ers, waterworks, and the like, in which distinctions must be between new construction and maintenance and repairs, he strongly urges the separation of items on the basis of productive and non-productive labor and material. The separation is made quite generally in the schedules offered in the committee report and in Mr. Luten's discussion of the same, but incidentally rather than upon a fixed principle. It may, therefore, help to point out this principle in order that it may serve as a guide to determine the method of handling the details.

The distinctions between the above two classes of labor and material are as follows:—

1. What might be termed productive material and labor, to borrow the term without modifying it to fit the facts exactly, is material that remains in the work and forms a permanent part of it, and labor which puts that material in its place and keeps it there.

2. Non-productive material and labor figuratively speaking, consists of tools, equipment, etc., used in handling the material put into the work and in holding it in place temporarily; such non-productive material being then removed permanently from the work, thenceforth to have no further conection with it. Non-productive labor is the labor which is put upon this non-productive material, in preparing it for use, in disposing of it, transporting it, etc.

3. There is also the usual class of non-productive labor, i.e., labor which has no direct effect in putting the materials into their positions in the structure.

Cost
- 1. *Material*
  - 1. Actually entering into work ÷ by items of diff. character.
    - 1. Actual quantities.
    - 2. F. o. b. price.
    - 3. Waste.
  - 2. Accessory or incidental.
    - 1. Quantity.
    - 2. Price.
    - 3. Salvage & loss.
  - 3. Labor. 1. Delivery to job.
- 2. *Labor*
  - 1. Direct or productive....
    - 1. Itemized by sections of varying character.
    - 2. Itemized by kind of work done (Gen. Div.)
    - 3. Spec. divisions, pay work.
  - 2. Indirect or non-productive.*
    - 1. On job
      - 1. Supervision
      - 2. Repairs.
      - 3. Incidentals.
    - 2. Material delivery (A material charge)
    - 3. General supervision.
  - 3. Yards or shop, direct labor.
- 3. *General Charges.*
  - 1. Direct to job..
    - 1. Bond and insurance.
    - 2. Expense.
    - 3. Fittings and repairs.
    - 4. Fuel and oil.
    - 5. Specials.
    - 6. Commissary (where required).
  - 2. Indirect to job
    - 1. Petty tools.
    - 2. Tools and machinery.
    - 3. Yard and shops, payroll and expense of general character.
    - 4. General office payroll and expense.

NOTE.—Under General Charges.—To be proportioned over cost of material or labor, or their sum.

*To be proportioned over the various items of productive labor.

CEMENT STRONG ROOMS.

In a recent English test of the burglar-proof qualities of vaults of reinforced concrete, a slab of the material six inches thick was perforated with a hole 3½ inches in diameter by means of the oxyacetylene blowpipe. When a steel bar was reached, it was instantly fused away by directing a jet of pure oxygen on the white-hot metal, but this metal-cutting jet had little effect on the concrete.

The time required for making the hole was 24 minutes. As a similar hole in any kind of steel could be made through an equal thickness within four minutes with the jet, it was evident that the concrete offered an important advantage for strong-room building.

SHALLOW FLOORS FOR RAILWAY BRIDGES.*

By O. F. Dalstrom.

In railway bridges of the through type, designed for crossings where local conditions do not govern the depth of the floor system, that depth is determined by sections that give the greatest economy of material consistent with simplicity of construction and facility of erection.

The Shallow Trough Floor Bridge.—The floor beam usually determines the depth of floor in designs of open floor through bridges, whether truss or plate girder type. The term "depth of floor" will be used throughout this discussion to indicate the distance from base of rail to lowest steel of span. If considerations governing the design of the trusses produce panels of considerable length, the stringers, instead of the floor beams, may determine the depth of floor. A single track truss span of 350 to 400 ft., with trusses 18 ft. 6 in. or 19 ft. centres, may have panels over 30 ft. in length. In such a design the economical depth of the stringer would be about the same as that of the floor beam. In common practice the floor beam would still be made deeper than the stringer to obtain simple details of connection between these members.

But conditions of grade and requirements of clearance below the bridge may make it necessary, in a measure, to disregard economy of material and simplicity of construction and erection to obtain designs that will meet all the requirements in special cases. Difficult conditions of grade under clearance, necessitating extreme shallowness of floor, are frequently encountered in crossings over streets and over other railways; and the type best adapted to any particular crossing must be determined by a careful study of the local conditions.

A crossing over another railway usually requires that the grades be carried above the normal grade of the line, with a through bridge over the railway at the apex of the grades. If the approach grades are long and heavy, the slightest reduction in the depth of the floor of the bridge means an appreciable reduction in the cost of the approaches. And—what may be of greater significance than the reduction of the cost of bridges and approaches—it means the reduction of grades that would be costly and otherwise objectionable, or practically impossible, from the standpoint of operation, where local conditions determine the limit of running out of the grade.

The files of the bridge department of the C. & N. W. contain the plans of a large number of bridges that have been designed to meet extreme conditions of clearance grade and curvature. A few of these designs have been selected, with special reference to shallowness of floor, as typical. Fig. 1 shows the floor details in the design of a double track through truss bridge of 170 ft. span, in which the depth of floor is 1 ft. 11 in. This bridge is designed for Cooper's Class E-50 locomotive; or a concentration of 60,000 lb. on each of two axles spaced 6 ft. 0 in. centre to centre.

The floor is of trough construction, the troughs being placed perpendicular to the axis of the bridge. Each trough carries a tie under each track, as shown in transverse section through troughs and floor beams in Fig. 1; the tie is supported at four points on horizontal angles riveted to the tops of diaphragms extending between the webs of the troughs. In every alternate trough, except those adjacent to the floor beam, special diaphragms are provided near the ends of the ties. To these diaphragms the ties are anchored by bolts

* A paper before the Western Society of Engineers, December 13th, 1911.