(Read at the stated meeting Thursday, January 2d, 1908.)

Cement—Its Use and Abuse.

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In a recent Government publication, Mr. Gifford Pinchot, Chief of the Forestry Bureau of the Agricultural Department, makes the following statement:

“In twenty years we may be in the midst of a lumber famine. We have enough standing and matured timber to last that long. With the timber that is growing the famine may be put off five years. One-fifth of the standing timber is embraced in forest reserves. The rest of it belongs to private ownership. We must be economical in the use of lumber.”

This fact is corroborated in other Government publications, in speeches by Government officials and in the publications in trade papers representing the lumber industry, the period of time now being reduced to fourteen years. The question, therefore, in view of the destruction of the lumber of our country, is, what material shall be substituted for it? In a new country, with primeval forests, it was but natural that the pioneer and those who followed him in the transformation of clearings into farm lands and cities, should use the resources at hand, and lumber was the first material employed in the construction of our homes, the making of our sidewalks, the building of our highways and railroad bridges and the laying of our first sewers and water mains. As time progressed and wealth and civilization grew, materials of a more fireproof and permanent character came into use, but nevertheless the great consumption of timber kept on until the state of affairs above described has come about.

Steel, stone and brick have all been used in the developing stage of our country as substitutes for lumber, all having their advantages and all representing varying elements of cost. Within the past ten years the development of our natural resources has included the utilization of enormous deposits of land available for

cement-making, which, together with the wonderful mechanical inventions of American cement manufacturers and experts in the production of the cheapest and best Portland cement in the world, has brought about the introduction and establishment of a new, permanent and economical building material, namely, Portland cement concrete.

In considering this new material, whose name indicates its quality—CONCRETE—we must analyze what it is and of what it is composed: (1) Cement, which is the strong binding material; (2) Sand, which is the first aggregate and with which the strong binding material (cement) is primarily mixed; (3) Water, the element that causes the hydrating action of the cement upon the sand; (4) Stone, the large aggregate which is bound together by the material formed of the cement, sand and water. Thus far the actual physical elements constituting this new material, concrete, are closely defined, but there is one element of a human character that goes into the making of this new building material and which is the prime element in its successful manufacture. That element is CARE, CARE, CARE.

It would seem that in the consideration of concrete as an element of construction, it has possibly had too much treatment from the extremely scientific and engineering standpoint, and the writer desires to consider it rather from a new standpoint, namely, that of a manufactured material. In the specifications for the steel that enters into the construction of a building or bridge, every element of chemical and mechanical test is prescribed by the engineer or architect. The steel beam, girder or column is made under the most rigid supervision of chemical and scientific experts in shops or works of the most approved character, and is finally, as the completed and finely finished, fully inspected and scientifically determined, building material, delivered upon the work. This beam, girder or column is a finished building material.

In the matter of concrete the cement has been carefully manufactured in a reputable, well constructed and well officered plant. It has met the chemical and scientific tests of the manufacturer, the inspector and engineer. It is brought upon the work as a finished product so far as its bonding qualities and permanent elements as a cement are concerned. At this point, the writer contends, a manufacturing process begins, and a manufacturing process on the success of which the entire construction of the

building, bridge or other edifice depends. To this cement, so scientifically manufactured and determined, is added a sand, the requirements of which may have been covered in a couple of lines hastily thrown together in the specifications, and which, in nine cases out of ten, has had no other test than the mere rubbing of it between the palms of two hands to determine whether or not it shows clay or other coloring substances.

The stone, similarly delivered upon the job, has had no serious inspection other than possibly to know the percentage passing through a two-inch ring. The water, which may contain all sorts of deleterious substances, is seldom, if ever, analyzed, and with these three materials, the qualities of which, in nine cases out of ten, have never been determined chemically or physically, the preparation for the manufacture on the job of the finished beam, girder or column of this new material—concrete—is begun.

When it is considered that the proportion of the cement is 1, of sand 3, of broken stone 6, and the whole to be made plastic and of just the right consistency with water, it can be readily understood that at this point of the manufacturing process there is a possible chance for error in some of the ingredients other than the cement, which is the only one fully equipped at the start for its work by reason of its scientific and careful manufacture, and careful and accurate tests.

When the proposition is stated that the making of concrete is a manufacturing process on the work, every architect and engineer can readily appreciate the importance of knowing the character of all the ingredients entering into his manufactured article, and the writer's purpose in raising this point is to secure the same examination for sand, stone and water as is secured for the cement prior to use in the new manufacturing process.

When the ingredients, properly selected and tested as they would be in any well regulated manufacturing establishment, are brought together there then should come on the part of contractor and engineer the same careful attention, vigilance and thought that govern any other large manufacturing enterprise, and in the making of the beams, girders and columns and other details of a building of concrete, there should be exercised the same care, the same watchfulness and the same everlasting attention to details as is exercised in the manufacturing establishment producing the steel beam, girder or column for a similar building under simi-

lar conditions. The best illustration of the point made above is shown in the little steel beam that I have here and in the jars of the various ingredients entering into the little cement beam also shown. In the one case, all the materials entering into the steel beam have been used and the beam itself finished before it is brought upon the work, while in the other case the materials in these little jars are all separated and the actual manufacture of the concrete beam takes place upon the work itself.

Now, bearing this thought in mind, the causes of failures of concrete become somewhat clearer; they generally go to faults in construction—what I call the “manufacture” of the building. There has never been known, so far as my information goes, the failure of a complete concrete building, though the records are full of cases where such buildings have been loaded beyond the calculated strains, and where in fire they have stood exposure that would have been fatal to buildings of other materials. The failures are always in construction; they always occur through some fault in structural design or in the use of poor sand, poor stone, poor water, poor workmanship, and never in the cement itself. An examination of the reports upon the concrete failures for a single year—some five or six in number—will show conclusively that they occurred only in course of construction, in every case being explainable from one of the causes above mentioned, and illustrating as clearly as can be illustrated to the engineer and architect the point that the writer makes, namely, that the construction of concrete buildings is a manufacturing operation and requires the same care, skill and diligence as the running of any large manufacturing plant.

As illustrating this proposition very clearly, the photograph herewith shown of the failure of the Bridgeman Building, in Philadelphia, sets forth exactly the reasons of a concrete failure. In this case it was alleged that the work was carelessly done, the supports were removed too soon and many other errors committed.

One remedy, and one which is likely to come to prevent some of these mistakes, will be the manufacture of cement lumber, or beams and other forms of building construction in the shape of units, in yards or factories away from the work, and the delivery of this cement lumber upon the job, precisely as lumber is now delivered. The development of the Cerutti, Siegwart, Perrot and

other unit form systems of cement lumber is likely to be one of the great features in the growth of concrete construction.

In considering, therefore, this new building material, the writer desires to divide his subject into several heads and to deal with concrete, (1) as a structural material, (2) as an architectural material, and (3) as a decorative material.

As a structural material, concrete in its successes is too well known to need much description at the writer's hands. Building

Philadelphia building collapses. Showing weak character of supports, many of which are spliced. statistics in this country alone disclose the fact that a great many buildings over eighty-five feet in height and from eight to sixteen stories, have been erected within the short period in which concrete has been used for this purpose and that there are numbers projected, under way or finished in all parts of the United States of the height mentioned. As to the use of concrete in reservoirs, dams, bridges, culverts, tunnels, sub-ways and all other forms of engineering construction, the scientific and engineering papers are full of accounts of such work. It is therefore of the abuses of concrete as a structural material that the writer desires to speak.

Having assumed that as a manufactured material concrete in

its various forms has been made of proper ingredients and with proper care, the next question comes as to the proper designing of concrete buildings. The designing, so far as the writer is aware, has rarely, if ever, been the cause of serious criticism, but it is in the carrying out of the designing that errors frequently occur. Experience has shown where columns have been improperly placed in course of construction, where beams have not been properly anchored, where reinforcing members have been put in upside down, where expanded metal has been laid with the mesh running the wrong way, and many other cases involving similar errors have been brought out in investigations of concrete construction. The results of such work are shown in the photograph of the Bridgeman Building referred to above.

As some of the concrete failures have been due to the premature removal of the timbering, there have been made a number of suggestions to obviate this, whereby, during the construction of the building, the load would be carried upon especially designed columns, and the final load would be carried by the cement used in the types of columns referred to. Thus there has been made the suggestion of a column made of sheet-iron cylinders which are filled with concrete, the cylinders carrying the load during construction and the hardened cement carrying the live load of the building when in use. Lattice columns designed by Professor Burr and used in the McGraw Building, in New York, furnishes another type contributing to the same result. Mr. Ross F. Tucker, of New York, uses for his columns large cement cylinders, two inches thick, which are in turn filled with concrete and which carry the construction load. This also forms an admirable fireproofing protection to the interior concrete and reinforcement.

All these suggestions and improvements are likely to add much to the safety of concrete work during construction, and would obviate many of the dangers which are improperly imputed to concrete.

Another suggestion made is, that in order to prevent the removal of the forms at too early a date, the contractor should have sufficient lumber to permit of the locking of these forms for a fixed term of days or weeks, to be determined by an examination of similar concrete laid under similar circumstances under the City Building Inspector's supervision on the job itself, and that the unlocking of the forms should only be done by him or his subordinates at a time when he is satisfied that the concrete has

actually hardened. As illustrating the construction of concrete buildings under the most favorable circumstances there are shown the following:

A substantial concrete building, designed by Ballinger & Perrot architects and engineers, Philadelphia.

The highest concrete building in Philadelphia. Plant of the Ketterlinus Lithographic Manufacturing Company, designed by Ballinger & Perrot, Philadelphia.

In dealing with concrete as an *architectural material*, an entirely new field has been opened up. Originally, designers of concrete houses in this country sought to make concrete tell the tale of stone, and by treating it as stone, made blocks imitating stone with which houses have been constructed in many parts of

Concrete columns and girders in the plant of the Victor Talking Machine Company. Camden, N. J.
An excellent illustration of this type of construction. Ballinger & Perrot, architects.

the country. While many of these houses built of blocks are to-day most excellent in design and construction, there is no question that some of the earlier ones—an example of which block is herewith shown—fail in artistic beauty by seeking to imitate with

Example of block intended to represent rock surface finish.

the plastic material, cement, the rigid material, stone. Cement is capable of much greater beauty when treated as a plastic material. That blocks, however, can make a beautiful house is shown by two illustrations of the Steers Mansion, at Greenwich, Conn. This house demonstrates that block construction, when properly treated, may result in beautiful exteriors, and further proves the

The residence of J. R. Steers at Greenwich, Conn., constructed of hollow concrete blocks, made by the dry process. An example of the approved usage of the concrete block as applied to residence work. Cost \$300,000.

Moyer residence. A true concrete house in which aggregate is exposed to give color and pleasing texture.

fact that the architectural defects in many of the houses of block construction are not to be charged to the blocks, but are attributable to the manner in which cement blocks have been designed or used.

It is, however, in the field of monolithic construction that concrete is doing its best work. The prominent architects, Carrere & Hastings, demonstrated the beauties of this form of construction when they erected for Mr. Flagler that beautiful group of hotel buildings at St. Augustine, Florida, and emphasized in this form of construction the antiquity and the Spanish atmosphere of that oldest American city. The adaptation of concrete to these beautiful forms of construction, its decorative features when used in combination with tiles, speak volumes for its decorative possibilities. This is also shown in the houses in Southern California, patterned after the old missions and kindred Spanish designs, red hand-made tiles furnishing the color. In the East a beautiful treatment of concrete is shown in the Moyer house, where the solid structural elements of the material are displayed, together with its decorative possibilities when encrusted with tiles.

In the artistic treatment of concrete, our architects have already learned much and are developing to-day in this great country of ours forms of concrete architecture that will be surpassed in no other country. With this material there will develop here a school of architecture, typically American, embodying within itself the beauty of the antique as well as every modern element that this day requires. The discussion of concrete at the recent meeting of the American Institute of Architects, at Chicago, shows the growing interest of the American architect on this subject and his faith in the future development of concrete construction.

So far as the use and abuse of concrete in *decoration* and treatment of surfaces are concerned, much might be written. Already reference has been made to the various methods of applying it in architectural designs and this leads naturally to the best possible treatment of the surface of concrete to secure satisfactory results. Possibly the Moyer House, which has a peculiar surface, affords one of the best illustrations of the pleasing effect to be obtained upon a concrete surface. A short description of how this was accomplished is as follows, written by Mr. Moyer himself:

"The aggregates used in the house described are composed of

Detail of Moyer house, showing application of colored clay tile on mosaic as window border with wall ornaments above. Also colored mosaics and tile.

1 part Vulcanite Portland cement, 3 parts limestone and white marble screenings about the size of sand, 5 parts of three-quarter-inch trap rock, 1 part rock and 1 part of one-inch white marble chips. When the boards were taken down the surface had the appearance of ordinary dead mouse-colored concrete, but as soon

Mercer tiles in Concrete, Racquet Club, Philadelphia. Column of Byzantine pattern in original unplastered concrete supporting heavy ceiling. The capital is ornamented with colored tiles, glazed and unglazed, flat and in relief. Colors, yellow, green, blue, gray, red, white and buff. Tiles were applied after removal of forms and the exposed undecorated portions of column left just as they appeared after removal of forms so as to develop contrast with tiles, both in color and texture.

Concrete bridge baluster treated by Quimby process. One part cement, three parts unscreened dark stone grit.

as scrubbed and washed with a hose, all the particles of trap rock, white marble chips, bonded together by light-colored mortar, were exposed, giving a surface which was slightly roughened, and a color effect and texture which are beautiful. Photographs do

not do justice to the color of this wall; it is bright and full of life. It is a true artistic and picturesque monolithic concrete house."

The work of Mr. Quimby, described in "Cement Age" of November, 1906, is also most interesting and instructive. Some of his surfaces shown herewith suggest other methods of treating concrete surfaces.

Mr. Henry C. Mercer has also developed in the Racquet Club, Philadelphia, practically a new school of concrete decoration and artistic treatment. Some of the accompanying illustrations show what can be done with cement and tiles by treating concrete frankly, even though these views indicate imperfectly the importance of this work, for you must picture to yourself the brilliant color of the tiles and the contrast between the dull gray of the cement and the mass of decorative color embedded within it.

So far as the abuses of concrete surfaces are concerned, the cast "cut-stone" blocks above referred to are fair illustrations, and it may be stated as a broad proposition that concrete is concrete with its own tale to tell and has a surface of its own to speak for itself, and wherever this surface is changed into some other material or some other surface, imitating some other material, it is very likely to be wrong from a decorative and artistic standpoint. The exception is where it is hammer dressed or cut by tools, as in the case of stone. This is an important distinction I wish to emphasize. Given two blocks of stone, one of concrete or artificial stone, and the other natural stone, it is manifestly possible to have them equally meritorious by cutting both or treating them in the same fashion, for in surface decoration we have by this method removed concrete from the domain of a plastic material. But when we attempt to reproduce this cut surface by casting it in a mold, then we do violence to a plastic process or art which results in monotonous repetition. Of course, this does not apply to columns, capitals or cornices. I am speaking of broad surfaces in monolith or made up of many units.

In conclusion, the writer can only add that from a long experience in the cement manufacturing industry, dating back to its pioneer days, in the early seventies, he has seen the growth of the industry himself and the growth of all the uses of this wonderful material, cement, and looking back over the long period covered by his connection with the industry, he has seen the great growth of concrete construction in all its forms to a degree beyond the

Mercer tiles in Racquet Club, Philadelphia. View of detail in Gothic fireplace adapted from original of the 14th century in castle at Trebbio, district of Sicci, near Florence. Frieze, banding and columns composed of glazed and unglazed tiles applied after the construction of the fireplace. The flatness of the large concrete area or face is broken by widely placed relief tiles silhouette.

expectations of the most sanguine. He has seen concrete gradually take the place of other materials because of its great strength, its fireproof qualities and its economical elements. He has seen it develop from the architectural and engineering standpoint; he has seen it grow in decorative and artistic possibilities, and it is his conclusion that concrete honestly, carefully and properly made, in buildings properly constructed and designed, will, with the present knowledge of the architectural capabilities and the artistic qualities of concrete, ultimately supersede for most uses the present materials of construction.

AMERICA USES MANY BARRELS.

Upwards of 150,000,000 barrels and circular packages are manufactured in the United States annually. Few people, except those whose business it is to know, realize the extensiveness of the cooperage industry in this country.

The heaviest demand comes from the cement business. The flour business ranks next, closely followed by sugar. Containers for fence staples, bolts, nuts, nails, and packages for roasted coffee, spices, crockery, fruits, vegetables, follow in the order named, while glass manufacturers, baking powder companies, liquor distillers, and candy, tobacco, and cheese packers are big users of barrels. The demand for barrels for molasses, oil, lard, and pork is also enormous, while dry paint, glue, snuff, oatmeal, screws, castings, and general hardwood articles annually increase the demand on the cooperage supply.

While the amount of expenditure for barrels can be quite closely estimated for a given year, it is not possible to say how many barrels are in actual use. The life of a barrel is put down at one year by the trade, but this is far from true. A majority of barrels are used many times. They begin as sugar or flour barrels, and are then sold to the farmer for shipping his produce to the market. It may be that they are returned to him several times, carrying potatoes to the market on the first trip, and tobacco or lettuce on the next, each cargo being lighter in weight than the previous one, owing to the weakened condition of the barrel. Finally the barrel may serve out its work as a refuse receptacle, and in the end can be used for fuel. Thus, it may be said, that a barrel fills as useful a career as almost any other manufactured article, and its life is much longer than a season.

The demand for barrels is steadily growing because modern machinery has made it possible to make them for the trade cheaper than almost any other form of durable package. That it is the most convenient form of package has long been acknowledged. The timber used in tight barrels has to be selected with care, as it must not only be water-tight, but barrels for the oil, whiskey, and paint trades in addition must be capable of resisting high internal pressure. The lumber used for this work must be carefully selected, that cured by slow air drying under shelter being the most satisfactory.