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# THE FILING OF ENGINEERING LITERATURE

## THE DEWEY DECIMAL SYSTEM OF CLASSIFICATION IN ENGINEERING AND ITS EXTENSION TO COVER MUNICIPAL ENGINEERING.

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In every engineering office there are catalogues, photographs, pamphlets, drawings, books, clippings, etc., which, to be of the greatest use, must be filed so as to be kept in order and yet to be easily accessible. In addition to such matter, the engineer should keep a list of references to articles in the engineering periodicals and in the proceedings of the engineering societies which are of particular interest to him.

The actual filing of such matter is probably best accomplished by the use of the familiar vertical system, and the index to the contents of the files is most conveniently kept on standard cards, 3 in. x 5 in. in size. Many systems of indexing have been devised which are more or less satisfactory. Any alphabetical system is open to the objection that it requires copious cross-indexing to make it of much value. The numerical systems are, therefore, the more popular, and justly so.

The Dewey decimal system, developed by Melvil Dewey, formerly director of the New York State Library, is probably the best of the numerical systems. It is in great favor with library workers and is used in the majority of the public libraries of the United States and Canada.

The following explanation of this system is based on that given in "An Extension of the Dewey Decimal System of Classification Applied to the Engineering Industries" by Breckenridge and Goodenough, of the Engineering Experiment Station of the University of Illinois at Urbana. This bulletin, as well as one giving a similar extension of the system to cover architecture and building, may be obtained from the Director of the station for a low price.

The essential characteristic of the Dewey system is its method of division and subdivision. The entire field

628.183(02)
H

Hazen, Allen.

Filtration of Public Water Supplies. 321+xii pp. Illust. John Wiley & Sons, New York, 3rd edition, 1903.

(Author Card)

628.183(02)
H

Filtration of Public Water Supplies.

Allen Hazen.

(Subject Card "a")

628.183(02)
H

Public Water Supplies, Filtration of.

Allen Hazen.

(Subject Card "b")

628.183(02)
H

Water Supplies, Filtration of Public.

Allen Hazen.

(Subject Card "c")

**Fig. 1.**

of knowledge is divided into nine chief classes numbered by the digits from 1 to 9. A tenth class for matter too general in nature to fall in any one of the other nine is numbered 0. The following are the primary classes:

| | |
|---|---|
| 0 General works. | 5 Natural sciences. |
| 1 Philosophy. | 6 Useful arts. |
| 2 Religion. | 7 Fine arts. |
| 3 Sociology. | 8 Literature. |
| 4 Philology. | 9 History. |

Each of these classes is again divided into nine divisions with a tenth for general matter, and each division is separated into nine sections. The sections are again subdivided, and the process may be carried as far as is desired. To show clearly the workings of the system, the divisions of Class 6 (useful arts) and the sections of Division 2 of this class (engineering) are given below:

| | |
|---|---|
| 600 Useful arts. | 620 Engineering. |
| 610 Medicine. | 621 Mechanical. |
| 620 Engineering. | 622 Mining. |
| 630 Agriculture. | 623 Military. |
| 640 Domestic science. | 624 Bridge and roof. |
| 650 Communication and commerce. | 625 Road and railway. |
| 660 Chemical technology. | 626 Canal. |
| 670 Manufactures | 627 River and harbor. |
| 680 Mechanic trades. | 628 Sanitary. |
| 690 Building. | 629 Other branches. |

It will be seen that the first digit gives the class; the second, the division; and the third, the section. Thus, 625 indicates Section 5 (road and railway engineering) of Division 2 (engineering) of Class 6 (useful arts). Further subdivision is indicated by the digits following the decimal point, which is placed as a matter of convenience after the section digit. For instance, 625.7 indicates highway engineering; 625.75, highway construction equipment; 625.753, highway consolidating machinery; 625,753.2, road rollers; 625.753.23, steam road rollers, and finally, 625.753.231, steam road rollers for macadam.

Following the classification list herein is the relative index, in which the terms of the classification are arranged alphabetically, each with its proper number. This index is manifestly incomplete, as it is impossible to include in it every subject that might come up in engineering practice. The skeleton is there, however, and the user may extend it further if he finds it advisable.

There are certain modifications in the use of the Dewey system. To avoid the writing of long numbers, a single letter may be used for the first three or four digits. Thus "H" might be used by a highway engineer in place of 625, "W" by a waterworks man in place of 628.1, and so forth.

Another modification consists in the use of an alphabetical arrangement for certain subsections where it is convenient, while retaining the decimal arrangement for the main divisions. For instance, under 625.821 (stone for macadam highways) the various varieties might be arranged alphabetically if desired. This is most useful where there are a large number of such minute divisions.

The use of "form divisions" is another useful modification. There are certain set forms, given on page 631, which are used throughout the range of the Dewey system. They may be still further extended thus:

064 Exhibits (under societies)
072 Laboratories (under universities)

They are usually enclosed in parentheses and annexed to the usual class number. Thus 62(07) indicates engineering education and 628.184(008) refers to patents regarding water sterilization and disinfection. If an engineer were particularly interested in patents, for example, he could reverse the usual manner of writing the class number and write it thus, (008)628.184, so that all the cards referring to patents would come together in his index.

Fig. 1 shows a set of cards for indexing a book or pamphlet and comprises both author and subject cards. These would be arranged alphabetically in the card drawers. To distinguish two cards having the same number, it is customary to write under the class number the initial or first two or three letters of the author's or publisher's name, though there are elaborate numerical lists published for this purpose.

625.892.212*

Gutter Construction for Streets and Road. T. Hugh Boorman. (Granite curbing and vitrified brick gutter.)

Canadian Engineer. Sept. 14, 1914. XXVII. 473.

625.892.22*

Gutter Construction for Streets and Roads. T. Hugh Boorman. (Standard type of combined concrete curb and gutter.)

Canadian Engineer. Sept. 14, 1914. XXVII. 473.

625.95*

Gutter Construction for Streets and Roads. T. Hugh Boorman. (Preparation of curb and gutter construction materials: concrete, asphalt, brick, wood or stone.)

Canadian Engineer. Sept. 14, 1914. XXVII. 473.

**Fig. 2.**

For references to articles in the engineering press, the writer uses the form shown in Fig. 2. These cards are arranged numerically in the drawers, and it is necessary to find the class number of subject under investigation before referring to them. This class number may be found in the relative index. The asterisk after the class number indicates that the article in question is in the writer's clipping file.

Three years' experience with the system outlined has convinced the writer that it is as near perfection as it is possible to get. It requires some intelligent attention to keep it in shape, but that is true of any system. It is hoped that the lists herein will be of value to city engineers, superintendents of waterworks, streets and sewers and others in municipal engineering work.

# Extension of the Dewey Decimal System of Classification to Cover Municipal Engineering.

**FORM DIVISIONS.**

01 Philosophy; theory.
02 Compends; text books; hand books; manuals.
03 Encyclopedias; dictionaries.
04 Essays; addresses.
05 Periodicals.
06 Societies.
07 Education; teaching; schools; colleges; universities.
08 Tables; diagrams; computations; tests; miscellanies.
09 History; progress; development.

001 Statistics; quantities.
002 Construction methods; costs.
003 Contracts; specifications.
004 Designs; drawings.
005 Executive; accounts; financial.
006 Working; maintenance.
007 Laws; rules; regulations; court decisions.
008 Patents.
009 Reports.

**CLASS NUMBERS.**

625.7 HIGHWAYS, ROADS AND STREETS.

.71 **Varieties.**
.711 Country roads.
.711.1 For heavy traffic; trunk highways.
.711.2 For medium traffic; inter-village roads.
.711.3 For light traffic.

.712 City streets.
.712.1 Thoroughfares.
.712.2 Minor streets.
.712.3 Streets for special purposes; motor roads; speedways.
.712.4 Alleys; lanes.
.712.5 Squares; public gardens.

.72 **Traffic.**
.721 Weight.
.722 Distribution.
.723 Effects.
.724 Censuses; counts.

.73 **Surveys and Designs.**
.731 Preliminary surveys; reconnaisances.
.732 Location surveys; staking out.
.733 Profiles.
.734 Curvature.
.734.1 Widening.
.734.2 Superelevation.

.74 **Features.**
.741 Alignment.
.742 Cross section.
.743 Crown.
.744 Slopes.
.745 Drainage.
.746 Accessories.
.746.1 Gutters; catch basins; gullies; inlets.
.746.2 Retaining walls; guard rails; parapets.
.746.3 Bridges; culverts.
.746.4 Milestones; signs; mirrors.
.746.5 Lighting; lamp posts.
.746.6 Other features.

.75 **Construction Equipment.**
.751 Excavating and grading machinery.
.751.1 Hand tools.
.751.2 Scrapers.
.751.3 Drags.
.751.4 Plows; scarifiers.
.751.5 Elevating graders.
.751.6 Trenching machinery.
.751.7 Power shovels.
.751.8 Other appliances.

.752 Hauling machinery.
.752.1 Wheelbarrows.
.752.2 Wagons; carts.
.752.3 Auto trucks.
.752.31 Steam.
.752.32 Gasoline.
.752.33 Electric.
.752.4 Cars.
.752.41 Dumping.
.752.42 Non-dumping.
.752.5 Locomotives.
.752.51 Steam.
.752.52 Gasoline; oil.
.752.53 Electric.
.752.54 Compressed air.
.752.6 Tractors.
.752.61 Steam.
.752.62 Gasoline or oil.
.752.7 Tractor wagons.
.752.8 Other machinery.

.753 Consolidating machinery.
.753.1 Tampers.
.753.11 Hand.
.753.12 Power.
.753.2 Rollers.
.753.21 Hand.
.753.22 Horse.
.753.23 Steam.
.753.231 Macadam.
.753.232 Asphalt.
.753.24 Gasoline or oil.
.753.241 Macadam.
.753.242 Asphalt.

.754 Quarrying and stone working machinery.
.754.1 Hand tools.
.754.2 Drills.
.754.3 Derricks.
.754.4 Cableways.
.754.5 Hoists.
.754.51 Hand.
.754.52 Horse.
.754.53 Steam.
.754.54 Gasoline or oil.
.754.55 Electric.
.754.56 Compressed air.
.754.6 Block splitters.
.754.7 Other appliances.

.755 Crushed stone, gravel and sand machinery.
.755.1 Hand tools.
.755.2 Crushers.
.755.21 Gyratory.
.755.22 Jaw.
.755.23 Rotary.
.755.24 Hammer or impact.
.755.3 Screens.
.755.31 Rotary.
.755.32 Shaking.
.755.33 Stationary.
.755.4 Washers.
.755.5 Heaters.
.755.6 Bins.
.755.7 Other appliances.

.756 Brick machinery.
.756.1 Clay mills.
.756.2 Brick machines.
.756.3 Dryers.
.756.4 Kilns.
.756.5 Other machinery.

.757 Concrete machinery.
.757.1 Mixers.
.757.11 Continuous.
.757.12 Batch.
.757.13 Gravity.
.757.2 Conveyers.
.757.21 Buggies; wheelbarrows.
.757.22 Buckets.
.757.23 Continuous; belts; pneumatic.
.757.3 Other appliances.

.758 Asphalt machinery.
.758.1 Hand tools.
.758.2 Mining appliances.
.758.3 Refinery appliances; stills; tanks.
.758.4 Hot mixers.
.758.5 Kettles; heaters.
.758.6 Other machinery.

.759 Wood block machinery.
.759.1 Hand tools.
.759.2 Special saws, etc.
.759.3 Dry kilns.
.759.4 Tanks.
.759.5 Treating cylinders.
.759.6 Pumps.
.759.7 Conveyers; transporters.
.759.8 Other appliances.

.76 **Maintenance.**
.761 Dragging; scraping.
.762 Rolling.
.763 Sprinkling.
.763.1 With water.
.763.2 With chemical solutions.
.764 Oiling; tarring.
.765 Treating with other materials.
.766 Sweeping.
.766.1 Patrol system.
.766.2 Horse or auto brooms.
.767 Vacuum cleaning.
.768 Flushing.
.768.1 With hose by hand.
.768.2 With horse or auto flushers.
.769 Miscellaneous methods of maintenance.
(For repairs, see under paving material in question).

.77 **Cultivation.**
.771 Tree planting
.771.1 Species.
.771.2 Arrangement.
.771.3 Care; maintenance.

.772 Boulevard space; parking.
.772.1 Lawns.
.772.2 Flower beds.

.773 Flower boxes.
.773.1 On electric light or trolley poles.

.78 **Sanitation.**

.79 **Other General Matter.**

625.8 PAVING MATERIALS.

.81 **Earth.**
.811 Sand-clay; top-soil.
.812 Gravel.
.813 Burnt-clay; ballast.
.814 Other earthy materials.

.82 **Macadam and Telford.**
.821 Stone.
.821.1 Trap.
.821.2 Limestone.
.821.3 Granite.
.821.4 Basalt.
.821.5 Porphyry.
.821.6 Other stones.

.83 **Stone Blocks.**
.831 Stone.
.831.1 Granite.
.831.2 Sandstone.
.831.3 Limestone.
.831.4 Basalt.
.831.5 Lava.
.831.6 Porphyry.
.831.7 Other stones.

.832 Joint fillers.
.832.1 Sand.
.832.2 Pitch; coal tar products.
.832.3 Asphalt.
.832.4 Cement grout.
.832.5 Wood.
.832.6 Other materials.

.84 **Brick.**
.841 Ordinary brick.
.842 Vitrified brick.
.843 Vitrified block.
.844 Scoria block.
.845 Other similar materials.
(For jointing materials see under 625.832 above).

.85 **Wood Block.**
.851 Wood.
.851.1 Yellow pine.
.851.2 British Columbia or Oregon fir.
.851.3 Norway deal.
.851.4 Jarrah.
.851.5 Karri.
.851.6 Other woods.

.852 Preservation.
.852.1 Creosoting.
.852.2 Kyanizing.
(For jointing materials see under 625.832 above).

.86 **Concrete.**
.861 Cement.
.862 Sand.
.863 Gravel.
.864 Crushed stone.
.865 Water.
866 Joints.
.866.1 Protection devices.

.867 Surfacing materials.
.867.1 Asphalt.
.867.2 Coal tar products.
.867.3 Mortar; granolithic.
.867.4 Other materials.

.868 Reinforcement.
.868.1 Bars.
.868.2 Fabric.

.87 **Asphalt and Bituminous Macadam**
.871 Asphalt.
.871.1 For sheet asphalt.
.871.2 For asphalt blocks.
.871.3 For mixing method.
.871.4 For penetration method.

.872 Coal tar products.
.872.1 For mixing method.
.872.2 For penetration method.
.873 Fluxes.
.874 Crushed stone.
.875 Gravel.
.876 Sand.

.88 **Other Paving Materials.**
.881 Shells.
.882 Slag.
.883 Cinders.
.884 Other materials.

.89 **Sidewalks and Curbing.**
.891 Sidewalks; crosswalks.
.891.1 Arrangement.
.891.11 Slope.
.891.12 Grade.
.891.13 Width.
.891.14 Position.
.891.2 Materials.
.891.21 Earth; gravel; cinders.
.891.22 Wood.
.891.23 Brick; tile.
.891.24 Stone; flagging.
.891.25 Concrete; artificial stone flags.
.891.26 Asphalt; coal tar products.
.891.27 Other materials.

.892 Curbing.
.892.1 Arrangement.
.892.11 Size.
.892.12 Shape.
.892.2 Materials.
.892.21 Stone.
.892.211 Limestone.
.892.212 Granite.
.892.213 Sandstone.
.892.214 Other stones.
.892.22 Concrete.
.892.221 Corner protection.
.892.222 Reinforcement.
.892.23 Wood.
.892.24 Vitrified clay.
.892.25 Other materials.

625.9 CONSTRUCTION.
.91 **Subgrade.**
.911 Excavation.
.912 Consolidation.
.913 Ditching and drainage.

.92 **Foundation.**
.921 Preparing material.
.921.1 Telford.
.921.2 Macadam.
.921.3 Concrete.
.921.4 Other materials.
(For methods of mixing, placing, spreading, consolidating, etc., see under 625.942 and 625.945, and so forth).

.93 **Cushion.**
.931 Sand.
.932 Mortar.
.933 Other materials.

.94 **Wearing Surface.**
.941 Earth.
.941.1 Gravel.
.941.2 Sand-clay; top-soil.
.941.3 Burnt-clay; ballast.
.941.4 Other earthy materials.
1 Spreading; 2 Shaping; 3 Rolling; tamping; 4 Finishing.

.942 Macadam; telford.
.942.1 Spreading stone.
.942.2 Consolidating.
.942.3 Sprinkling.
.942.4 Accessory construction.

.943 Block paving; stone; brick; wood block; asphalt block.
.943.1 Distributing blocks.
.943.2 Placing blocks.
.943.3 Consolidating blocks.
.943.4 Jointing blocks.

.944 Asphalt; bituminous macadam.
.944.1 Mixing material.
.944.2 Distributing material.
.944.3 Consolidating material.
.944.4 Sprinkling with oil, tar or asphalt.

.945 Concrete.
.945.1 Mixing materials.
.945.2 Distributing materials.
.945.3 Consolidating materials.

.946 Other kinds of paving.

.95 **Sidewalks and Curbing.**
.951 Preparing materials.
.952 Placing.
.953 Jointing.
.954 Other operations.

.96 **Street Railways.**
.961 Preparing the foundation.
.962 Laying the track.
.963 Paving between and adjacent to rails.

628. **SANITARY ENGINEERING.**
628.1 WATER SUPPLY.
.11 **Sources of Supply.**
.111 Lakes and ponds.
.111.1 Quality.
.111.11 Physical.
.111.12 Chemical.
.111.13 Bacteriological.
.111.14 Protection of quality; prevention of pollution.
.111.15 Other data.

.112 Flowing streams; rivers; brooks; creeks; impounding reservoirs.
.112.1 Quality.
.112.11 Physical.
.112.12 Chemical.
.112.13 Bacteriological.
.112.14 Protection of quality; prevention of pollution.
.112.15 Other data.

.113 Underground waters; springs; wells; galleries.
.113.1 Quality.
.113.11 Physical.
.113.12 Chemical.
.113.13 Bacteriological.
.113.14 Protection of quality; prevention of pollution.
.113.15 Other data.
.114 Yield.
.114.1 Rainfall.
.114.11 Amount.
.114.12 Rate.
.114.13 Distribution.
.114.14 Other data.
.114.2 Evaporation.
.114.21 From land area.
.114.22 From water surface.
.114.23 Other data.
.114.3 Percolation.
.114.4 Runoff.
.114.5 Underground waters.
.114.51 Pumping tests.
.114.6 Other data on yield.

.115 Consumption.
.115.1 Domestic.
.115.11 Amount.
.115.12 Variation.
.115.13 Other data.
.115.2 Industrial.
.115.21 Amount.
.115.22 Variation.
.115.23 Other data.
.115.3 Public (except fire).
.115.31 Amount.
.115.32 Variation.
.115.33 Other data.
.115.4 Fire protection.
.115.41 Amount.
.115.42 Other data.
.115.5 Waste.
.115.51 Amount.
.115.52 Detection.
.115.521 By inspection.
.115.522 By metering.
.115.523 By Deacon meter.
.115.524 By pitometer.
.115.525 By pulsograph.
.115.526 By other methods.
.115.53 Prevention.
.115.531 By inspection.
.115.532 By metering.
.115.533 By other methods.
.115.6 Total consumption.
.115.61 Quantity.
.115.62 Variation.
.115.621 Hourly.
.115.622 Daily.
.115.623 Weekly.
.115.624 Monthly; seasonal.
.115.625 Annual.
.115.63 Other data.

.116 Pressure.
.116.1 For domestic use.
.116.2 For industrial use.
.116.3 For public use.
.116.4 For fire protection.
.116.5 For other purposes.
.116.6 Gauges.
.116.61 Indicating.
.116.62 Recording.
.116.7 Other data.

.12 **Hydraulics.**
.121 Of canals; conduits; pipe lines.
.122 Of fire streams; hose; nozzles.
.123 Of distribution system.
.124 Of pumping machinery.

.125 Measuring devices.
.125.1 Weirs.
.125.2 Orifices.
.125.3 Meters.
.125.4 Pitometers; pitot tubes.
.125.5 Other devices.

.126 Other hydraulic questions.

.13 **Collection of Water.**
.131 Impounding reservoirs.
.131.1 Dams.
.131.11 Earth.
.131.12 Rock fill.
.131.13 Masonry; concrete.
.131.14 Wood.
.131.15 Steel.
.131.16 Other materials.
.131.2 Outlets.
.131.21 Tunnels.
.131.22 Towers.
.131.23 Other devices.

.132 Diversion.
.132.1 Dams.
.132.11 Earth.
.132.12 Rock fill.
.132.13 Masonry; concrete.
.132.14 Wood.
.132.15 Steel.
.132.16 Other materials.

.133 Underground water collection.
.133.1 Wells.
.133.11 Shallow.
.133.111 Large open.
.133.112 Driven.
.133.12 Deep.
.133.2 Springs.
.133.21 Spring basins.
.133.3 Galleries.
.133.4 Other devices.
.134 Other adjuncts.

.14 **Pumping.**
.141 Intakes.
.141.1 Cribs.
.141.2 Towers.
.141.3 Screens.
.141.4 Other devices.
.142 Suction wells.
.143 Steam plant.
.143.1 Boilers.
.143.11 Fire tube.
.143.12 Water tube.
.143.13 Other types.
.143.2 Fuel handling machinery.
.143.21 Cars.
.143.22 Trolleys.
.143.23 Conveyers.
.143.3 Chimneys.
.143.4 Forced and induced draft apparatus.
.143.5 Feed pumps.
.143.6 Condensers.
.143.61 Surface.
.143.62 Jet.
.143.63 Barometric.
.143.64 Air pumps and auxiliaries.
.143.7 Engines.
.143.71 Reciprocating.
.143.711 Low speed.
.143.712 High speed.
.143.713 Turbines.
.143.713.1 Impulse.
.143.713.2 Reaction.
.143.8 Piping.
.143.9 Miscellaneous appliances.

.144 Water power plant.
.144.1 Turbines.
.144.2 Pelton wheels.
.144.3 Overshot wheels.
.144.4 Governors.
.144.5 Other devices.

.145 Gas plant.
.145.1 Producers.
.145.2 Purifiers.
.145.3 Gasometers.
.145.4 Engines.
.145.5 Other appliances.

.146 Electric plant.
.146.1 Generators.
.146.11 Direct current.
.146.12 Alternating current.
.146.2 Switch gear.
.146.3 Transformers.
.146.4 Transmission line.
.146.5 Motors.
.146.51 Direct current.
.146.52 Alternating current.
.146.6 Other appliances.

.147 Compressed air plant.
.147.1 Compressors.
.147.2 Storage tanks.
.147.3 Pipe lines.
.147.4 Other appliances.

.148 Pumps.
.148.1 Reciprocating.
.148.11 Steam.
.148.12 Hydraulic.
.148.13 Power.
.148.2 Rotary.
.148.3 Centrifugal.
.148.4 Pneumatic.
.148.41 Displacement.
.148.42 Air lift.
.148.5 Gas.
.148.51 Humphrey.
.148.6 Other varieties.

.15 **Storage and Service Reservoirs.**
.151 Surveys; design.
.152 Surface.
.152.1 Earth.
.152.11 Open.
.152.12 Covered.
.152.2 Masonry; concrete.
.152.21 Open.
.152.22 Covered.

.153 Elevated.
.153.1 Tanks.
.153.11 Wood.
.153.12 Iron; steel.
.153.13 Masonry; concrete.
.153.14 Other materials.
.153.2 Standpipes.
.153.21 Wood.
.153.22 Iron; steel.
.153.23 Masonry; concrete.
.153.24 Other materials.

.154 Adjuncts.
.154.1 Inlets.
.154.2 Outlets.
.154.3 Overflows.
.154.4 Drains.
.154.5 Regulators; automatic valves.
.154.6 Other devices.

.16 **Canals, Conduits and Aqueducts.**
.161 Surveys; designs.
.162 Open canals.
.162.1 Unlined.
.162.2 Lined.
.162.3 Flumes.
.162.31 Wood.
.162.32 Metal.
.162.33 Other materials.

.163 Closed conduits.
.163.1 Tunnels.
.163.11 Unlined.
.163.12 Lined.
.163.2 Aqueducts.
.163.21 Stone; brick.
.163.22 Concrete.
.163.3 Pipe lines.
.163.31 Wood.
.163.32 Iron; steel.
.163.33 Other materials.
(For mains and services, see 628.17 below).

.164 Adjuncts.
.164.1 Gates; valves.
.164.2 Relief valves.
.164.3 Air valves.
.164.31 Inlet.
.164.32 Outlet.
.164.4 Blowoffs; drains.
.164.5 Other adjuncts.

.17 **Mains and Services.**
.171 Surveys; designs.
.172 Mains.
.172.1 Cast iron.
.172.2 Wrought iron; steel.
.172.21 Seamless.
.172.22 Welded.
.172.23 Rivetted.
.172.24 Lock bar.
.172.25 Other types.
.172.3 Wood.
.172.31 Bored.
.172.32 Stave.
.172.4 Other forms of mains.

.173 Joints.
.173.1 Turned and bored.
.173.2 Flanged and bolted.
.173.3 Leaded.
.173.31 Poured.
.173.32 Lead wool.
.173.4 Wood wedges.
.173.5 Leadite.
.173.6 Other materials.

.174 Coatings.
.174.1 Angus Smith solution.
.174.2 Asphaltic preparations.
.174.3 Jute wrapping.
.174.4 Other methods.
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# Relative Index for the Dewey Decimal System of Classification to Cover Municipal Engineering.

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## C.

# MAIN PEDESTALS, QUEBEC BRIDGE

## NOTES ON THE DESIGN OF THE FOUR 400-TON SHOES TO TRANSFER THE LOAD FROM THE CANTILEVER AND ANCHOR ARMS TO THE MAIN PIERS—METHOD OF FABRICATION AND ASSEMBLAGE.

By H. P. BORDEN,
Assistant to Chief Engineer, Quebec Bridge.

Each of the four main shoes of the new Quebec Bridge are designed to transfer the following loads:

| | |
|---|---|
| Main vertical post .................... | 26,600,000 lbs. |
| Cantilever arm chord ................ | 29,600,000 lbs. |
| Anchor arm chord .................... | 24,100,000 lbs. |
| Cantilever arm Compression diagonal ... | 7,820,000 lbs. |
| Anchor arm compression diagonal ...... | 7,810,000 lbs. |

Resolving the above, this pedestal supports a maximum vertical and horizontal reaction of 55,000,000 and 32,000,000 lbs. respectively. Owing to the unprecedented size of the members required to transfer these loads to the shoe and the necessarily unusual proportions of the shoe itself which is required to distribute these loads to the masonry, the design of this member probably entailed more investigation and study than any other single detail in connection with the bridge.

The shoe is 26 ft. 4 in. x 20 ft. 10 in. at the base and 19 ft. high. To facilitate fabrication, shipping and erection, it is constructed in three stories. The lower story, or base, is 4 ft. high and is composed of 4 steel castings. These castings probably constitute a record for weight and size of steel castings in Canada, weighing over 40 tons each. These members have webs and flanges ranging from 2½ in. to 3 in. in thickness, the webs being supported by cross diaphragm walls of the same thickness, at frequent intervals. These castings are planed on a machine designed especially for this purpose, great care being taken to get a uniform depth for each of the 4 castings. When erected in place they are bolted together with 2½-in. bolts through exterior flanges, thus forming a base through which the vertical and horizontal reactions from the upper portions of the shore are transmitted to the masonry. The horizontal reactions at the

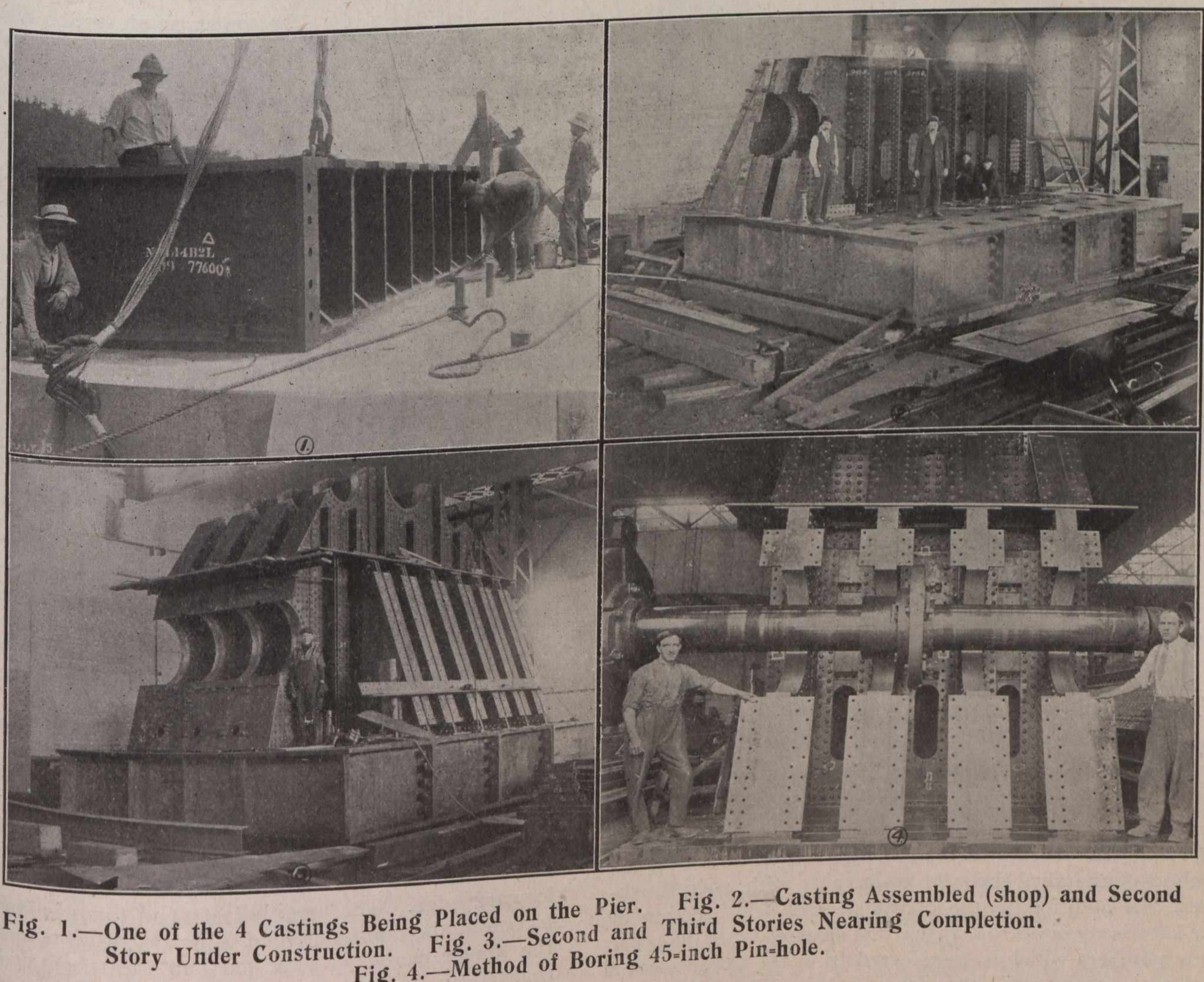


Fig. 1.—One of the 4 Castings Being Placed on the Pier. Fig. 2.—Casting Assembled (shop) and Second Story Under Construction. Fig. 3.—Second and Third Stories Nearing Completion. Fig. 4.—Method of Boring 45-inch Pin-hole.

pier can in every case be taken care of by the 30% coefficient of friction assumed between steel and masonry, but an additional factor of safety is provided by 44 3-in. anchor bolts and dowels. The dowels in the interior of the castings are grouted into the masonry and embedded in concrete with which the casting will be filled. The anchor bolts through the exterior lower flanges of the castings are grouted into the masonry with cement, that portion of bolt passing through the steel flange being grouted with molten zinc.

The middle section of the shoe is of built-up construction and is field-riveted to the lower section. This portion of the member is 10 ft. high and is composed mainly of 4 heavy webs which correspond to the webs of the bottom chords. The chord stresses are transmitted direct to this section of the shoe through 30-in. pins with 45-in. bushings. In addition to the chord stresses, this section of the shoe is required to transmit the stresses from the other web members which is transferred from the upper section and as a consequence the webs of the middle section become very heavy, the maximum thickness at the pin being 9¼ in., requiring a 1⅛-in. rivet 12 in. long. The loads distributed upon these webs are transferred uniformly to the base by means of 7 heavy brackets on each side, field riveted to both webs and castings. It was found when designing the connections between brackets and webs that the largest angles rolled would not provide sufficient rivet area to transmit the vertical shear. As a result, special connection-angles with 12-in. legs were manufactured from 1-in. plates. While it is expected that this design will undoubtedly to a large extent distribute the loads uniformly over the lower section, yet the contingencies of fabrication and erection are such that the actual results might not correspond to the theoretical expectations. To provide against the possibility of the load on the centre webs not distributing as expected, the steel castings on the base have been made sufficiently strong to distribute any such concentrated loading. The connection plates for the main bottom laterals are field riveted to the top and bottom of this section. When it is understood that these laterals have an inclination in both the vertical and horizontal plane and the face of the shoe to which they are connected is sloped at another angle in the vertical plane, it speaks well for the accuracy of the shop work that the connection holes in all these parts matched exactly when the shoe came to be assembled.

The top or third section contains one 45-in. and two 30-in. half-pin holes which take the bushing for the 30- and 20-in. pins of the main post and diagonal compression members respectively. This section has 4 main webs which correspond to the 4 webs of the web members and post as well as the webs of the second section immediately below. In order to uniformly distribute the reaction, brackets are connected to the sides of the outer webs, spaced to correspond to the lower brackets. This top section is braced by very heavy brackets and diaphragms so that, assuming the whole shoe to act as a girder, transversely, the top and bottom stories will act as the flanges and the middle story as the web.

The maximum vertical loads on the shoe result in a uniform bearing of 660 lbs. per sq. in. on the granite masonry of the pier. This reaction comes from dead load, live load, impact, traction and vertical wind. In addition to the above there are transverse and longitudinal wind loads of 1,300,000 and 6,200,000 lbs. respectively. The transverse force is the horizontal component of the wind forces carried to the shoe by the lateral bracing and chords, and results in an increased toe pressure at the leeward edge. The longitudinal wind force is due to a torque at the main pier, due to normal wind pressure on the longer cantilever arm and half the suspended span resisted by the shorter anchor arm. This action results in equal and opposite reaction on the windward and leeward shoes on the main pier in a direction parallel to the longitudinal axis of the bridge. This longitudinal reaction is resisted by the friction between the steel castings and the masonry. As these castings are narrow in this direction, there is an overturning moment which is assumed to act on each casting individually and not on the entire base as a whole, which results in a very short lever

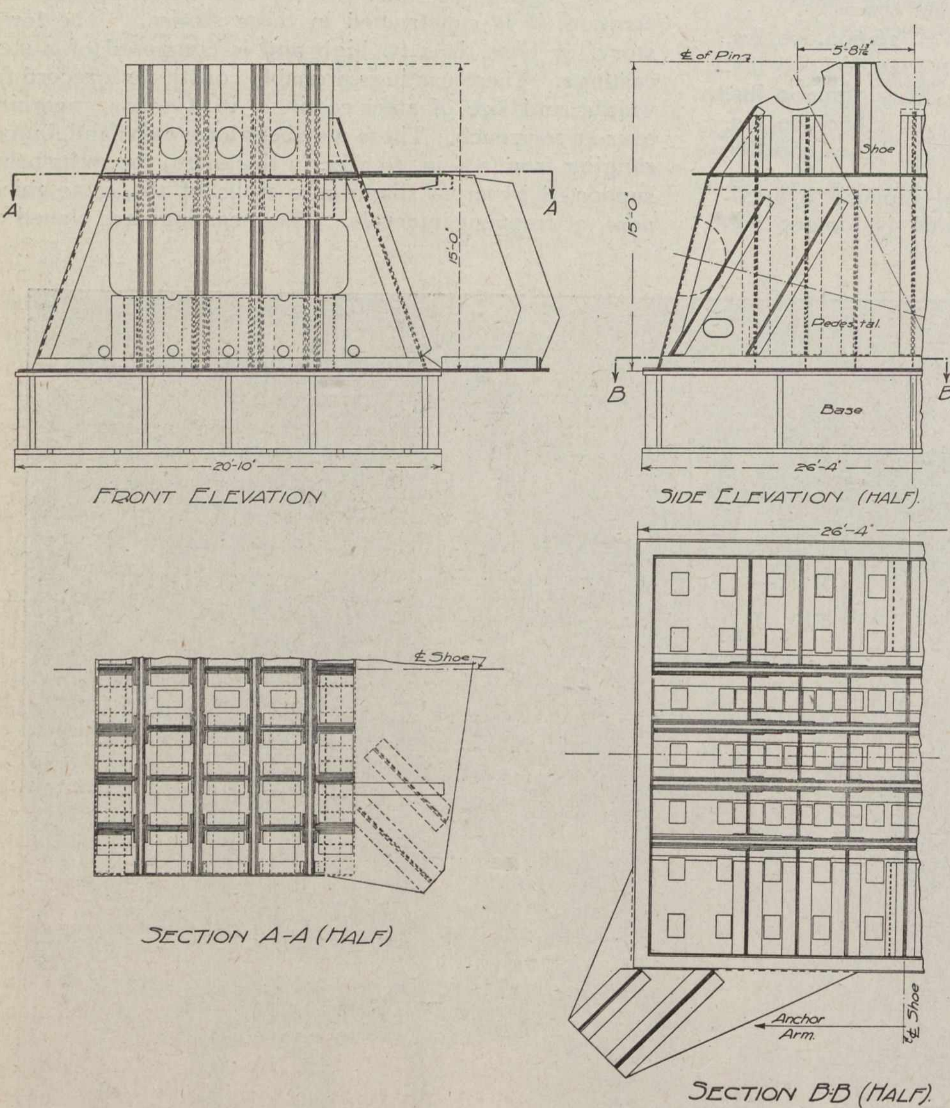



**Fig. 5.—Elevations and Sections of Shoe for Main Pier Bearing.**

arm as compared with that used in determining the toe pressure from the transverse wind force acting at right angles. Certain allowances are made for the fact that the castings are riveted to the middle section, but even with this allowance there is a very appreciable increase in the pressure at the edges of the castings. Under such maximum conditions and assumptions, it is found that the maximum toe pressure amounts to 915 lbs. per sq. in. for all loads.

In all these calculations the following wind loads have been assumed: A wind load of 30 lbs. per sq. ft. of exposed surface of two trusses and 1½ times the eleva-

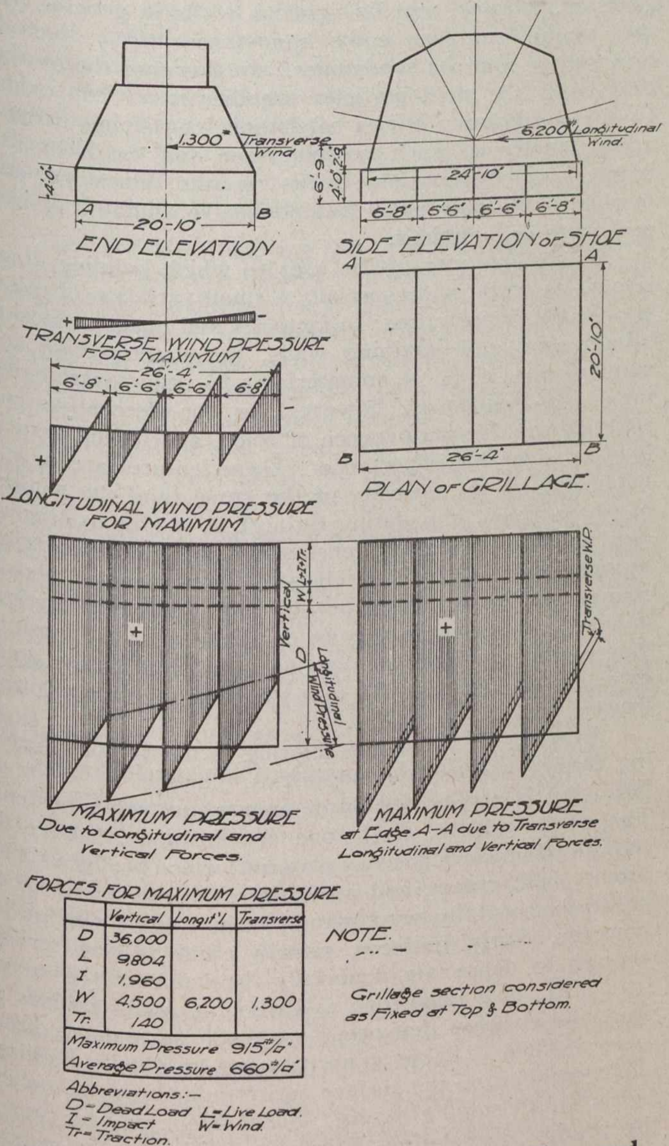



**Fig. 6.—Diagram of Pressure Between Shoe and Masonry.**

tion of the floor and 300 lbs. per lin. ft. on the exposed surface of a train covering the whole bridge applied 9 ft. above base of rail.

After the various parts of the shoe have been fabricated in the shop it is entirely assembled on concrete and steel skids and all field connections are reamed out in place or to a steel template. All loose parts are match-marked with stencil and steel dies and all important centre lines chisel-marked on abutting faces. It is then taken down and the main sections re-assembled on the bed of the boring mill, and after having been accurately lined up with field level, transit and other special mechanical appliances, the five holes are bored at one setting. When this operation has been completed the shoe is again taken apart for shipment, the lower base being shipped in four sections, the middle in two main sections, and the top in one. When completed, each shoe weighs about 440 tons. The exterior faces of the middle section are covered with facia plates to give a finished appearance. These plates, as well as all diaphragms and top flange of castings, are provided with manholes, thus providing access to all parts of the shoe for riveting, inspection and painting. In order to prevent rain water settling in the interior, the shoe is partially filled with concrete which is sloped from the centre towards the sides, thus allowing all water to drain out through the holes in the facia plates.

In Fig. 1 is shown one of the four steel castings forming the lower story. It is being placed on the main pier. A thin grout is brushed over the masonry rest before the casting is put in place. The castings are assembled as shown in Fig. 2, which is a shop view showing erection on skids, and a start made on the erection of the middle section of the shoe. In Fig. 3 the second and third

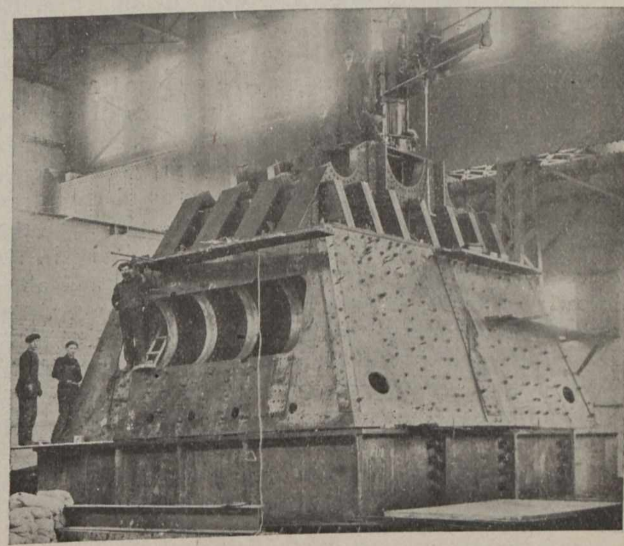


**Fig. 7.—View of a Pedestal, Completely Assembled.**

stories are shown nearing completion, the side brackets on the middle section being put in place for reaming. Fig. 4 shows an end view of the middle section and illustrates the method of boring the 45-inch pin-holes.

A general view of the completely assembled shoe is given in Fig. 7. The second story has its covering of facia plates. Every hole is reamed or drilled from the solid before being taken apart. It takes about 2 months to assemble, ream and bore this shoe in the shop, not including the time required for fabrication.

## TORONTO HARBOR COMMISSIONERS TO CONTINUE WORK.

Although the early formation of ice on the bay will seriously interfere with their work along the waterfront, the Toronto Harbor Commissioners have made a careful survey of the territory under construction and are picking out the portions of the work that can be continued during the winter, in order to give employment to as many men as possible. A considerable portion of this work will consist of grading operations along the waterfront.

## POROSITY OF BUILDING STONE.*

By D. G. Campbell, M.E.

THE quality of a building stone depends upon a number of factors, of which the following are more directly influenced by the porosity or water contents: strength, color, mechanical disintegration by climatic agencies, and rate of chemical decay.

Porosity in itself has small effect in determining relative qualities of building stones. That is, stones may vary in percentage of pore space from 0.5 up to 20 or 25%, and yet, other things being equal, these extremes may not show great variation in strength. The important point in connection with porosity, however, is the *size* of the individual pores.

Sandstones are the least compact of the stones used largely for building; and their porosity ranges up to 28% of the total volume, which is near the theoretical maximum. Such rock, when exposed to water, will absorb large quantities, and is equally capable of releasing it by evaporation. Moreover, it is difficult completely to fill the pores of such a stone with water. Stones of which the pores are very fine are slow to give up their contained water; if this be then expanded by frost, such stone is gradually weakened and disintegrated. It is by reason of this fact that sandstones may be quarried and laid in freezing weather without injury, whereas fine-grained stones are likely to be seriously injured by such treatment.

Limestones and marbles have much less pore space than sandstones, ranging from 1 up to as much as 10%; while in granite the pore space is less than 1%. In these stones, the pores are capillary or sub-capillary in size. Hence, such stones absorb but little water, and absorb it slowly; once in, it is equally hard to get out. When such a stone, saturated with water, is exposed to a hard frost, freezing expands the pores, and by breaking the union of the interlocked grains weakens the structure. Stones of such fine-pored character are injured by being quarried in cold weather, for the small percentage of "residual water" cannot then escape readily, and may repeatedly freeze and thaw in the stone, before evaporating, thus increasing the destructive effect.

This distinction applies only to true porosity; for if a stone be laminated, water filling the spaces between the bedding planes may do a great deal of damage. Hence the rapid disintegration of inferior, shaly sandstones under severe climatic conditions.

If limestone and marble be thoroughly seasoned before being used, their small ratio of porosity, and fine pores, are great advantages, contributing much to their durability (*Merrill*). This is because the sub-capillary pores absorb water with extreme slowness and difficulty. Hence, it would seem inadvisable to employ marble or compact limestone where it would be exposed to dampness combined with extremes of temperature. The following table (*Buckley*) gives the ranges in loss of strength suffered by various samples of building stones due to alternations of freezing and thawing for 35 days:

**Loss of Strength by Freezing and Thawing.**

| Rock. | Orig. strength, lb. per sq. in. | Loss of strength, lb. per sq. in. | Loss, % |
|---|---|---|---|
| Granite ....... | 24,300 | 8,210 | 32 |
| " ....... | 34,600 | 2,800 | 8 |
| Limestone ..... | 30,680 | 13,675 | 44 |
| " ..... | 8,100 | 570 | 7 |
| Sandstone ..... | 4,170 | 1,950 | 46 |
| " ..... | 5,330 | 930 | 17 |

*From the School of Mines Quarterly, Columbia University.

**Life of Building Stone.** (*Julien*).

| | | |
|---|---|---|
| Coarse brownstone .................. | 5 to 15 | years |
| Fine laminated brownstone ........... | 20 to 50 | " |
| Coarse fossiliferous limestone ......... | 20 to 40 | " |
| Coarse dolomitic marble ............. | 40 | " |
| Fine-grained marble .................. | 50 to 100 | " |
| Granite ............................ | 75 to 200 | " |
| Quartzite .......................... | 75 to 200 | " |

The color of a building stone may be due to one or all of three factors: inherent color of the minerals composing the rock; material that acts as a binder to hold the rock particles together; foreign matter and impurities. As examples of the first may be mentioned granites, gneisses, diorites, and the igneous rocks in general. In the second category come sandstones mainly, such as brownstone and red sandstones. In this case the cement that holds the sand particles together is an iron oxide. In the third group comes sandstones containing carbonaceous material, such as bluestone and the like; also igneous and metamorphic rocks, granite, limestone, and marble, containing small but noticeable amounts of iron carbonate or sulphides.

In the majority of the uses to which building stone is put, its color, and especially a small variation of color, is of slight importance. In factories and business blocks, breakwaters and retaining walls, for street paving and similar uses, color is immaterial. In ornamental buildings and residences, however, or for decorative and artistic uses, the permanence of color, and its uniformity, is of considerable importance. These features are largely influenced by the porosity of the stone, and the amount of water which, percolating through it, is able to dissolve mechanically or change chemically the color-producing ingredients. In the first class of rocks named above, change of color is effected only by alteration of the original minerals; this change may be complete after the lapse of long periods of time, but does not take place to any great extent in the ordinary life of a structure or piece of ornamental work.

In rocks of which the coloring is due to, or affected by, foreign matter and impurities, change of color or bleaching is accelerated by dampness and water content. The sedimentaries, sandstone for instance, frequently contain much carbonaceous material, which produces blue, brown, buff, cream, and other tints. These may fade or be washed out by percolating water. This change is, however, fairly uniform, usually, and is not serious enough to depreciate materially the value of the stone.

With such impurities as carbonate and sulphides of iron, the changes that occur are much more marked and objectionable. These impurities are gradually oxidized and deposited on the surface as irregular brown blotches, or as long dripping stains. Such result may be caused by gradual percolation of iron impurities in the cement and mortar used in construction, or in the material of the backwall. This objectionable condition is most frequently met in limestones and some marbles, occasionally in granite; it greatly reduces the value, if it does not completely prohibit a stone so affected from being used for ornamental purposes where it is exposed to moisture.

In such rocks as red sandstones and brownstone, there is much iron present in the form of oxide, serving as a cement to bind the particles of sand together. In this case no appreciable alteration of color is to be feared.

Besides the staining or bleaching produced by the oxidation of carbonate and sulphides of iron, a serious chemical effect is sometimes noted. This is due to the action of sulphurous and sulphuric acids released by this decomposition, which dissolve calcium carbonate, and deposit an incrustation of calcium sulphate on the surface of the stone. If the quantity of such impurities be large, this may be a source of serious weakening. Artificial stones and concretes have been made from rock and slags carrying a large percentage of iron, and they were either seriously decomposed or completely disintegrated within a few years.

Again, when a stone is subject to the action of running water, or water under pressure, or especially both together, the calcium carbonate contents of the stone must be kept low. Water containing even slight amounts of carbon dioxide is an excellent solvent for that mineral, and not only wears it away on the surface, but, seeping through, is likely to honey-comb it so as to render it useless. An instance is noted where, in an English aqueduct, limestone was used in the construction, and in a few years the leakage through honey-combing had assumed serious proportions. Rocks composed of or bound together by siliceous material are not noticeably affected this way, as silica is insoluble in ordinary surface water.

The minerals composing the igneous rocks, as granite and rhyolite, are also subject to alteration and decay, but this proceeds so slowly that it is seldom apparent in the ordinary lifetime of a structure. Quartz and feldspar are the principal minerals. The former does not change at all, the latter very slowly under the influence of weather-weathering. The accessory minerals, mica, pyroxene, amphibole, and olivine sometimes accur in considerable proportions. These decay by oxidation and hydration much more rapidly and, especially if rich in iron, may cause trouble. If the stone contain many minute fractures, this weakening may be intensified, due to the fact that the products of alteration, serpentine, talc, chlorite, and the like, forming in thin, slippery layers and scales, make an excellent lubricant to aid any severe stress or shock in rupturing the stone. For this reason, stones rich in crystal micas, amphiboles, and pyroxenes, greenstone for instance, are usually viewed with disfavor.

To summarize the foregoing, it may be said that:

(1) The strongest and most enduring rocks have the least porosity; granites and gneisses less than 1%, limestones up to 10%, sandstones up to 20%. (This is ascribed to the comparative value of the binding material, silica, calcium carbonate, and iron oxide, respectively, the relative value of these as binding agents being (*Buckley*) in the order named.)

(2) Of unseasoned stones, those having large pores, as the sandstones, are less likely to be injured by freezing than those having sub-capillary pores.

(3) Water seeping through porous rocks usually bleaches and carries away color-forming impurities, and these may be deposited on the surface in the form of incrustations and stains.

(4) A porous stone possessing calcareous ingredients, on exposure to running water or to water under pressure, is likely soon to become honey-combed and to disintegrate.

(5) The accessory minerals of igneous rocks are also subject to slow alteration by oxidation and hydration, and if present in large quantities, may prove a source of weakness.

The MacArthur Concrete Pile & Foundation Company has sold the patent rights to drive the pedestal pile in Japan to the Oriental Compressol Company, of Tokio, Japan.

## THE "FALL INCREASER" FOR LOW WATER FALLS.

By Clemens Herschel,

Civil and Hydraulic Engineer, New York City.

WITH the exhaustion of the available high falls for power purposes, the low falls will necessarily attract more attention than hitherto, from the builders of such plants. These last-named power sites frequently suffer materially from "back-water," in addition to the inroads made upon their annual output of power by low water.

A remedy for both of these power abatements lies, of course, in the use of auxiliary heat engines, but the use of these, means an increase of cost per kilowatt hour during the time of their running, and of the average cost per kilowatt hour during the year. Against low water inroads there is no other remedy; but against back-water power losses the use of the fall increaser offers a remedy that costs less in many cases than burning the fuel needed for generating the same power; that is to say, costs less than to run heat engines installed for the purpose of increasing the output of power during times of low water.

The fall increaser was invented in 1907, in the course of a competition for a power house design for Geneva, Switzerland, in which the competitors were especially invited to provide means for increasing the fall acting on the turbines during the times when, by reason of an over-abundant water supply, the fall shall have been diminished. In the case named, the dam was to have consisted merely of "Stoney" gates; with the head water level nigh constant; so that the fall was expected to vary from 43 ft. down to 26 ft. This power house has not yet been commenced, but by the use of fall increasers, and by letting the freshet water pass through them, instead of allowing it to waste away under the Stoney gates, a suction could be exercised at the outlet of the turbine draft-tubes, that would keep the fall at 43 ft., and maintain the full power output some of the time of back-water, and at very nearly full power output, (when there is not enough freshet water to operate all of the fall increasers) the rest of the time.

Since 1907, the fall increaser has been tested at the Holyoke, Mass., Public Testing Flume; so that designs for it, and computations showing just what it will accomplish in any given case, can now be made with precision. A full account of these tests was published in the Harvard Engineering Journal, of June, 1908, and from this record it appears that the "operating water" (freshet water used) was as much as 14 sec.-ft.; the "water lifted" (turbine discharge) 7 sec.ft.; the "operating head" (natural head) was up to 14.35 ft.; the "head gained by the use of the fall increaser," up to 12.52 ft.; the fall increaser penstock, 16 inches in diameter; not mere "laboratory experiments," as anyone can see.

Similar experiments were made thereafter by one Dübi, in Zürich, Switzerland, the results published in book form, and they, naturally, have confirmed the results of the Holyoke tests. It thus only remains now to apply the fall increaser in actual practice.

That this has not already been done, need surprise no one. It is accounted for from the fact that 10 years or more are not infrequently needed to overcome the inertia, business jealousies, misconception of, and lack of appreciation with which new ideas of this sort are generally treated. It was thus with the Venturi water meter, a first cousin of the fall increaser, 6,000 or 7,000 of which are now in use the world over, though it was 10 years before anyone would use it, except its inventor.

The fact that the fall increaser is only of limited application, and cannot practically be added to a plant already in operation (it must be built into the foundations of the power house) has also much to do with the delay, up to date, of its use in operation.

Its value at any mill site depends on the regime of the river; whether there is back-water, to a material extent, and during enough days in the year.

The situation must also be such as to permit of the conveyance of the freshet water to be utilized to the fall increaser inlets; no long head-race canal.

The writer of this has had cases in which the estimated additional first cost for putting in fall increasers would be returned in value of the *additional* kilowatt hours produced in one average year, or less; and from that the situation ranges up to periods and measurements of back-water so small that it does not pay to build fall increasers; even though first cost is paid but once (operation and maintenance are merely nominal), while the average additional kilowatt hours produced are produced and gained every year.

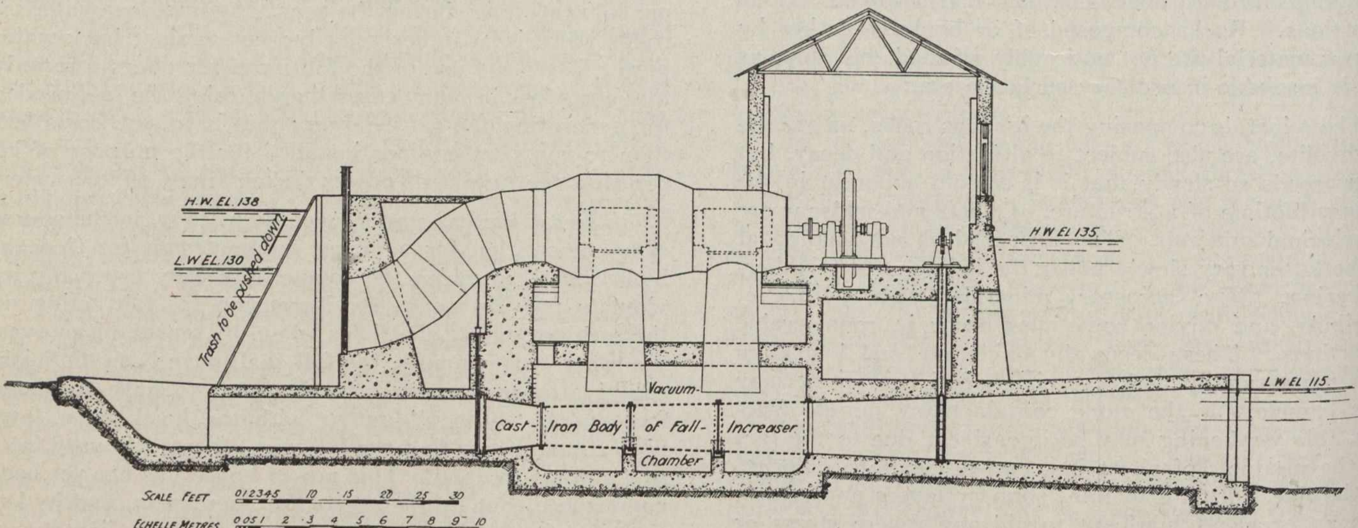
The money considerations involved are well shown by the results of some examinations made. In one case, for an estimated additional cost of $50,000 an additional 8⅓ million kilowatt hours, distributed during times of high water, (that is, when sorely needed), would be secured on the average, annually, forever. The net profit was estimated at not less than $23,000 per annum, forever. This plant has not yet been begun, and may be fitted with fall increasers when built.

In another case, fall increasers would produce, in an average year, 158 million kilowatt hours. They would keep the power practically constant throughout the back-water half of the year, instead of having it fall from some 250,000 h.p. down to about half that amount, during that period; (not considering the low-water half of the year). The additional cost entailed by building them would have been, as per estimate, one million dollars.

It might be thought, at first view, that fall increasers would have offered notable advantages at the Wasdell's Falls, Ont.,* power house, recently put in service, but impending improvements both in the Severn River and at Lake Simcoe outlet will do much to make the fall at this power house nigh constant throughout the year.

Incidentally fall increasers would greatly aid in keeping the racks clear of trash, which, when fall increasers are installed, needs only to be pushed down, and within range of their action, so as to pass through them; instead of having to be raked and lifted up and carried ashore. See the illustration, which is of an extreme case of back-water; only 3 ft. of fall left out of 12 ft. fall at ordinary water, on which account a siphon penstock is shown, to be kept clear of air at the summit by a small (an inch or two) fall increaser acting as an air exhauster.

Roughly and generally speaking, the "operating water" is double the turbine discharge, and the fall acting on the turbine is increased 50%, which increases the power given out by 80%. So long as back-water does not diminish the fall more than 33%, fall increasers will restore (from the fall and power then obtaining) the full, or normal, fall and power, and be of material benefit also, beyond the 33% mark.




**Cross-section of a Power House, Showing Application of Fall Increaser. It Shows Also the Use of a Syphon Penstock. Note the Low Fall Remaining at Extreme High Water.**

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* See *The Canadian Engineer*, October 8, 1914, page 509, for full description of this development.

## THE ROGER'S PASS TUNNEL IN B.C.

Since the publication of our last article descriptive of the progress already made in driving the 5-mile tunnel for the Canadian Pacific Railway under Roger's Pass at Glacier, B.C., the work has been advanced by the contractors, Foley, Welch & Stewart, with the greatest possible rapidity. On the east side the pioneer bore has been advanced considerably over a mile while the 8 x 11-ft. centre heading and the full tunnel section had been driven, on October 1st, a distance of 3,100 and 400 ft. respectively. At the western end the approach cut, requiring the excavation of 350,000 cubic yards, has been completed at that time, and the pioneer bore has been advanced over 2,000 ft. In the main tunnel portal a number of small headings have been worked for a considerable distance.

# Editorial

## THE "GLAGSESTEN" THEORY IN THE STORAGE OF IMPURE WATER.

In investigations which he has long had under way, Dr. A. C. Houston, director of water examination to the Metropolitan Water Board, of London, Eng., has become convinced that storage of impure water is not only demonstratively a process making for safety, but that a most important influence is at work, *viz.*, the devitalization of the undesirable bacteria, owing to their finding water a most unsuitable medium for their sustained activity. In his recent report, a section of which enlarges upon the value of storage in water purification, cognizance is given of such factors as the influence of glass on bacteria, and the effect of agglutination, sedimentation, sticking and enshrouding processes. With due consideration for the opinions of other writers on the theory that these factors really have an influence, he gives to it, for the sake of brevity, the name "glagsesten." The property of glass by which it imparts certain constituents to water, although relatively insoluble, is taken into consideration in conjunction with the storage of water in reservoirs, experiments in the latter confirming laboratory results with the former. It is concluded that the same principle of gradual devitalization is at work in both cases, although, perhaps, with a difference in degree.

The agglutination or clumping together of bacteria is readily explained by the apparent loss of vitality under conditions of storage. "If," Dr. Houston remarks, "we compare stored water with unstored water, we find that the former contains far fewer excremental bacteria than the latter, and the results on the average are not appreciably affected by preliminary violent shaking of the samples with lead shot sand and a mixture of shot and sand. Still it might be maintained that the shaking operations were not sufficiently drastic to break up the clumps, and if this is true the only difference between drinking raw river water and the same water after storage in reservoirs may conceivably be, that in the former case we ingest separated bacilli, and in the latter case clumps or balls of bacilli."

The sedimentation is, of course, a great factor in the importance of storage, and its influence is frequently quite noticeable in even less than twenty-four hours. As for particles in suspension tending to stick to various materials, it was demonstrated that shaking operations with shot and sand failed to explain all the observed facts relating to the storage of the impure water, indicating that sedimentation in itself was not wholly accountable. It was remarked that if the bacteria stick so closely as to be undetachable when subjected to the above process there is good ground to believe that they will stick so long to the sides and bottoms of reservoirs as to lose their vitality and die.

Discussing the enshrouding process, Dr. Houston does not appear to lay much importance upon it in his report. If, however, the enshrouding during the physical and chemical changes which occur under conditions of storage is so complete as to resist all shot and sand shaking operations, and so manifold that when a suitable nutrient medium is introduced no growth takes place, there would appear to be some ground for believing that ingestion of such a water would not be followed by any evil results.

The agglutination, sedimentation, sticking and enshrouding processes, concludes Dr. Houston, all make for the retention of pathogenic bacteria much longer in storage reservoirs than would otherwise be the case; so long, indeed, as perhaps to exceed the most extravagant estimate as to the length of time such microbes can live in water.

## ENGINEERING ETHICS.

The Council of the Canadian Society of Civil Engineers has circulated among the members a ballot for the proposed amendment of several by-laws, to be considered at the next annual meeting of the Society. An important one among them is a proposed code of ethics, for adoption in place of the existing code. The regulations are as follows, and relate to every corporate member:—

(1) He shall act in all professional matters strictly in a fiduciary manner with regard to any clients whom he may advise and his charges to such clients shall constitute his only remuneration in connection with such work, except as provided by Clause 4.

(2) He shall not accept any trade commissions, discounts, allowances, or any indirect profit in connection with any work which he is engaged to design or superintend or with any professional business which may be entrusted to him.

(3) He shall not, while acting in a professional capacity, be at the same time, without disclosing the fact in writing to his clients, a director or member, or a shareholder in, or act as agent for, any contracting or manufacturing company or firm or business with which he may have occasion to deal on behalf of his clients or have any financial interest in such a business.

(4) He shall not receive directly or indirectly any royalty, gratuity or commission, on any patented or protected article or process used on work which he is carrying out for his clients, unless and until such royalty, gratuity or commission has been authorized in writing by those clients.

(5) He shall not improperly solicit professional work, either directly or by an agent nor shall he pay, by commission or otherwise, any person who may introduce clients to him.

(6) He shall not be the medium of payments made on his clients' behalf to any contractor or business firm (unless specially so requested by his clients) but shall only issue certificates or recommendations for payment by his clients.

Any alleged breach of these regulations or any alleged professional misconduct by a corporate member which may be brought before the Council, properly vouched for and supported by sufficient evidence, shall be investigated, and if proved, shall be dealt with by the Council, either by the expulsion of the offender from the Society or in such other manner as the Council may think fit.

## NEW PUMPING EQUIPMENT AT BRACEBRIDGE, ONTARIO.

BRACEBRIDGE, Ont., has lately installed and put in operation some new electric-driven pumping equipment, to supply water at high pressure for fire service; or, alternatively, to double the quantity of water at half that high pressure. This system, known as the series-parallel arrangement of pumps, is one which is used quite frequently on municipal waterworks systems.

The equipment at Bracebridge consists of 2 single-stage Mather & Platt patent turbine pumps, each capable of pumping 800 Imp. gal. per min. against a total pressure head of 60 lb. The piping, as shown in the accompanying illustrations, is arranged so that these pumps may be run in parallel giving a total of 1,600 Imp. gal. per min. against a head of 60 lbs. They may otherwise be run in series, giving 800 Imp. gal. per min. against a head of 120 lbs. or they may be run singly, each giving 800 gal. against a head of 60 lbs.

Particular attention has been given to the testing of this equipment. Fig. 3 shows the equipment set up complete in the testing plant at Rockfield, Que., of the Canadian Allis-Chalmers, Limited, who manufactured the pumps. Curves giving the characteristics of the pumps at rated speed, as obtained in the test, are shown in Fig. 4.

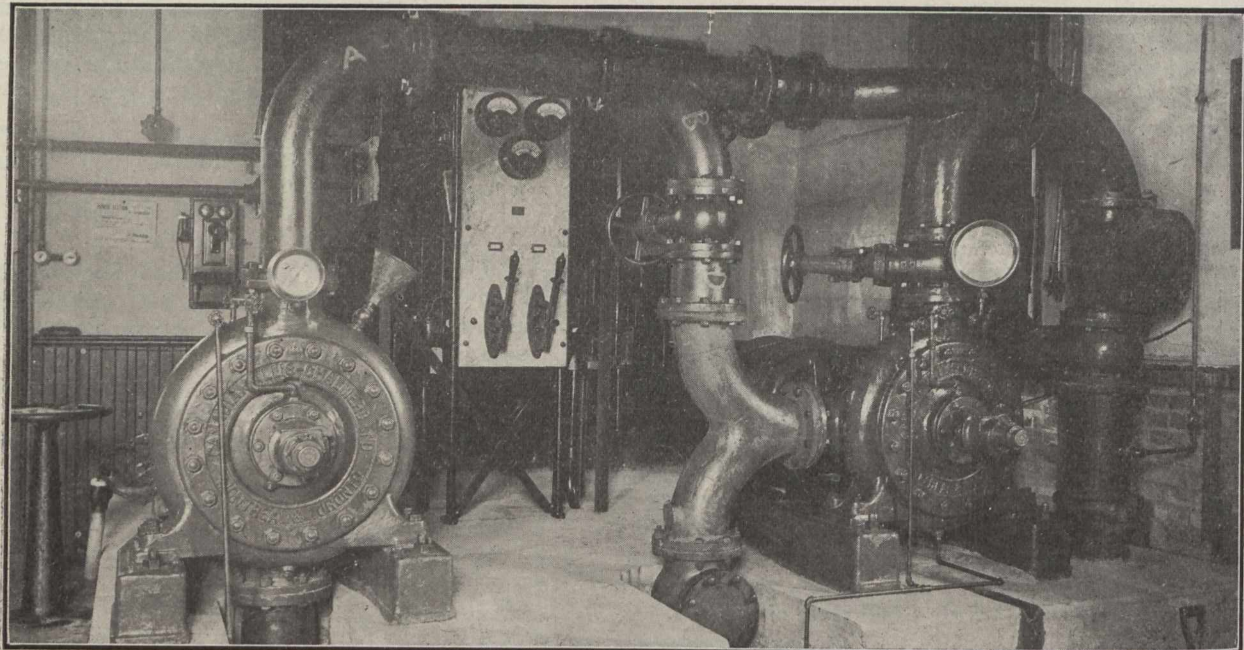

**Fig. 1.—View of the New Installation at Bracebridge, Ont.**

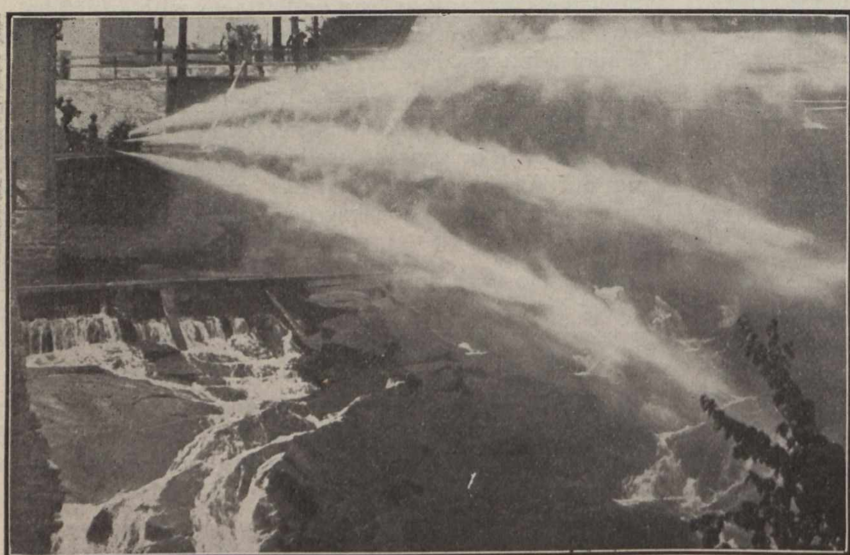

**Fig. 2.—Four Fire Streams (one at a sharp inclination in the background) by Which the Pumps Were Loaded in the 24-hour Duration Test.**

After installation, which is illustrated in Fig. 1, the pumps were given a 24-hour run under fire pressure conditions. They were loaded on 4 fire nozzles. (Fig. 2.) To obtain the correct load on these pumps, with rated speed, the pressure was adjusted to that corresponding to the rated quantity of water, as shown in Fig. 4. After this duration test was completed the units were put into service.

Each pump is driven by a direct connected C.G.E. squirrel-cage induction motor rated 60 h.p., 3-phase, 60 cycles, 2,300 volts, 1,800 r.p.m. At the end of the 24-hour run these motors showed a shut-down rise in temperature of 26° C. in the iron and 21° C. in the coils, both being the hottest spots found. From the pump curves it can be seen that 53 h.p. are required to drive each pump at rated capacity, head, and speed, so that not only is ample power provided to drive the pumps but the temperature rise in the motors shows liberal rating. The idea of having ample capacity in the motor is to take advantage of the overload characteristics of the pump. These pumps are equipped with diffusion guides on exit.

Referring to Fig. 5, the advantage of the use of diffusion guides can readily be seen, when the pump is for waterworks systems or similar service. These curves are taken from two other actual pumps, one with and one without diffusion guides, and both rated 2,500 gal. per min., 880 r.p.m., and 180 ft. head.

The efficiency curves show a higher efficiency in the pump having diffusion guides, due to the better hydraulic conditions prevailing on account of having definite passages for the guidance of the water from the impeller and to the smaller losses in the smaller impeller required. On account of the smaller power required at no load and at full load by the pump with diffusion guides, it is evident that

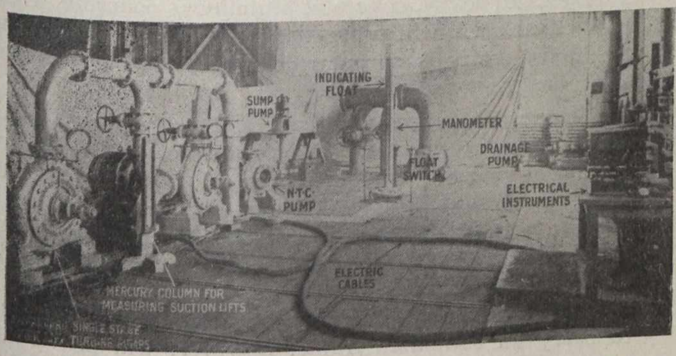


**Fig. 3.—Arrangement of Equipment, Pump-testing Plant.**

its efficiency curve must be higher over the full range of the pump since the b.h.p. curves are nearly straight lines.

It will be noted that, with the pump not having diffusion guides, the point of maximum capacity is not very far beyond the point of maximum efficiency which is at rated capacity of the pump. The pump having diffusion guides, however, gives considerably greater capacity than that at which maximum efficiency occurs. So, by taking advantage of the overload guarantee of electric motors (25% for 2 hours) it can be seen that approximately 30% extra capacity can be obtained for two hours. This is valuable for heavy fire service and all the more valuable since the pressure only drops approximately 15 per cent. With a pump not having diffusion guides the pressure falls to zero on small overload demands, which would be serious if firemen coupled on a few extra lines of hose and opened them out too much. Furthermore, with this latter type, no advantage can be taken of the overload capacity of the electric motor.

The characteristics of the diffusion guide pump were fully demonstrated at Bracebridge. The nozzles were removed and the discharge regulated by a valve. The discharge was increased above the rated capacity and the pressure held up as shown on the curve in Fig. 4. The equipment was intended for 4 fire streams and it was shown that nearly 7 could be obtained without a serious falling off in pressure, or overloading of the motor.

The overload relay on the motor was set for between 35 and 40% overload. On opening up the discharge wide the motors automatically tripped out. These conditions correspond to a break in the water mains and showed how the pressure was automatically removed which would prevent a big washout around the break in the water main. The overload relay can be arranged either to operate an alarm or trip the motor out or both.

Mr. W. C. Simmons, superintendent of the municipal systems at Bracebridge, laid out the equipment and put in the installation. The convenience with which his

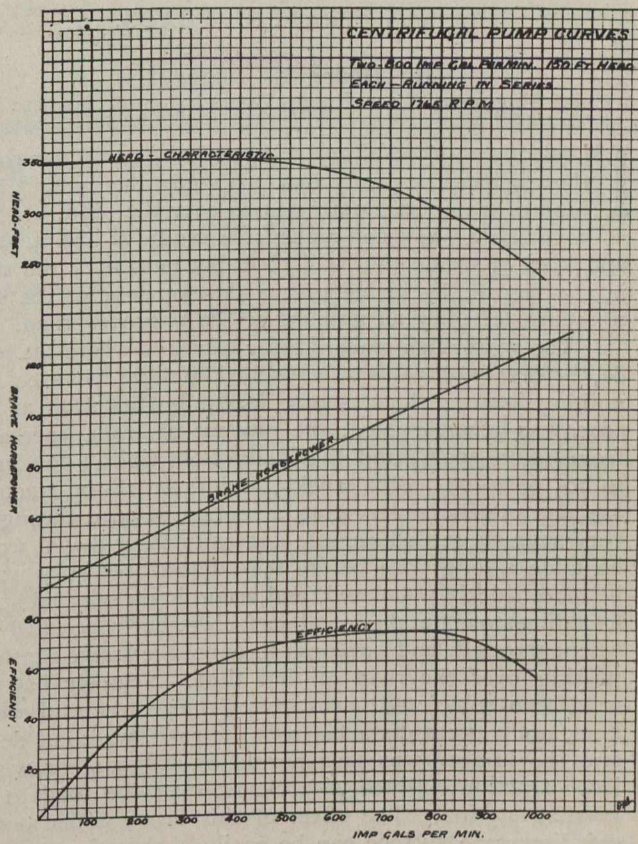


**Fig. 4.—Characteristics of Two 800-gal. per min. Pumps Running in Series, 150 ft. Head, 1,765 r.p.m.**

equipment may be operated is worthy of notice. The operator, standing in front of the switchboard, can start up both motors from that position and is able to watch his instruments while doing so. After the motors are started, by facing about, he has all the valves within reach and the gauges are mounted in front of him, so that he is able to see just exactly what is happening when opening the valves. It is easily possible to start everything from rest and have fire pressure on the mains within 30 seconds from the time the alarm is sent in.

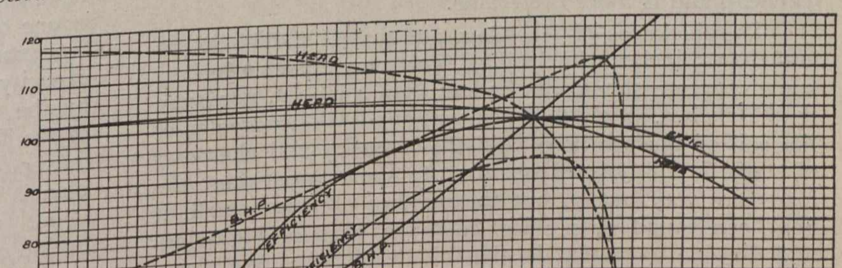


**Fig. 5.—Effect of Diffusion Guides on the Characteristics of a Centrifugal Pump, as Shown by Actual Test.**

## HEAVY TRAFFIC ROADS.

By Henry G. Shirley,
Chief Engineer, State Roads Commission of Maryland.

IN selecting a type of surfacing for any particular road, the engineer not only has to study the amount and kind of traffic that daily passes over the road, but has to make a very comprehensive study of the amount and kind of traffic that will probably pass over the road in the future, by virtue of the development of the surrounding territory on account of the improved road.

The writer has made studies of roads where the traffic, before improvement, consisted of light vehicles and nothing heavier than 2-horse loads, but as soon as the road was reconstructed, the amount of traffic increased from 50 to 300%, and the loads from light 2-ton loads to 10 to 12-ton motor trucks, and 14 to 18-ton tractors. He also recalls constructing a section of road through a very sparsely settled section, and estimating that it would be quite a long time before the adjacent territory would be more thickly populated, and accordingly selected a soft local limestone for the metal surfacing, but which had sufficient strength and hardness to carry the traffic that was passing over the road at that time. Scarcely had the road been completed when several large tracts of woodland, not a great distance from the road, were cut down, and the lumber was transported on wagons, drawn by large traction engines with cleats, over the road to the railroad station. The effect of this heavy traffic on the soft limestone surface can be easily surmised.

**Drainage.**—Drainage of a road-bed that is required to carry heavy traffic, should be well taken care of by tile or other sub-surface drains, so as to render the subfoundation as dry and firm as possible. The maximum grade should not exceed a 6 per cent., and the alignment should be as straight as possible, with all sharp curves and bends eliminated. The width of the roadway and the width and thickness of the metal surfacing should be designed to meet the requirements of the present as well as the future traffic which it will have to accommodate, but the minimum width should not be less than 30 feet, nor the metal surfacing less than 18 feet. Broken stone or gravel make a fair foundation, but concrete is almost as cheap and is more preferable.

The thickness of macadam and gravel should not be less than 5 inches after rolling, nor more than 10 inches, while concrete should not be less than 4 inches, nor more than 8 inches, depending primarily upon the character of the soil of the sub-base, and the intensity and character of traffic it will have to sustain. In some cases where the loads are very heavy, but the number of loads small, it has been found economical to lay a strip of high-class and durable pavement in the middle of the road for a width of 9 to 14 feet, with a cheaper and less durable material on each side.

Before selecting the type of pavement to be used, a close and accurate census of the different kinds of traffic should be taken, a very thorough study made of the surrounding section, and an estimate made as to the possible increase of the different kinds of traffic, or the decrease of one kind and the large increase of the other. It is the opinion of the writer that in no other line of engineering should there be a larger factor of safety used than in estimating the amount, intensity, and kind of motor and self-propelled traffic that will pass over our improved roads in the near future. The great change in the character of traffic developed in the past five years, is but a small index to what can be expected in the next five years to come.

The types of pavements used on heavy traffic roads should be selected as to their fitness to stand the kind and intensity of the traffic that will travel them. Roads in the outlying districts, where horse-drawn traffic comprises the larger percentage, should be constructed of macadam with a light surface treatment. Concrete will also be found serviceable and desirable. Where motor traffic is in the majority, bituminous macadam or concrete will give good results. Near the centres of population, where the traffic is mixed and heavy, concrete, bituminous concrete, asphalt or vitrified brick will prove the most economical. Where the heavy traffic is concentrated, brick, asphalt or stone block are the most suitable.

There can be given no hard and set rule for selecting the type of construction that should be used on a given section of road to carry a known traffic. For local conditions, the availability of materials, etc., play such an important part in the selection of the type of surfacing in any locality, that each individual case must be worked out on its own merits.

The following method of selecting a type of surfacing to carry an estimated traffic, however, will prove fairly accurate where a study can be made and the maintenance cost can be had of roads constructed and maintained under similar conditions:

Where the annual cost of maintenance of a less durable type of road surfacing will exceed the annual cost of maintenance of a more durable type of surfacing, plus 4 per cent. on the excess cost of the more durable type over the less durable type, the more durable type should be used, and vice versa.

The maintenance on heavy traffic roads should be continuous and thorough—never allowing the surface to remain broken any length of time, but as soon as the slightest defect or indication of failure appears, it should be speedily repaired.

## LARGE PROJECTED HYDRO-ELECTRIC STATION IN NORWAY.

The proposed exploitation of the water-power in the Take Falls, with the co-operation of the Norwegian State, is one of the largest undertakings in the country. The first stage is the building of a power-station with a capacity of 125,000 h.p., which can be obtained simply by the regulation of the Totak, by retaining the water of the Totak during the high-water season and using the power of the Vinje waters without any regulation. The plan is based upon an English Company contracting for about 100,000 h.p. for a period of 30 years, with the option of a further 20 years at $7.25 per h.p. per annum, the energy to be supplied as alternate current of some 10,000 volts, the factories in question to be erected within a distance of 100 kilometres from the power-station. The Take waters represent one of Norway's largest and best water-power streams. By regulating the Totak and the Vinje waters a capacity of 250,000 h.p. is confidently reckoned upon, and of this 140,000 h.p. will come from the Totak after regulation. Of this the Hyllands Fall represents 15,000 h.p. The exploitation of either the Totak and the Vinje is not expected to offer any difficulties whatever from a technical point of view, and the cost can, it is confidently asserted, be kept at a comparatively low figure, the existing roads for transport, for one thing, being adequate. The cost of the finished power-station for the first 125,000 h.p. is calculated at $26.80 per electric h.p., and the next 125,000 h.p. will naturally come out somewhat cheaper.

## ONTARIO'S MINERAL PRODUCTION IN 1913.

The following table gives a summary of the mineral production of the Province of Ontario for the year 1913, as presented in the statistical review by Thos. W. Gibson, Deputy Minister of Mines, in the 23rd annual report of the Bureau of Mines, 1914.

**Table I.—Mineral Production of Ontario, 1913.**

| Product. | Quantity. | Value. |
|---|---|---|
| *Metallic:* | | |
| Gold ................ozs. | 220,837 | $ 4,558,518 |
| Silver ..............ozs. | 29,724,931 | 16,579,094 |
| Copper .............tons | 12,941 | 1,840,492 |
| Nickel ..............tons | 24,838 | 5,237,477 |
| Iron ore ............tons | 195,937 | 424,072 |
| Pig iron ............tons | 648,899 | 8,719,892 |
| Cobalt oxide, etc. .....lbs. | (a) 1,188,526 | 420,386 |
| Nickel do .....lbs. | (b) 232,255 | 13,326 |
| | ........... | $37,793,257 |
| Less Ontario iron ore (132,708 tons) smelted into pig iron ........ | ........... | 285,322 |
| Net metallic production. | ........... | $37,507,935 |
| *Non-metallic:* | | |
| Arsenic, refined .......lbs. | (c) 2,450,758 | 64,146 |
| Brick, common .......No. | 408,808,000 | 3,452,352 |
| Tile drain ............No. | 16,935,000 | 292,767 |
| Brick, paving, etc. ....No. | 18,547,000 | 243,119 |
| Brick, pressed ........No. | 81,238,000 | 919,741 |
| Stone, building and crushed | ........... | 1,137,153 |
| Calcium carbide ......tons | 2,052 | 123,100 |
| Cement, Portland .....bbl. | 3,802,321 | 4,105,455 |
| Corundum ..........tons | 1,177 | 137,036 |
| Feldspar ...........tons | 18,615 | 67,142 |
| Graphite, refined .....tons | 1,788 | 93,054 |
| Gypsum ............tons | 40,581 | 92,627 |
| Iron pyrites .........tons | 71,620 | 171,687 |
| Lime ..............bush. | 2,300,991 | 390,600 |
| Mica ...............tons | 386 | 55,264 |
| Natural gas..million cu. ft. | 12,516 | 2,362,021 |
| Peat ...............tons | 500 | 1,750 |
| Petroleum ......Imp. gal. | 7,915,761 | 398,051 |
| Pottery ............... | ........... | 52,875 |
| Quartz ............tons | | 130,860 |
| Salt ...............tons | 54,320 | 474,372 |
| Sewer pipe ............ | 96,799 | 600,297 |
| Sand and gravel ...cu. yd. | ........... | 233,567 |
| Talc, ground ........tons | 425,978 | 125,340 |
| | 20,738 | |
| Non-metallic production | ........... | $15,724,376 |
| Add metallic production. | ........... | 37,507,935 |
| Total ............. | ........... | $53,232,311 |

(a) The estimated quantity of metallic cobalt contained in the ores raised from the silver-cobalt mines was 377 tons; this includes the quantity converted into oxide.

(b) The estimated quantity of metallic nickel contained in the silver-cobalt ores was 821 tons, which is included in the quantity converted into oxide.

(c) The ores extracted from the Cobalt silver mines are estimated to have contained 3,633 tons of arsenic, which includes the quantity of refined arsenic given in the table.

# Coast to Coast

**St. John, N.B.**—Dredging operations at Salmonier have been completed. A channel, 940 ft. long has been cut into the main basin at Little Harbor to avoid danger from running ice in the winter.

**Vancouver, B.C.**—Mr. J. G. Bury, vice-president of the C.P.R., while in the city last week, announced that the Kettle Valley Railway from Midway to Merritt, providing an alternative scenic route by way of the Crow's Nest Pass, will be in operation by next June.

**Edmonton, Alta.**—When the season closes about 345 miles of grading and steel will have been laid upon the Edmonton, Dunvegan and British Columbia, and upon the Alberta and Great Waterways Railways this year. The J. D. McArthur Construction Company are the contractors for the work.

**Hamilton, Ont.**—The National Gas Company states that it will lay 7½ miles of pipe before January 1st, as required by its franchise. Tenders for trenching and laying pipe-lines from Black Heath to Hamilton, a distance of 16 miles, and also for the above length of line within the city limits are now being advertised.

**Toronto, Ont.**—A large steel buoy steamer, 164½ ft. in length, 30 ft. breadth, and 13 ft. depth, built for the department of marine and fisheries, was launched at the Polson Iron Works on November 7th. It is equipped with triple expansion jet-condensing engines of 900 h.p. capacity, and will be provided with all modern electrical equipment, including search light, etc.

**Vancouver, B.C.**—Oil burning locomotives will be used, according to statements made in an official interview, by the Grand Trunk Pacific on its transcontinental route. The company is preparing contracts for large developments, and oil storage facilities are receiving considerable attention. The terminals at Prince George, Endako, Smithers and Pacific, noted in these columns last week, are among the divisional points where storages will be established.

**Toronto, Ont.**—To relieve transportation difficulties in Ward 7, the city will proceed immediately with the construction of a car line extending west on Bloor Street from Dundas Street to Quebec Avenue, at an approximate cost of $125,000. Permanent track will not be laid this fall, but a temporary line will be constructed without delay, and will be in operation before the end of the year. It will be a single track provided with turn-out switches. The Street Railway Company has offered to operate the line charging the city 20c. per car mile and allowing single fare rates to passengers using both the proposed line and the company's service.

**Montreal, Que.**—Grading has been completed on the Canadian Northern Railway from Montreal to the harbor of Vancouver, and it is expected that this length will be completely railed before the beginning of the new year. Two gaps each of about 50 miles in length are waiting for steel in British Columbia, and track-laying is going on at the rate of about two miles per day. There are also three bridges to be completed, viz., at the Back River, at the crossing of the Chat River above Ottawa, and a third in British Columbia. The substructures for the three have been finished, and the superstructures will be completed in about a month. The company's big undertaking at Mount Royal has progressed very favorably since the last announcement in these columns. Over a mile of tunnel has been excavated to full cross section and about 600 ft. of lining has been put in.

## CANADIAN SOCIETY OF CIVIL ENGINEERS, REGULAR MEETING, NOV. 5th, 1914.

The President, Mr. M. J. Butler, C.M.G., occupied the chair. The speaker of the evening was Professor H. E. T. Haultain, M. Can. Soc. C.E., of the University of Toronto. The opening paper was a description of an integrating machine for weighing materials in motion. Mr. Haultain described a device which has been in use in the gas works in Toronto since the beginning of this year, whereby coal is weighed without interruption as it passes over the conveyer system. The explanation was illustrated by models and actual working parts.

The automatic weigher consists essentially of a portion of depressible track over which the conveyer runs. The centre of the depressible track is connected to a series of weighing levers which in turn by their motion impart a movement to an integrator. The integrator travels on a plane circular disk which is caused to revolve by the motion of the conveyer itself. The combination of the rotation of the disk and the side movement of the integrator thereon enables a card to be drawn showing the weight passed over the machine. The introduction of batteries renders it possible to record the weights on an ordinary dial.

Following the curtain raiser Professor Haultain read a paper entitled "The Wielder of the Weapon." This unique and masterly address was followed by an interesting discussion taken part in by Messrs. M. J. Butler, R. A. Ross, Professor Porter, Walter J. Francis, Charles E. Fraser, R. F. Uniacke, Julian C. Smith, and J. M. R. Fairbairn.

## PERSONAL.

W. K. MOWATT has been appointed hydro-electric inspector for the city of Brampton.

A. W. THORNE, of St. John, N.B., has been appointed provisional secretary of the New Brunswick Union of Municipalities during the illness of Mr. J. W. McCready.

A. E. PICKERING, formerly manager of the Tagona Light and Power Co., Sault Ste. Marie, is manager for the city of the same concern now that it is taken over by the city.

C. M. WATERMAN, Canadian manager of the Eugene Dietzgen Co., Limited, has returned to Toronto after an extended visit to the firm's head office and factory at Chicago, Ill.

C. A. ELLIS, for several years resident engineer at Winnipeg for the Dominion Bridge Co., has been appointed assistant professor of civil engineering at the University of Illinois.

A. S. FARMER, formerly superintendent in Moncton, N.B., of the natural gas department of the Moncton Tramways Electricity and Gas Co., has resigned to accept a similar position in Oklahoma.

JOHN S. BATES has been appointed superintendent of the Dominion Forest Products Laboratories of McGill University to succeed Mr. A. G. McIntyre, who resigned to take charge of a new paper mill at Bathurst, N.B. Mr. Bates is a graduate of Acadia University in arts and science, and of Columbia University in chemical engineering.

The Canadian Northern Railway is developing a 50,000-h.p. plant from the Sumallo and Nicaloon Rivers, which will be employed in operating the Canadian Northern trains from Port Mann to the False Creek terminals at Vancouver, B.C.

## OBITUARY.

Last week the death occurred of Mr. Donald McDermid, Toronto. For many years he had been engaged in railroad construction work. On the mountain division of the C.P.R. he constructed a number of bridges and snow sheds. He was also associated with Mackenzie, Mann & Co. on the C.N.R. At one time he was in partnership with Hon. J. S. Hendrie, now Lieutenant-Governor of Ontario, in the firm of McDermid and Hendrie.

The death has been announced of Mr. Keith Ross Cameron, whose connection with railway building in Ontario is well known. Mr. Cameron was engaged in railway work for some time with the Grand Trunk Railway, and later with the Lake Erie and Detroit River Railway.

## BACK COPIES WANTED.

The following back copies of *The Canadian Engineer* are required by one of our Canadian libraries to complete sets for binding:—January 1st, 1907; February 1st, 1907; March 1st, 1907; January 29th, 1909; January 8th, 1912; October 31st, 1912, and January 2nd, 1913. If any of our readers can supply one or more of these copies, we will be glad to extend his subscription one month for each copy returned to this office.

## COMING MEETINGS.

AMERICAN HIGHWAYS ASSOCIATION.—**Fourth American Road Congress to be held in Atlanta, Ga., November 9th to 13th, 1914. I. S. Pennybacker, Executive Secretary, and Chas. P. Light, Business Manager, Colorado Building, Washington, D.C.**

WASHINGTON STATE GOOD ROADS ASSOCIATION.—**Convention to be held at Spokane, Wash., November 18th, 19th, and 20th. Secretary, M. D. Lechey, Alaska Building, Seattle, Wash.**

ANNUAL MEETING, AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—**The annual meeting of the American Society of Mechanical Engineers will be held in New York, December 1st to 4th, 1914. Secretary, Calvin W. Rice, 29 West 39th Street, New York.**

AMERICAN ROAD BUILDERS ASSOCIATION.—**Eleventh Annual Convention; fifth American Good Roads Congress, and 6th Annual Exhibition of Machinery and Materials. International Amphitheatre, Chicago, Ill., December 14th to 18th, 1914. Secretary, E. L. Powers, 150 Nassau Street, New York, N.Y.**

CANADIAN NATIONAL CLAY PRODUCTS ASSOCIATION.—Annual Convention to be held at the King Edward Hotel in Toronto, January 26, 27, and 28, 1915. Secretary, G. C. Keith, 32 Colborne Street, Toronto.

EIGHTH CHICAGO CEMENT SHOW.—**To be held in the Coliseum, Chicago, Ill., from February 10th to 17th, 1915. Cement Products Exhibition Co., J. P. Beck, General Manager, 208 La Salle Street, Chicago.**

AMERICAN WATERWORKS ASSOCIATION.—**The 35th annual convention, to be held in Cincinnati, Ohio, May 10th to 14th, 1915. Secretary, J. M. Diven, 47 State Street, Troy, N.Y.**

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—**Annual meeting to be held at the Iowa State College, Ames, Iowa, June 22nd to 25th, 1915. Secretary, F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.**