their ability to transfer shear. Shear of both ends, equal to double the shear at one end, shall be considered as an equally distributed transverse load over the entire length of the member with cover plates, batten plates and lattice in vertical plane. If of more than two channels or similar sections, connections of cover plates, batten plates, and lattice shall have sufficient connection to the flange of the outer channels or similar shapes to transmit the entire shear.

Cover plates, batten plates and lattice in vertical plane shall also have the ability to sustain the member in a horizontal position acting as the web of a girder supported only at the two ends, or supported only at the center. For the purpose of this last investigation, the total weight of the member shall be increased by a ratio of 2½. Preferably lattice shall be of uniform proportions for the entire length of a member. From the stresses as indicated, lattice should be designated with limitations by compression formula for stiffness, also the connecting rivets to flanges with limitations for bearing, shear and flexure.

Lacing shall be of width not less than two diameters of the rivets used to connect the same.

Rivets may be spaced within 3 diameters and spacing shall never exceed seven diameters of the rivet either in longitudinal, transverse or diagonal directions. Neither shall the pitch of rivets ever exceed twelve times the thickness of the thinest material through which they pass. Rivets to be spaced not less than 1¼ or more than 4 diameters from the edge, except rivets in lacing, one diameter of edge. In all cases rivets to be spaced not more than 1½ diameters from an end.

Preferably rivets in single shear shall have diameter equal to the thickest material through which they pass.

Extension of Sundry Compression Formulæ.

(a)—Cooper Chord Segments .... $20000-90\frac{L}{R}$

(b)—Cooper Posts, Through Bridges .... $17000-90\frac{L}{R}$

(c)—Cooper Posts, Deck Bridges .... $18000-80\frac{L}{R}$

(d)—Cooper Lateral Struts and Rigid Bracing . $13000-60\frac{L}{R}$

(e)—Carnegie 1903, page 143, 2 Pin Ends.. $\dfrac{20000}{1+\dfrac{L^2}{18000\,R^2}}$

(f)—Suggested—Unit Stress, say (20000) times $\dfrac{1\frac{1}{2}}{1+\dfrac{L^2}{5000\,R^2}}$

and compression never to exceed ¾ Unit Stress.

The move to the coast is seen in the incorporation here of the Western Explosives, Limited, in which the moving spirit is George C. Tunstall, Jr., of Montreal. With him are associated other Eastern people. A site of 805 acres has been secured on Bowen Island, not far from the entrance to Vancouver's harbor, and to George McFarlane has been let the contract to erect the various buildings that will be used in the manufacture of dynamite, black powder and acids. The initial investment on the powder plant is approximated at $150,000 and on the acid plant $250,000. Mr. Tunstall was with the Hamilton Powder Company for a number of years, and later sales agent of the Standard Explosives. The output of the plant will start with 400 cases of dynamite and 300 cases of black powder per day, and acids will be manufactured, not only for the company's own use, but also for the trade.

HYDRAULIC-FILL DAMS.*

By Walter S. Morton, Mem. Conn. Soc. C.E.

The conveyance of material by the agency of water had its origin in the hydraulic mining regions of California. Through ditches and pipes streams were delivered under high heads and great pressure and directed against the face of the bank by a controlling device known as a "hydraulic giant" or "monitor," with a velocity of from 100 to 200 feet per second, which undermined, cut and loosened everything except hard rock and at such a small cost that hydraulic mines carrying but a few cents' worth of gold to the ton were profitably worked.

This method has been successfully applied to the construction of the highest earth dams built in the world and at a surprisingly low cost, the water accomplishing all the work of the pick, plough, wagon or dump cart, and through a proper arrangement of the flumes, assorting, distributing and depositing the material at will and consolidating it to a degree impossible by the ordinary method of rolling and tamping.

The fundamental principles laid down by Mr. James D. Schuyler, member American Society of Civil Engineers, who has designed and supervised a larger part of the hydraulic-fill dams so far constructed, and applicable to any earth dam, as given in his excellent paper on "Recent Practice in Hydraulic-Fill Dam Construction," published in "Proceedngs," October, 1906, are as follows:—

1. The foundation must be of an impermeable character and have a water-tight connection with a rock or clay bottom upon which it rests.

2. It must be practically impervious to water in a whole or at least goodly portion of its entire cross section.

3. It must have slopes sufficiently flat to be stable under all conditions of saturation from the water in the reservoir or from soaking rains.

4. The crest of the dam must be sufficiently above the highest water line to insure against the possibility of overtopping by extraordinary freshets or by waves driven up its inner slopes by gales of wind.

5. It must not settle, crack, or show any signs of change or movement after final completion and when put in service.

These requirements are fulfilled in the building of earth dams by the ordinary method of moistening, rolling and tamping, and the proper selection and distribution of materials, and by the exercise of great vigilance and care in construction, but at a much greater cost and with a more limited sectional area.

In general, hydraulic-fill dams are being constructed in the following manner:—

A stream of water must be brought to a point adjacent to and above the top of the proposed dam under great pressure, either by gravity from a source still higher up, or by pumping from the stream below, the latter condition more commonly existing. In the case of very high dams there must also exist a bank of thirty or more feet in height lying above the dam site and not too great a distance from it. In dams of moderate height, not only the water, but the material can be obtained near the bottom of the dam and forced into the embankment by the use of sufficient power.

The stream conveyed to the borrow pit by means of pipes leading from the pump or from the gravity flumes terminates in short sections of hose attached to which are the monitors or controlling devices; the hose, generally of four inches diameter, and the nozzles of two and one-half inches diameter or less. The nozzles are brought within twenty to fifty feet of the face of the bank and directed against it at the bottom. The pressure at the nozzle should not be less than seventy-five pounds per square inch, and preferably more. This powerful stream undermines the bank, loosens and disintegrates the material, moving even boulders of large size. Leading from the foot of this bank

* Read before the Connecticut Society of Civil Engineers.