to the cornice. The distance from floor to floor is 12 feet 6 inches for the office stories, and 17 feet in the telegraph exchange on the sixteenth floor. The concrete construction as compared with a similar structural steel design permitted a reduction in height of about one foot for each story, a saving due to the shallower floors. The construction is on the Ransome system, in which the concrete is reinforced by rods, bars, stirrups, and hoops of twisted steel, is solid and continuous throughout, and was essentially completed as the work progressed, the rate at times being one entire story finished every twelve days. The foundations are of the spread type, and rest upon a good stratum of gravel and sand.

The boldness of the structural design, at least for that period in the development of the use of concrete, is well shown by the spacing of the columns, which is such as to require girders of 16 to 33 foot span, and floor panels 16 x 33 feet between the main girders. The columns are 16 to 33 feet apart, center to center, and decrease in size from 34 inches by 38 inches at the basement to 12 inches by 12 inches at the roof. The footings vary in size according to position and loading, and are built independent of the columns. Each has a rectangular pedestal, slightly greater in horizontal dimensions than the column, and upon this is a cast-iron base plate provided with circular projections to form top seats for vertical round steel bars imbedded in each column to add compressive resistance thereto. Each column, according to its size, has four, six, or eight such bars, 2 to 3½ inches in diameter, and the joints of these are formed by faced ends in contact. Besides, each column has four to ten twisted steel bars to resist tensile strains due to wind pressure loads, and rectangular hoops, lapped and tied by wire, to bind the bars at vertical intervals of 12 inches.

As mentioned above, the main girders between columns are of 16 to 33 foot span, and those of the first floor, including floor slabs, have a depth of 36 inches, those of the second floor 34 inches, and all above the latter 27 inches. The width throughout is 20 inches. They are formed monolithic with the walls, columns, and floors, and the extremities of their horizontal steel rods project into the columns between the vertical reinforcing members of the latter. The girders are additionally strengthened by alternately inverted U-bars of twisted steel. The junctions with the columns are reinforced by vertical diagonal twisted bars, from the top of the girder downward, and from the bottom upward into the body of the column, the lower ones being concealed in concrete brackets.

The exterior walls, exclusive of facing, are 8 inches thick, with the exception of those in contact with the walls of adjacent buildings, and these are from 3 to 4 inches thick. All are reinforced by vertical and horizontal twisted steel bars. The exterior facework is of 4½-inch marble for the three lower floors, and above these of glazed bright gray brick with terra-cotta trimmings. The brick facing is supported at each floor by a ledge formed in the concrete, and is also secured by wire anchors projecting from the concrete. The marble facing and the terra-cotta trimmings are provided with grooves in the back, the top and bottom surfaces of which have upward inclinations. These grooves engage with ribs of similar section on the face of the concrete, and thus form a species of dovetail joint. The exterior window and door frames are of cast iron for the first floor, and of sheet iron for the remaining stories. There are four hydraulic elevators running in concrete wells for passenger and freight purposes, and two for use in connection with the floors below the surface level. The space beneath the sidewalk is utilized, and in this connection concrete retaining walls are employed.

For the installation of the concrete steel construction, three stories of interior forms and two stories of exterior forms were used. The method of employing these forms is illustrated in the first of the accompanying engravings. The interior forms of each story were removed in twenty-one days, and were used for the construction of the third story above. The exterior forms were removed in fourteen days, and applied in the construction of the second story above. At the time the photograph was taken the ninth floor, with its beams and girders, and the columns of the story below, had been completed in about twenty-three days, and its interior forms had been raised to be used for the twelfth floor and the eleventh story columns. The exterior forms for this floor had been raised from the tenth floor and the ninth-story columns, which were completed in about fourteen days. As the forms were raised, the portable scaffold, shown at the tenth and eleventh floors, was raised coincidentally with the forms.

At the fifth floor level may be seen the swinging scaffold employed by the general contractor for the brickwork. At the second story is shown the marble facing and its strap-iron anchors projecting from the concrete wall. These anchors, which were used in addition to the dovetailing described above, are placed at joints in the marblework, and each has a small steel pin which passes through a hole in the anchor and is fitted into a recess cut into the marble. The black waterproof paint, seen at the third story, was employed to insure the marble against the possibility of stain from the concrete. This paint was applied at the time when the forms were removed, thus offering a means for a thorough inspection of the surface of the concrete as the building progressed and as the load increased. It is claimed that this paint has since remained in as perfect a condition as when first applied. All the stories up to and including the ninth were in the process of being plastered, and all other branches of the work, such as the installment of the marble-work on the floors, doors, and partitions, the heating, plumbing, and electric work necessary for completely furnishing the interior, were being completed, for each floor formed a perfect roof as soon as concreted.

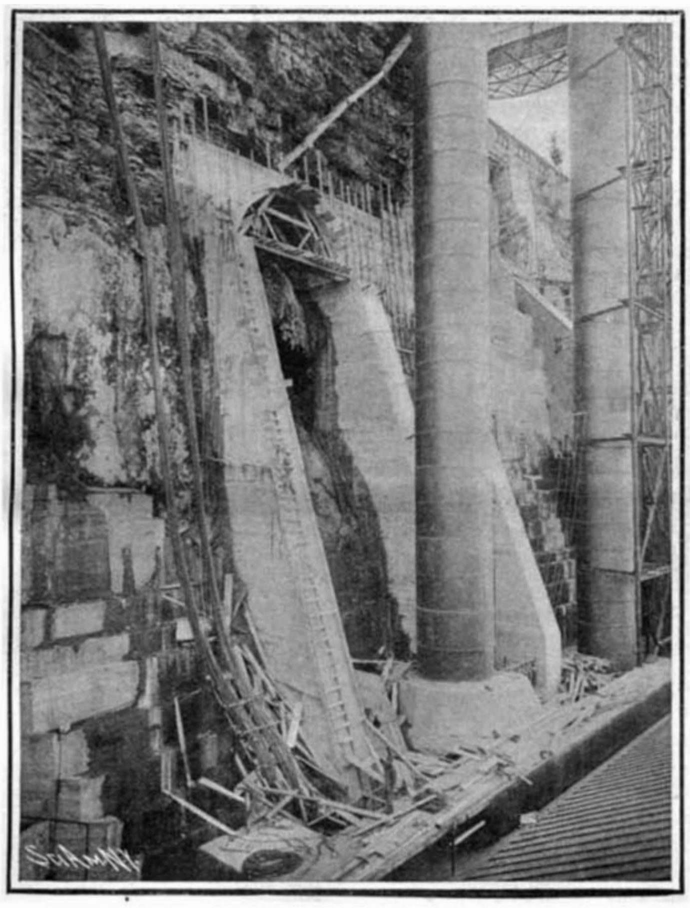
The second photograph is a view of the third floor, showing the beam and girder forms filled with concrete, and the completion of the floor above about to be accomplished. At the extreme left is shown the method of providing round steel bars to furnish compressive resistance that the area of the column may be reduced. The bars are carried to a point from 6 to 18 inches above the floor level, and rest directly on the tops of the bars below, with a joint made with an inclosing pipe sleeve filled with neat cement. At this point also may be seen the method of employing twisted steel uprights, diagonals, and horizontals in the columns and tops of girders at the supports, to resist wind and floor load stresses. In the foreground are shown the twisted steel U-bars used to assist in withstanding longitudinal sheer in the girders.

A GREAT CONCRETE RETAINING WALL.

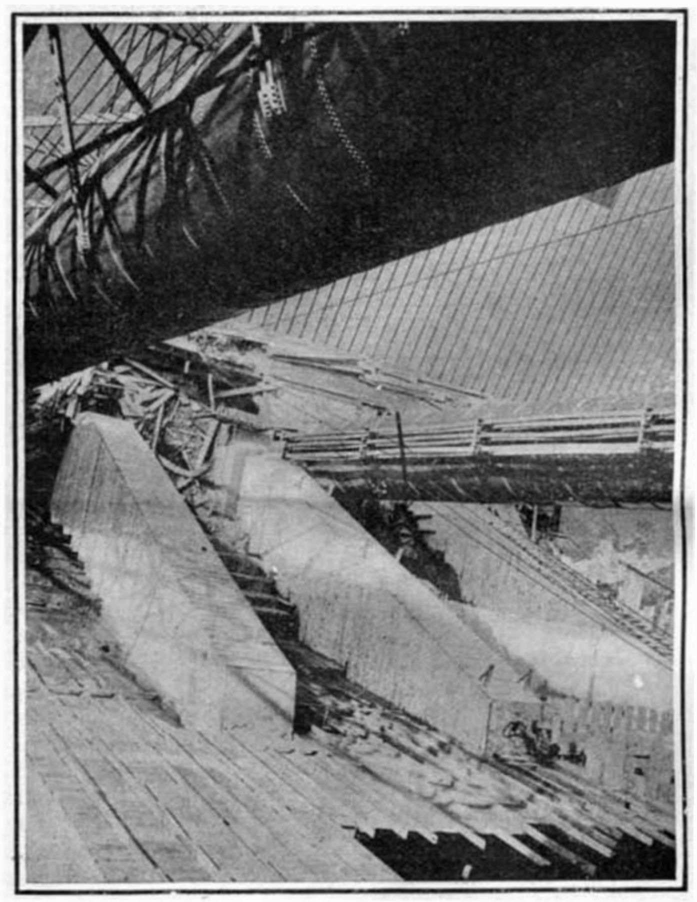
BY ORRIN E. DUNLAP.

What is believed to be the highest concrete wall in existence has just been completed by the Niagara Falls Hydraulic Power and Manufacturing Company at Niagara Falls. This remarkable work was made necessary by the slow but constant deterioration of the cliff to the rear of the company's power station, which is situated at the water's edge in the gorge, on the New York side of the river below the upper steel arch bridge. At this point the talus or apron of fragments has been cleared away to make room for the power house. The cliff is vertical, the rock being limestone at the top, resting on gray shales, which the rain and frost more or less affect. It is claimed by geologists that the recession of the Falls of Niagara is due to the destruction of the shales, leaving the heavy limestone without the support of the softer rocks beneath, so that from time to time huge blocks break away and fall into the river below. To-day, where it is possible to look under the sheet of falling water of the Falls, the limestone would evidently be without support; that it projects out shelf-like, and no doubt will in time break away. Knowing that this action was taking place at Niagara, the Niagara Falls Hydraulic Power and Manufacturing Company felt that in time the deterioration of the shale back of its power station would injure the strength of the supports of the limestone above, and thus endanger the retaining walls of the forebays, while the possibility of falling rocks was a source of danger to the power house as well as the employes and workmen about the power station at the water's edge. While this prospective danger was unquestionably a very long way off, the realization of its occurring caused the company to take careful steps to avoid it, thus anticipating any likelihood of injury to its employes or power station.

It was these conditions that resulted in Chief Engineer John L. Harper designing the facing wall referred to. He found that the cliff had previously been faced up to the shale, at which time the possibility of extending it to the top was not considered. It was therefore deemed advisable to construct three pilasters to give the upper and heavier parts of the facing wall a more stable support. The wall is made of 1-3-5 concrete filled with a clean rubble. Its length is about 200 feet, and it is not less than two feet thick at any point. The wall drops to the level of the tail water, and extends fully 150 feet above the eaves of the power house, which are 30 feet high, making a facing 200 feet high composed of about 7,000 cubic yards of concrete. The pilasters are 5 feet wide and 80 feet high. In places the wall has a thickness of as much as 12 feet.


The Highest of Concrete Walls.

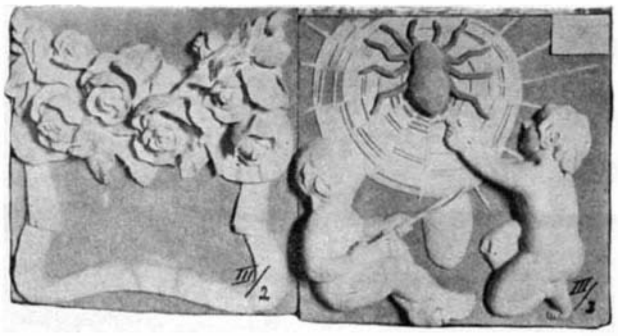

Character of Cliff Above the Wall.


Bird's Eye View of the Pilasters of the Concrete Wall.

A GREAT CONCRETE RETAINING WALL.

A series of experiments made by Chief Engineer Harper would indicate no danger of the water, resulting from seepage, freezing behind the wall, as it was found that the water never attained a lower temperature than 39 deg. F. at the outside of the bank in the most severe conditions of wind and weather. The removal of the water is abundantly provided for by means of weepers.

In one of the accompanying pictures of this notable work an arch shows. This was built for the purpose of protecting a natural grotto, in which a spring is located. This has been most successfully accomplished without in any manner detracting from the strength



Bas-Relief Made With One Part White Cement and Three Parts of Sand.

Bas-Relief Stamped in a Mold of Plaster and Made With One Part White Cement and Four Volumes of Sand.

and usefulness of the facing wall, by arching the grotto.

It is worthy of note that all the sand and stone used in this construction was dumped on the east side of the terminal railway tracks about 300 feet back from the edge of the bank, from which point it was carried by means of an aerial cableway to a concrete mixer that stood near the edge of the bank. The mixture was dumped into chutes that carried it to the point of use, without causing a separation of the concrete mixture, the mass sliding as a unit in the chutes which were steep, smooth, and small. The scale on which the work was done called for the placing of from 80 to 90 square yards of concrete every day.

THE ARTISTIC POSSIBILITIES OF CEMENT.

The use of cement is becoming more and more important, not only to the architect, engineer and builder, but also to the artist, for plastic and sculptural purposes, and few realize that, unlike Italian terra-cotta, it can be made to withstand the rigor of our northern winters, and is equally impervious to heat and dampness. With certain treatment, a color, texture and durability is obtained, reproducing to a remarkable extent the old stone figures of another age.

In a recent visit to Mr. W. R. Mercer's studio, the writer was able to convince himself of this. Hitherto, cement for plastic purposes has been of a cold, gray, flat tone, which did not lend itself to the ancient forms and ideas, but after some years of experiment, Mr. Mercer seems to have found a method by which he overcomes this defect. The lover of art is thus able to have within his reach some of the famous examples of ancient sculpture at a naturally much reduced price.

In the studio one may see fonts, urns, busts, bas-reliefs, etc., all destined for the decoration of a garden, which is Mr. Mercer's specialty. One of the great troubles encountered at the beginning of his experiments was the making of a mold that would incase the cement and not take it in so close an embrace as to render its release impossible without breaking the cast. This problem was solved by the use of flexible molds, prepared in such a way as to avoid the repeated failure caused by the casts sticking and the cement not properly hardening before the disintegration of the composition used in the mold.

It is hard to enumerate the difficulties that beset the artist at this juncture. Cement is a non-combustible, hard, very durable and cheap material, which can be cast in a cold state by simply mixing with water—hence its great adaptability to the fine arts. It is, however, less ductile than plaster of Paris, and though this difficulty has been overcome by stirring, pressure and other methods of application, its gray color and unsympathetic texture have chiefly repelled the artist. In combating the color certain pigments vitiate the strength of the cement, others do not. Some act chemically upon it so as to transform the tint of the mixture. Certain cements neutralize or weaken when colored more quickly than others, while the rapidity with which the cement dries, whether in the sun or dark, or whether more or less subjected to dampness, will be found to influence the color, or even vary the natural gray tone itself. Further, the method of application of the color, whether injected entirely through the cement before setting, applied during setting from the mold, or incrusted upon the latter in a comparatively thin envelope during setting, modified the result.

As to the texture, certain masses of cement, falling upon the earth outside of molds, or hardening inadvertently in bags and boxes, have assumed this texture of stone, while other masses present a very unpleasing nondescript surface. When molds are used this non-ductility of the material requiring stirring may blotch the surface with areas where the finer particles seem to have collected in a sort of paste. On the other hand, when cast too dry, the cavities are not properly filled. Owing to these difficulties the cement will not always take the texture of the mold, therefore one must resort to other means. The mold itself may be incrusted with ingredients which will communicate their texture to the cement, or materials, coarse and fine, may be introduced into the original mixture so as to modify the result. In a word, the cement is merely a glue causing the gravel and sand to adhere to each other, and is used as a medium and not as a base. The process, which any one can work out for himself if he wishes, lies almost entirely in the adding of certain ingredients to the raw cement. The texture and color are matters of workmanship and taste. When the process is learned it will be possible to reproduce almost any work of art with the accuracy of the copies seen in the illustrations. Once the mold is made there is practically no limit to the number of reproductions.

The production of a white cement has been the endeavor of many investigators, and even at the present time, the problem cannot be considered completely solved. It is the powerful coloring action of the iron which has proven to be an insurmountable difficulty in the practical utilization of many a good idea. It has been an undoubted step forward that Julius Gresley, of Liesberg, Switzerland, contents himself with the production of white Roman cement and does not attempt to produce white Portland cement in which the high burning temperature and the hardness of the clinker substantially increased the chief difficulty mentioned. White cement will probably be always used for the attaining of artistic effects, and for this purpose the strength of Roman cement is quite sufficient. Gresley mixes clay free from iron, particularly kaolin and pipe clay, with lime in such proportions that the clinker is constituted according to the chemical formula

$x(SiO_2 2CaO) +$
$y(Al_2O_3 2CaO)$ or
$x(SiO_2 2CaO) +$
$y(Al_2O_3 2CaO) +$
$2(SO_3CaO)$

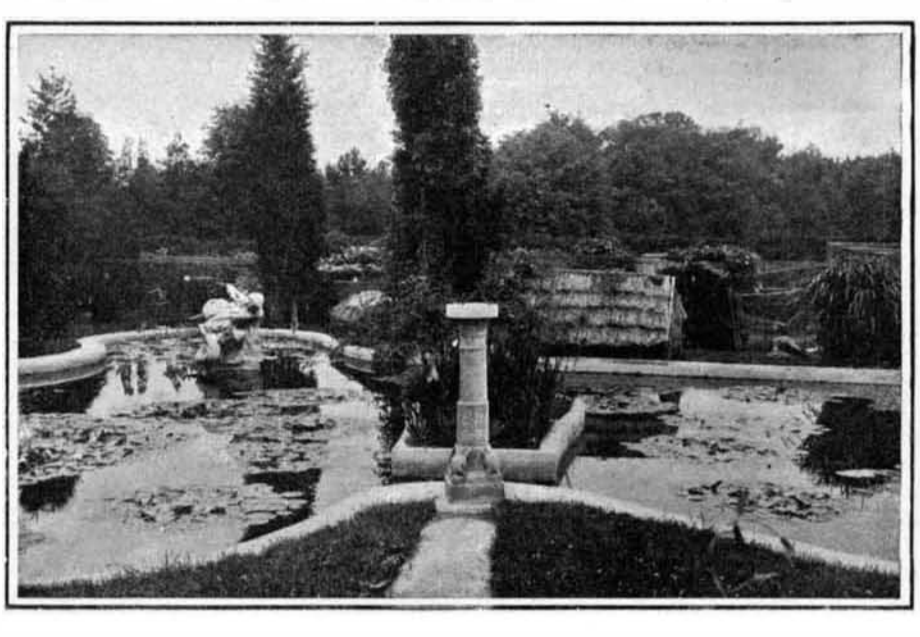
and thereby attains a white cement, answering all proper tests in regard to tensile and compressive strength and which either with or without added coloring matter, lends itself excellently for decorative purposes. We publish herewith two illustrations from photographs of decorative work made of "Marbrit," the name under which the raw material for the production of the Gresley white cement is known, and these show the excellent results obtainable with this substance.

The Figure and the Pedestal are of Cement.

The Genesis of the Chauffeur.

Chauffeurs existed, says Figaro, long before there were automobiles. History tells us that along about the year 1795, there sprang up in France, principally in the eastern and central regions, fantastically dressed men with their faces blackened with soot and their eyes carefully concealed, who gained admittance to farm houses and other isolated dwellings at night and committed all kinds of depredations and outrages. They had an atrocious habit especially, from which they obtained the name that posterity has preserved for them. They first garroted their victims, and dragged them in front of a great fire, where they burned the soles of their feet. Then they demanded of them where their money and jewels were concealed. Such interrogatories could scarcely be resisted. It is from this that is derived the appellation of "chauffeur," which once so terrified old ladies, but which at present evokes in us only cheerful and pleasing thoughts of automobilism, and of voyages and excursions at twenty-five and thirty miles an hour, in which there is nothing but the roads and paved streets that are scorched.

Aluminium and lead will not alloy. They mix when melted, but separate when cooling.



A Sun Dial Cast in Cement in Imitation of the Font of Turtles.

A Cement Flower-Box. The Original Has Been so Closely Imitated That Even the Wear of Time Has Been Reproduced.

THE ARTISTIC POSSIBILITIES OF CEMENT.