGE.
Fig. 22—Cedar Avenue Bridge.

Fig. 23—Cedar Avenue Bridge.
from general lines and without fineness of detail. The restrictions of
space for the roadway prevented that freedom of treatment which is
necessary to secure the best results.

The writer has always felt a strong repugnance to the use of stone
as a beam. Such a beam is not self-supporting and can never be more
than a symbol of deception. Accordingly he tried to relieve the curse by
giving the fascia the form of an arch, but while the curve of the soffit
is somewhat pleasing, the required clearance for the roadway prevented a
rise that would afford much resemblance to an arch.

The concealment of the steel work by the concrete is likewise a de-
ception and would furnish an excellent theme for a tirade by an artist
of Ruskin's school. However, it is noticeable that more pretentious
structures are not free from such faults and it is probable that the minds
of the people of Cleveland Heights are not disturbed thereby.

At Cedar Avenue the adjoining arch for Doan Brook and the railing
of the small highway bridge in the foreground enhance the appearance
of the structure.

The reddish color of the East Boulevard bridge, designed about a
year later, resulted from some criticism of the glaring whiteness of
concrete.

The elevation of the concrete fascia of the Mayfield Road bridge,
Fig. 24, was designed in the office of Robert Hoffman, Chief Engineer,
Department of Public Service. In this case the concrete fascia is built
directly upon the outer girder, and it was desired to cover the stiffener
angles and secure a pleasing effect without the use of too large a mass
of concrete.

In East Cleveland the artists were not so active. The attitude was
rather a stubborn opposition to everything proposed by the company.
Steel arches were demanded because of the one formerly used at East
Boulevard, and a type of iron railing was designed and adopted by the
council. The company was finally able to avoid all but seven of the
arches. It had little interest in the railings. Now that the bridges are
completed the consensus of opinion locally is in favor of the plate-girders,
and it is admitted that the lines of the railings are too fine.

The band of concrete—a concrete beam—used with the plate-girder
spans is another effort at concealment (Fig. 25).

Apart from questions of beauty the recesses in the abutments for the
shoes of the arch bridges are found to be a loitering place for boys and
a receptacle for rubbish and filth.

RETAINING WALLS.

Numerous retaining walls were required to prevent encroachments
of the embankments on private property. Fig. 26 shows a wall along the
land of the Peerless Motor Car Company. This company built an iron
fence on the right-of-way line at the beginning of the work and refused
FIG. 24—MAYFIELD ROAD BRIDGE.

FIG. 25—SHAW AVENUE BRIDGE, EAST CLEVELAND.
to sell a slope right or a parcel of land. In order to care for the requisite number of tracks a cross-section of roadbed and retaining wall, as shown in Fig. 27, was adopted. The wall was built, the track depressed and switching service to three industries maintained on the line adjacent to the wall without disturbing the fence. The length of the wall was 490 ft. Its cost was $7.00 per cu. yd.

It should be said that the above wall is next east of Ninety-third Street where the track depression began.

A larger wall built for similar reasons along the property of the Stearns Automobile Company was described in the Cornell Civil Engineer for March, 1913, page 336. This is a reinforced counterfort wall resting on piers (Figs. 28 and 29). The face is vertical and resistance to overturning is secured by attaching the counterforts to a slab resting on the piers and placing the embankment and tracks over the slab. The estimates showed a saving of about 20 per cent. over the cost of a gravity wall. The cost per cu. yd. was $6.55.

TRESTLES.

Pile trestles were used at nearly all of the street crossings. In East Cleveland there was one continuous trestle about 2,600 ft. long. All trestles over the streets were constructed to carry regular traffic. Track stringers and ties were used repeatedly at the several crossings.

The long trestle cost $9.40 per linear foot and after filling a credit of $3.25 per linear foot was made for the timber removed, making the net cost per foot $6.15.

Several trestles were constructed to serve private industries from the elevated tracks.

A common land driver was used for the long trestle. A Bucyrus mounted driver was borrowed from the railroad company on one occasion and later pendulum leads suspended from the boom of a locomotive crane were used (Fig. 30). The latter device was described in Engineering News, November 23, 1911, page 625, and erroneously credited to a contractor. Its particular merit is that the leads can be readily laid aside and the crane used for handling timber or even for shifting cars. Its mobility is much greater than that of the Bucyrus driver. For driving a large number of piles it would not be economical, but in building a trestle out from a bank as the piles are driven, it is very efficient. The rig was devised and used by the bridge foreman, John Kopp. The cost of the leads was $211.00.

At Mayfield Road much entertainment was furnished the local residents by excavating a deep hole in hard shale underneath the tracks and supporting them with a trestle. It was many months before the steam shovel, in excavating the subway, was ready to pass beneath the tracks, and meanwhile the people were permitted to contemplate the strange proceeding of digging a trench to make a place for a bridge (Fig. 5).
IN CLEVELAND, OHIO.

FIG. 26—RETAINING WALL.

FIG. 27—CROSS-SECTION OF TRACKS.
ELIMINATION OF GRADE CROSSINGS

STREET GRADES AND PAVEMENTS.

In Cleveland it was generally held by the city officials that changes of street grades should be so made that the maximum rate would be 4 per cent. In some cases this could not be done without material alterations in the proposed railroad profile and an increase in the ruling grade. The street crossings where this condition prevailed were all located along the base of a hill upon which is located the suburban village of Euclid Heights. The ascent of this hill involved much steeper grades, and so there was little to be lost in using street grades in excess of the desired maximum. At Cornell Road a 5 per cent. grade was agreed upon. At Cedar Avenue it was necessary to use a 6 per cent. grade, and at East Boulevard the grade is 10 per cent. As a matter of economy to the railroad company the steeper grade would make the shorter change in the street surface, which, besides the saving in construction, would incur a fewer number of damage claims for change of grade. As a slight offset to this, stone block pavement at cost of $2.77 per sq. yd. was required when the grade exceeded 4 per cent. The brick paving, used elsewhere, cost about $1.07 per sq. yd.; but these questions of economy were given no weight in determining the grades.

At Cornell Road it was found advantageous to alter the alinement, throwing the track about 65 ft. farther south. This change served to lessen materially the extent of the alteration in the street grade.

In East Cleveland the problems were very simple. In each case the original roadbed gave a slight hump to the street profile and it was generally sufficient to cut off that hump, leaving the new grade line nearly straight (Figs. 38, 39, 40 and 41).

In Cleveland the pavement was generally laid on a six-inch concrete base. In East Cleveland the earth is generally very sandy, and in such cases the brick was laid directly on the sand. Pavements laid in this way have given good results. On a few streets where the subsoil was clay, a six-inch concrete base was used.

At East Boulevard a good macadam pavement 12½ in. thick was constructed by a local contractor.

The costs of the pavements are about as follows:

Medina stone block (concrete base not included), 30.8 cents per sq. ft.—contract work.

Vitrified brick (concrete base not included), 11.84 cents per sq. ft.—contract work.

Vitrified brick, sand foundation, 11.9 cents per sq. ft.—direct labor.

Macadam, 19 cents per sq. ft.—contract work.

Concrete base, 6 in. thick, 6½ cents per sq. ft.—contract work.

WATER PIPES.

All water pipes encountered in the work were lowered to a minimum depth of six feet below the new street grades. The work was done generally in Cleveland by the City Water Department and by day labor. On numerous occasions where trenches were to be dug the company was re-
Fig. 28—Retaining Wall

Fig. 29—Retaining Wall
quested to furnish the labor. That was a material advantage because the rate of pay was greater for city employés.

This is but one of the many evidences of the freedom from politics of the Cleveland City Water Department.

The methods of accounting in the Water Department are such that where a street was vacated, the company was charged with the cost of the old water line, and where a new street was opened, the new water line was built without expense to the company.

A considerable loss was incurred on one occasion by the cracking of a number of sections of 36-in. main when burning out the lead. An ex-city employé had been hired as a foreman and on the advice of an employé of the Water Department he was permitted to take up the pipe. In his zeal to make a good showing he cooled the pipe with water which caused the cracks and rendered the pipe useless.

There were two 36-in. mains, both of which intersected the deepest cut and their depression in hard shale was very expensive.

SEWERS.

There were sewers to be lowered or diverted in nearly all of the streets crossed. In East Cleveland the work was generally simple. Where there was room below the pavement to cap a sewer with six or eight inches of concrete, no depression was made. The concrete cap was used for depths less than 2½ ft. from the top of sewer to surface of pavement.

From Hower Avenue to Superior Street, East Cleveland, a sewer extended parallel to the track and under the proposed embankment. It was located on private land that was purchased for additional right-of-way. This sewer was relocated on the southerly side of the new embankment. It consists of a 15-in. clay pipe about 20 ft. below the ground surface and 1,761 ft. long. Its cost was $7,089.53, or $4.03 per ft. The bottom of the trench was in shale for a distance of 935 ft.

In Cleveland the sewers were without interest save in Quincy Avenue and East One Hundred and Fifth Street. In Quincy Avenue the depression was so great that the contractor did his work in a tunnel. The tunnel was 380 ft. long. The major diameter of the sewer was 4.23 ft.

The East One Hundred and Fifth Street sewer was 7 ft. 6 in. in diameter and so located that the bottom of the invert north of the railroad was above the final top of rail. Three rectangular channels shown in Fig. 33 were built beneath the tracks to carry the flow. In time of flood these channels will be under a low head. They are built of concrete and roofed with steel beams bedded in concrete. A depression was cut in the bottom of the sewer to drain the channels under the tracks. It extended about 1,000 ft. down the street. The excavation in the sewer was done without blasting and the material trucked out on small cars. The material was hard shale, brick and concrete. Fig. 34 shows how the sewer was expanded behind the abutments to connect with the rectangular channels. The work on this sewer was done by the company.
WALKS.

In Cleveland the sidewalks were generally built by the city contractor. In East Cleveland they were built by the company. In some instances walks were built in Cleveland by the company.

New sidewalks were constructed generally of concrete. Old stone flagging was relaid when found in good condition and not damaged in handling. In 1912 Cleveland had a general contract for sidewalks under which it paid 12 cents per sq. ft. for 2½-in. flagging laid. The usual price for flagging delivered on the ground was 10 cents per sq. ft. It cost the company 4 to 5 cents per sq. ft. to relay flagging with its own men. This included redressing when broken. The flagging was bedded in a 4-in. layer of cinders, the price of which is included in the cost of laying.

The price for concrete walks under the general Cleveland contract was 13 cents per sq. ft. Concrete walks built by the railroad forces cost a minimum of 15 cents. It was interesting to observe the differences in operations that tended to make up the difference in cost.

The company paid 18½ cents per hour for labor. It is not known what the Cleveland contractor paid. It probably was no less.

The company used sand at a cost of 88 cents per cu. yd., delivered f. o. b. at point where used. The contractor frequently used sand excavated from the site of the walk. Such sand was sometimes good. It was often mixed with loam and any discrimination in its selection was naturally in the contractor's favor.

The company built walks 5 in. thick and gave good measure. The contractor built walks 5 in. thick, but was careful that they should not overrun in thickness.

Some contract walks went to pieces the first winter. An examination indicated very little cement below the upper half-inch of the walk's thickness. Walks built by the company have not yet shown any such behavior.

The company walks were carefully jointed to care for temperature changes. The contract walks were marked so as to present a jointed appearance, but provision for actual motion was mainly by accident.

The forces used by the company were not organized to build walks, and engaged in such work intermittently and for short periods. The handling of material from cars to walks was seldom done in the most economical manner, because the sidewalks were inconveniently located with respect to the tracks on which materials were received. The controlling reason for the building of walks by the company was to expedite the work and to remedy bad conditions for street traffic.

SEEDING SLOPES.

The East Cleveland ordinance required that the slopes of the embankment be covered with grass. To do this in an economical manner was no little task. The material of which the embankments were made was sand, very poor clay and shale.
The slopes were finished with the best material available and then well seeded with bromus inermis and hard fescue, mingled with oats in the forepart of the summer and later with rye. These grasses are very hardy and thrive on poor dry soil. They make very little turf before the second year and the grain was used for protection during the first season. The slopes were generally seeded as soon as prepared, and if that happened in the fall, rye was used instead of oats, because the rye would live during the winter.

The slope of the embankment was 1½ to 1 and to hold the earth against washing by the rain strips of board were placed on edge along the slope, parallel with the track and about 2½ ft. apart. They were secured to small stakes and then covered with earth so as to be scarcely visible. The boards and the stakes were taken from old form material and from the wreckage of buildings which were removed from the right-of-way. No charge was made for such material.
The seeding in general was quite successful and at the end of the second season the slopes were well covered.

The cost of seeding as above described was about one-half cent per sq. ft. The area seeded was approximately 12 acres, and about 47½ lbs. of grass seed were used per acre.

GENERAL PROCEDURE—EXAMPLE.

There were three Cleveland ordinances. Two were passed December 28, 1908, the third was passed January 25, 1909. They provided that

the work should be completed within two years. The East Cleveland ordinance was not passed until December 28, 1909. It likewise provided two years for the performance of the work. The excavation was in Cleveland and the fill was mainly in East Cleveland. The excavation, including the Quincy Yard and the Euclid borrow pit, amounted to 691,000 cu. yds. The embankment amounted to 537,000 cu. yds.
It was manifestly unwise to waste the material excavated, and no suitable spoil bank was available. Yet it seemed necessary to proceed with the work regardless of the situation in East Cleveland. It was possible to complete the work in Cleveland leaving a runoff from Euclid Avenue eastward to Lakeview Avenue, having a grade of about 1.2 percent. Such a grade would of course require the service of a pusher for the westbound traffic.

**Fig. 32—36-Inch Water Main at Quincy Avenue.**

Under these conditions the work was not only slow and expensive, but any program laid out was necessarily tentative and adapted to only a part of the work.

With the passing of the East Cleveland ordinance, it became possible for the first time to treat the work as a whole, and thereafter it was pushed rapidly forward.

All traffic was operated for the first time over the new grade in Cleveland on November 1, 1910. In East Cleveland the new grade was
FIG. 33—105TH STREET SEWER UNDER RAILROAD TRACKS.

FIG. 34—105TH STREET SEWER BEHIND ABUTMENTS.
placed in service throughout the city November 22, 1911. The street work was practically completed in 1912 in both Cleveland and East Cleveland. Although the time of final completion in each city was delayed considerably beyond the limit of the ordinances, the rate of progress had given general satisfaction and there were no complaints. It was early seen that the company had started to carry out in good faith the obligations assumed, and a spirit of friendliness and co-operation developed which made the work very pleasant.

The various controlling features of the work had been carefully studied long before its beginning and a careful program prepared covering the territory from Ninety-third Street to Superior Street. If the uncertainties of 1909, due to the pending East Cleveland ordinance be excepted, it may be said that this program was followed very closely, and in accordance with a time schedule that was always determined well in advance of the work. Because of this systematic planning there was never any delay through lack of material, and never any reduction of force through lack of work.

In February, 1910, the concrete construction for the ensuing year was carefully mapped out and explained to Foreman Bisset. At the end of the year he had accomplished a little more work than was planned. The same thing happened in 1911.

In estimating the progress of the excavation the monthly output of the shovel was taken at 20,000 cu. yds. The maximum output was 43,245 cu. yds., but the assumed average resulted in a close conformity to the program.

The best example of the working of this program is the portion of the work covering the Euclid Avenue crossing.

The first move in construction was to build a temporary line for regular traffic from Cornell Road across Euclid Avenue to a point east of the Euclid Avenue station. This move was for the purpose of providing dumping ground from Mayfield Road to Lakeview Avenue, and to permit the construction of the Euclid Avenue bridge. All regular traffic was turned over this temporary line June 7, 1909. Material from the steam shovel was hauled over the old Euclid Avenue crossing until August 14, 1909. The crossing was then abandoned to permit work on the bridge abutments.

The location of the temporary line (Fig. 1) was such that a portion of the street might be depressed 3 ft. 6 in. as planned, and the two north-easterly girders erected, leaving space for street cars to pass under the girders, and by a sharp ascent pass over the temporary track at the street grade. The clear head room underneath the girders and the temporary trestle was 14 ft. 6 in. The street car tracks were spread to permit the placing of a trestle bent between them. After the partial depression of the street—by a city contractor—the pavement was relaid, part of it in temporary position, pending the removal of the railroad tracks from the street surface. The trestle (Fig. 35) was completed September 6, 1910. At this time enough of the abutments had been completed to permit the
erection of three girders. Five girders were used in the bridge. The two northeasterly girders were erected and made ready for traffic in September and October. On November 1, 1910, all traffic was turned over the bridge. The old track was taken up and the street depressed and repaved before winter. The ground was sandy, which fact was of great assistance to the work so late in the season when the weather was cold and wet.

It was a very difficult matter to get each party concerned in the street depression to move promptly and get the roadway in shape for winter. There were wire conduits, water and gas pipes to lower, paving to take up and relay, earth to remove, street car tracks to take up and relay and all street traffic to maintain. It was a busy time. Six weeks of patient, earnest effort were expended in getting everything in readi-

FIG. 35—TRESTLE OVER EUCLID AVENUE.

ness for the change on November 1, and there was efficient co-operation of the finest kind.

As soon as the flurry due to a change in running track had subsided, the third girder was erected and two tracks were then available over the street.

On March 18, 1911, the abutments were complete. The remainder of the steel work was then erected and in October, 1911, the concrete superstructure was all in place.

The turning of traffic over the bridge at Euclid Avenue involved the completion of a track at the new grade from Mayfield Road to Superior Street. Many other details were being followed up while the Euclid
Avenue crossing was under way. There were grading, trestle building, masonry, steel work and street work all in progress and all arranged without conflict or delay. Every important move was planned a long time in advance, and its date carefully fixed by a study of the progress made and the common need.

ACCIDENTS.

The record of derailments which occurred on the work consist of:

1. A derailment on the East Cleveland trestle near Lakeview Avenue on the night of January 19, 1911. The derailed car ran the full length of the trestle, and the train parted near Superior Street. No serious damage resulted.

2. A derailment occurred at Superior Street, just east of the Su-

![Fig. 36—Mayfield Road—Derailment.](image)

perior Street bridge, on September 10, 1911. Several cars were turned over the bank, resulting in a considerable financial loss.

3. A derailment occurred just west of the Mayfield Road bridge on the morning of December 5, 1911. The train parted and one of the cars in the rear end of the train bumped into and demolished the concrete end post on the Mayfield Road bridge (Fig. 36). No serious damage was done. There were six cars detached from the train by the failure of the coupling and the distance passed over by the remainder of the train, after the application of brakes, indicates an initial speed of twenty miles per hour. For those who have been building bridge fenders of
concrete to guard against damage to supports by derailments, this occurrence is of especial interest. The impact was that of six loaded freight cars running about twenty miles per hour. The speed was somewhat lessened after leaving the rails. In the final impact against the concrete bridge railing, the post cracked clear through horizontally, but was not dislocated, and the railing was split a total length on the far side of 12 ft. 6 in., on the near side 7 ft. 6 in. The body of the post was 2 ft. 1 in. square. The railing was 1 ft. thick in the panel and 2 ft. wide at the top. The upper part of the railing was reinforced by four longitudinal bars 3/4 in. in diameter. The panel was built over American Steel & Wire Co. 7-A woven wire.

These derailments were occasioned by too great speed, in spite of the fact that slow boards were in position on both sides of the points where the derailments occurred, and that the slow orders had been bulletined by the Superintendent. The trains were all freight trains and no serious personal injuries resulted.

On August 17, 1910, a locomotive crane was upset and fell from the trestle in East Cleveland to the soft embankment below. The crane had been hoisting earth in skips from a foundation and was overbalanced. The engineer admitted that he had used poor judgment in handling the load. He jumped from the cab as the machine overturned and escaped with a few bruises. No one was injured. The repairs to the crane cost $1,414.38.

On July 8, 1912, a crane was overturned while dismantling a steam shovel. The track on which it was standing, a pit loading track, was badly out of level and when the weight of the dipper came on the boom of the crane, the latter swung round in spite of attempts to hold it, and the crane was upset. The engineer jumped, no one was injured and very little damage was done.

PERSONAL INJURIES.

It is the belief of the writer that a large number of personal injuries are due to the impatience and thoughtlessness of foremen.

A nervous, impatient, blustering foreman keeps his men excited. A team of young, high-strung, powerful horses once belonging to the writer were described by their driver as very unsteady and hard to control. A later driver said the horses were as steady as a team of oxen and that he could do anything with them. The spirit of the latter driver is to be desired in a foreman. He should always be master of the situation, calm, self-reliant and resourceful, having complete and constant control of his men and being always alert for their safety. Men working in large gangs are subjected to danger not alone because of their own acts, but by the acts of their co-workers, and it is vitally essential that the foreman should have their safety constantly in mind. There are many other dangers not growing out of the presence of co-workers, but which bring disaster through errors of judgment. Such conditions require the
presence and direction of a man of large experience and superior judgment.

It too often happens that in his zeal to accomplish much work the foreman is careless of his men and leaving them to rely upon their own resources, keeps them in such a state of fear as to defeat his efforts to make progress.

Upon the work described these facts were duly impressed upon all the foremen. They were told that they were responsible for the safety of their men and that they must strive to avoid injuries. Occasionally comparisons were made of the number of accidents in different gangs, but no data was ever secured that tended to prove one foreman more careful than another. The personal injuries appeared rather to be governed by the nature of the work in hand. Pile driving and trestle building seemed to give rise to the greatest number and concrete form building next. In the latter case, injuries resulted most frequently from stepping on nails in the old form material. Strong efforts were made to eliminate accidents from this cause. The workmen were repeatedly warned and the nails were pulled promptly after the forms were removed.

The most serious injury which occurred on the work was the mangleing of a hand in the gearing of a Lidgerwood unloader.

The construction of bridges over trolley lines was especially difficult and dangerous. On three of the streets the trolley service was maintained continuously, with slight exceptions at East One Hundred and Fifth Street and Cedar Avenue, and the men working around the wires were repeatedly cautioned about the danger of electric shocks. The completion of the work without accident from this cause was a great relief to all in authority.

Another danger was that of collisions with trains on the street crossings. The danger was greatly increased by the construction work, and both flagmen and street gates were used for protection. It is a curious fact that, after providing the usual safeguards, danger was then due almost entirely to drivers of vehicles who would try to run over the crossings in front of approaching trains and in spite of warnings from the flagmen. Current comment seems to place all blame for injuries at such places on the railroads. It is chargeable more properly to the impatience of restraint so often exhibited by people who feel themselves either above or outside the law. Cleveland's Director of Public Service has argued for crossing gates instead of flagmen, because of lack of obedience to the flagmen's warnings. The writer has frequently seen drivers of vehicles endeavor to run beneath the gates as they were being lowered and instances have occurred where automobiles have run through the gates after they were down.

The total number of injuries reported was about 290, and the average total expense per case was $22.76. This includes injuries of the most trivial nature. Every known case was reported and recorded for possible use in the future. Even though an injury was trivial, it might
sometime lead to a damage claim and then a correct record of the facts would be useful.

Considering the extent and duration of the work it is felt that the number of injuries is not excessive.

ACCOUNTING.

Because of the somewhat complicated relations of the various interested parties and the general use of direct labor, it was early discerned that the accounting was an exceedingly important part of the task and that in the end a successful adjustment of the obligations of the parties might involve considerable difficulty. With this in mind, a careful study was made of the subject and many precautions observed to insure success. The first move was to secure assistants worthy of the highest confidence, the next to post them fully concerning the aims and results to hold in mind and the means for their attainment.

Payments for land or for legal claims were made by the Legal Department. All other bills were approved and vouchedered by the writer.

A monthly statement of expenditures was made to the Auditor. The largest part was held in a suspense account, pending the completion of the work.

Expenditures by either city were submitted for the approval of the writer.

The bills for all material, supplies, tools or services were verified by the Division Engineer. Supporting papers were filed with every voucher.

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**Fig. 37—Old Bridge at Fairmount Road.**
Fig. 38—Elberon Avenue, East Cleveland, Before Separation of Grades.

Fig. 39—Elberon Avenue, East Cleveland, After Separation of Grades.
It was the expressed purpose of the writer to make the record so clear, and to keep the unit costs so well within bounds that the final results would necessarily prove satisfactory. The successful achievement of that purpose has not yet been questioned.

The time of all workmen, whether in the employ of the railroad or any other corporation, was taken daily by the timekeeper. He also made or secured from the foremen distribution of labor. Payment for labor was made once per month. The rolls were prepared and the distribution checked in the writer’s office.

A storekeeper was employed to disburse tools and material and to account for their use.

Records of progress were continually kept to insure that the desired rate was maintained, and to stimulate the workmen to put forth their best efforts. Records of cost were made to control the expenditures. No part of the work could continue unduly expensive without receiving early attention from the office.

In order to secure the necessary unit prices and to properly interpret the accounts, the latter were placed wholly in the hands of an engineer who had previous experience in such matters, and who had demonstrated his ability on the present work.

Some things often discussed as theories could not be treated with a precision to satisfy an analytic mind. The most conspicuous case was that of form material. The great bulk of this material was composed of 4 in. × 6 in. and 2 in. lumber. It was used many times, until worn out or cut up. In the beginning all lumber delivered to a certain structure was charged thereto, and when taken away, credited, first cost being used in each case. It was expected that this would work out all right in the end if we were careful to have little material on hand. But in the rush of work, form material sometimes disappeared or credits failed to be made so that in figuring the final unit costs, the form material used is not a true record. It was adjusted in the light of the best knowledge available. The same is true in a very much lesser degree of the concrete material. The record was not always perfect.

A distribution of earth was made by carloads and the average carload derived from excavation measurement.

The preliminary estimate of the cost of the construction work was $1,843,690. The actual cost was about 11.2 per cent. less than the estimate. Other work, not part of the general project, was done for the "Short Line," for private parties and for the Nickel Plate, which brought the total expenditure for construction up to $2,257,059.44.

The cost of engineering was 3.62 per cent. of the cost of construction. It includes salaries, stationery and repairs of instruments.

The cost of administration amounted to 3.69 per cent. of the cost of construction and included salaries, office rent, supplies and telephone service.

The total amount expended in the purchase of tools and equipment is $40,000.
The estimated value of material on hand at the close of the work is $7,000.

Unit prices, where given, include a proper proportion of overhead charges.

CONSTRUCTION CONTRACTS WITH THE CITY.

Contracts were let by the city of Cleveland for the superstructure and substructure of the Cornell Road bridge in June, 1909. It was completed September 22, 1910. A contract was similarly let for the abutments of the Adelbert Road bridge September 24, 1909. They were completed in September, 1910. The superstructure for the latter bridge was contracted for March 23, 1910, and was completed in May, 1911.

During the work on the above bridges the operations of the company's construction forces were disturbed considerably by the slowness of the contractors.

The depression of Cedar Avenue was the next work in order for the city to undertake. The only practicable way to dispose of the material to be excavated in the street was to haul it on cars to spoil banks along the railroad. Any delay in the work would interfere seriously with the progress on the railroad bridge over Cedar Avenue. Under these circumstances it did not seem wise to permit an independent contractor to get control of the job.

A condition of similar relation to the administration of the whole undertaking existed at Fairmount Road (Fig. 37).

The highway already crossed the track on an overhead bridge, but there was room between the abutments for only one track, where four were needed. It was necessary to close Fairmount Road and remove the southerly abutment before the steam shovel approached it from the west. Should the removal of the abutment be placed in the hands of a small contractor, it might readily happen that the whole grading outfit would be compelled to sit idly by and watch the removal of the old masonry.

With these conditions in mind, it was decided to bid on the city contracts and to bid low enough to make sure that the company was the lowest bidder. This method was tried at Cedar Avenue and later adopted in all city work except in paving and sewers. The paving in no way affected the operations of the railroad, and it was better to make use of independent paving organizations than to increase the work of the Grade Elimination Department.

These remarks apply only to the work in Cleveland, as in East Cleveland the ordinance provided that the company should do all the work.

The contractors who bid against the company suffered some inconvenience and expense for which there appeared to be no remedy.

Having taken a city contract in the name of the company, the writer had the unusual experience of approving as engineer for the company drawings prepared by the city for work to be done by him for the rail-
road company which held the contract. All payments under the contracts were made on estimates approved by the writer as engineer for the company and received by the writer as representative of the contractor. It was the most successful game of chasing the devil about the stump the writer has thus far encountered. The results seemed to be entirely satisfactory to all concerned except the unfortunate bidders.

The question as to whether the company should announce its intentions in advance of a letting and thus avoid the consequent disappointment of the unsuccessful bidders was carefully canvassed and decided in the negative.

LIST OF CITY CONTRACTS TAKEN BY THE COMPANY.

Quincy Avenue—Foundations; concrete; grading.
East One Hundred and Fifth Street—Foundations; concrete; grading; modifying sewer.
Woodhill and Fairmount Roads—Grading and concrete.
East Boulevard—Highway Bridge; Doan Brook.
Cedar Avenue—Grading; Doan Brook Bridge.
Mayfield Road—Grading.

OPPOSITION TO THE PROJECT.

The portion of the Nickel Plate which is paralleled by the "Short Line" passes along the Fairmount Reservoir and through the adjacent section of Wade Park, crossing East Boulevard, Doan Brook and Cedar Avenue. It then skirts the rear of the grounds of Adelbert College and the Case School of Applied Science on the east, crosses Euclid Avenue, and follows East Cleveland Cemetery to a point near the city line. In East Cleveland it next crosses a series of eight residence streets, occupied by medium-priced houses, and parallels Euclid Avenue at a distance of about 600 ft. throughout that city.

The original grade of the road in East Cleveland was nearly level. Approaching Euclid Avenue from the east for 1300 ft. there was an ascending grade of 7/10 per cent. Euclid Avenue was crossed on an uncompensated 4-degree curve and the grade continued to the summit in the rear of Adelbert College (Fig. 2).

The territory surrounding the college is a fine residence district, across the railroad to the southeast is Cleveland Heights, the location of many of Cleveland's finest houses, and East Cleveland is a city of suburban residences. It was but natural that people living in this region should strongly oppose the granting of increased railway facilities and a few active opponents of the project were quick to enlist their support. There was no denial that the "Short Line" was asking for a valuable franchise, but the project meant much for the future development of the city and the proposal to so construct the road as to eliminate all grade crossings without expense to the city seemed like a suitable return. The opposition took the form of a demand that the tracks be depressed beneath the streets in East Cleveland and thus, following the desired 3/10 grade, be low enough to permit a tunnel under the summit near the college. This with electric traction and
FIG. 40—EDDY ROAD, EAST CLEVELAND, BEFORE SEPARATION OF GRADES.

FIG. 41—EDDY ROAD, EAST CLEVELAND, AFTER SEPARATION OF GRADES.
ornamental bridges increased enormously the estimate of the cost, but worse than that, the grade line ran into a cut beyond the pumping station, too deep for consideration. The railroads could not accept the plan and the Mayor of Cleveland, Tom Johnson, was able to understand the reason. He did not hasten matters. There was a free and fair discussion in public of the merits of the plan and up to the last vote of the Council the outcome was uncertain. But the contest was one of logic and the company won.

The passage of the Cleveland ordinance had an important bearing on the situation in East Cleveland. The opposition felt that it was losing ground and that the passing of the desired ordinance was but a matter of time.

The work is now completed. The residents of East Cleveland are well pleased with the results and general satisfaction and harmony prevail.

Figs. 38 and 39 show the crossing of Elberon Avenue, East Cleveland, before and after the separation of grades. The house at the end of the street is facing Euclid Avenue, which runs parallel to the railroad.

Figs. 40 and 41 are similar views of the crossing of Eddy Road. The house on an elevation at the end of the street in the view of the grade crossing is the Cleveland home of Mr. John D. Rockefeller.

**CHRONOLOGY.**

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>December 28</td>
<td>Two Cleveland ordinances passed the council.</td>
</tr>
<tr>
<td>1909 January 25</td>
<td>The remaining Cleveland ordinance passed council.</td>
</tr>
<tr>
<td>February 3</td>
<td>Organization of department begun.</td>
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<tr>
<td>March 1</td>
<td>Construction of temporary running track east of Mayfield Road began.</td>
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<tr>
<td>April 15</td>
<td>Steam shovel began work.</td>
</tr>
<tr>
<td>June 7</td>
<td>Train No. 6 was the last train to cross Euclid Avenue on the old main track.</td>
</tr>
<tr>
<td>August 26</td>
<td>Steam shovel began excavation in Cedar Avenue.</td>
</tr>
<tr>
<td>December 28</td>
<td>East Cleveland ordinance passed.</td>
</tr>
<tr>
<td>1910 February 8</td>
<td>Temporary main Ninety-third Street to Fairmount Road placed in service.</td>
</tr>
<tr>
<td>February 24</td>
<td>Began concrete work with company force.</td>
</tr>
<tr>
<td>March 24</td>
<td>First train over new bridge at Cedar Avenue and new grade to Mayfield Road.</td>
</tr>
<tr>
<td>June 1</td>
<td>Steam shovel began work in Mayfield Road.</td>
</tr>
<tr>
<td>August 24</td>
<td>Traffic turned over new grade from Ninety-third Street to East Boulevard.</td>
</tr>
<tr>
<td>October 1</td>
<td>Steam shovel began work in Quincy Avenue.</td>
</tr>
<tr>
<td>November 1</td>
<td>Traffic turned over new grade from Mayfield Road to Superior Street.</td>
</tr>
<tr>
<td></td>
<td>New grade in service in all Cleveland territory.</td>
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</table>
ELIMINATION OF GRADE CROSSINGS

1911
November 22  Traffic turned over new grade Superior Street to Ivanhoe Road.
            New grade in service throughout East Cleveland.

1912
March 1    Steel work completed.
July 1     Operation of Cleveland Short Line Railway began.
October 1  Nickel Plate ready for double-track operation.

CONCLUSION.

The work is now complete. According to common standards, it may be considered a success. The people along the route are pleased with the result, the officers of the two municipalities have expressed their gratification, the four-track roadbed was completed before the "Short Line" was ready to lay its track; the transportation officials of the Nickel Plate are satisfied with the comparatively slight interference with traffic and the cost is below the estimate.

Under such circumstances it would be ungrateful to remember occasional defects and failures or to wish that any task had been better done. The employees of the Department gave the most faithful attention to their work and strove diligently to excel in the tasks assigned. It is a pleasure to acknowledge here a large measure of indebtedness for their skilled and faithful assistance and to wish them the best success in their new positions.

To an Engineer it will be of interest to know that the writer attributes a goodly portion of the satisfaction of the Operating Department to his full realization that the first business of a railroad is to handle traffic. It is built for that purpose. After building it is obligated to its patrons to render good service and the funds for improvements are derived either directly or indirectly from that service.

To those who find this account lacking in some particular that has aroused their interest, it may be said that in its preparation the principal problem has been one of selection. Neither time nor space could be used to describe all of the interesting features of the work. If what has been written shall serve to refresh the memory and stimulate to further excellence like efforts of the reader, the paper will have served its highest purpose.

The General Manager of the Nickel Plate, Mr. A. W. Johnston, is a Civil Engineer. To this fortunate circumstance and his rare personal qualities of leadership can be ascribed much support and co-operation from other departments without which such a successful record would have been impossible. The writer also enjoyed the unqualified support of the President, Mr. W. H. Canniff, and of the General Counsel, Mr. John H. Clarke. Altogether he found more to enjoy in these four years of busy life and more loyal and harmonious assistance than might reasonably have been hoped, and he feels profoundly grateful to all who were concerned in bringing the work to a successful completion.