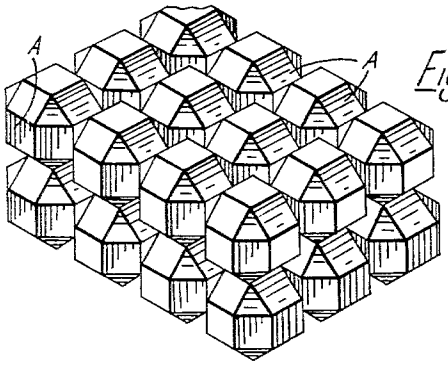
Jan. 18, 1966 G. M. ADIE 3,229,437

CONCRETE STRUCTURES

Filed Sept. 19, 1962

Fig. 1.



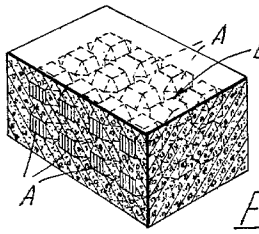


Fig. 8

Fig. 2

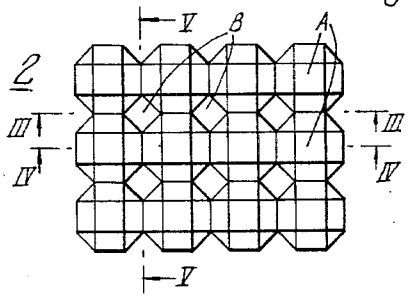


Fig. 3.

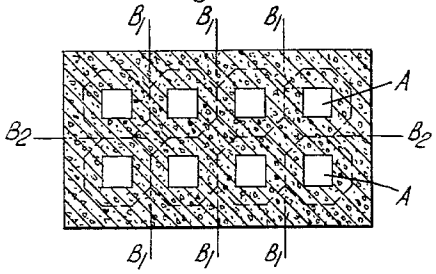


Fig. 4.

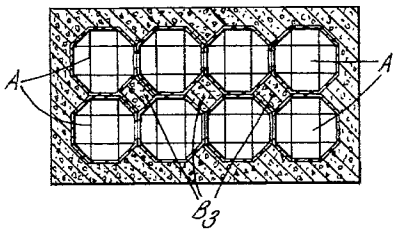


Fig. 5.

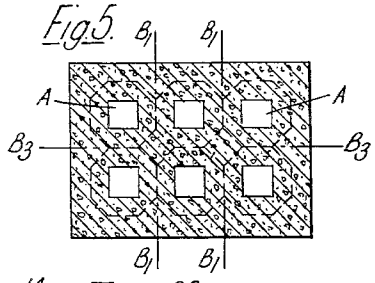


Fig. 6.

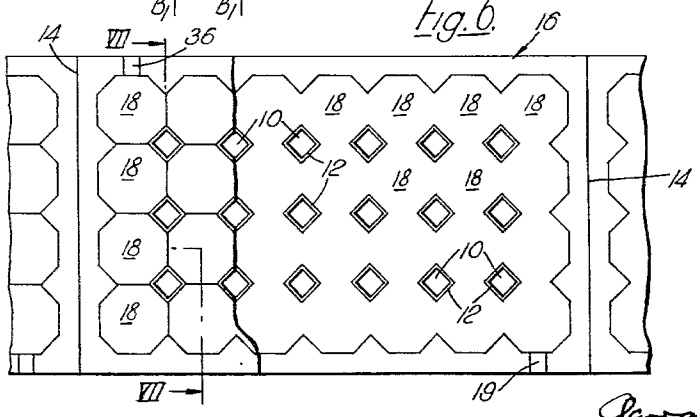
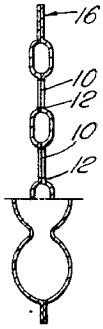


Fig. 7.



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CONCRETE STRUCTURES

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Claims priority, application Great Britain, Sept. 3, 1957, 27,841/57
3 Claims. (Cl. 52—576)

This invention relates to monolithic structures and is a continuation-in-part of my copending application Serial Number 758,837 filed September 3, 1958 now abandoned.

One of the main economy factors affecting the design of concrete structures is that of the weight or quantity or bulk of material used. The amount of concrete demanded in a structure in order to provide the necessary strength is not the same at all places in the structure. Nevertheless, the members or sections of a concrete structure are frequently made of uniform cross-section for simplicity of construction and other reasons and consequently more material is used than is theoretically necessary. In the case of walls and other supporting members, certain width to height ratios are normally adopted which lead to the use of a quantity of material in excess of that demanded by considerations of compressive strength. In the case of certain types of dams, a certain thickness is required to resist overturning and this generally leads to excess weight of material being used.

The invention is concerned with a system of construction which enables a concrete structure to be given desirable dimensions or a desired overall bulk without involving the use of a weight or quantity of materials corresponding to that overall bulk.

In its broadest aspect, the present invention consists in the construction of a cellular monolithic structure the inter-cellular spaces in which form a three-dimensional grid.

In the ideal structure in accordance with the invention, the cells are 26-sided regular geometrical figures of which all the principal cross-sections are octagons. In that case, the grid system is of identical cross-section in each of the three principal mutually prependicular planes and the grid members are of square cross-section.

For a given bulk, the amount of concrete used in such a structure is quite small. In the ideal case just cited, it is 25% of the bulk and a very important economy can arise in the cost of transportation and handling of the materials (cement and aggregate) of the concrete. However, the cells themselves, which must be physical cells and not mere voids, are bulky and this may lead to transportation and storage problems of their own. Accordingly, the invention includes also within its scope the production of the cells on the site by means of inflatable elements.

Such inflatable elements can be in the form of fluid tight containers adapted, on inflation, to become locally swelled to form a series of interconnected cells. A tube the expansion of which is restricted locally at intervals along its length can constitute such an inflatable element. In its preferred form, however, the element is in the form of a bag which is flat in the deflated condition and is provided with holes allowing for passage of the material of the structure, inflation of the bag leading to swellings clustered round the holes and which approximate to polyhedrons or to spheres which in use are flattened so that they approximate to polyhedrons.

The invention also includes within its scope monolithic structures of opposite construction to those described above, namely, in which the cells are filled with the structural material while the three-dimensional grid system is void.

In order that the invention may be thoroughly understood, it will be further explained with reference to the accompanying drawings, given by way of example, in which:

FIGURE 1 shows in prespective an assembly of cells;

FIGURE 2 is a plan view of the assembly of FIGURE 1;

FIGURE 3 is a section on the line III—III of FIGURE 2 with concrete cast over the cells;

FIGURE 4 is a section on the line IV—IV of FIGURE 2 with concrete cast over the cells;

FIGURE 5 is a section on the line V—V of FIGURE 2 with concrete cast over the cells;

FIGURE 6 shows an inflatable bag for use in accordance with the invention, and

FIGURE 7 is a section taken on the line VII—VII in FIGURE 6 showing the bag in the inflated condition;

FIGURE 8 is a perspective view of the assembly of cells of FIGURE 1 with concrete cast over the cells.

All the cells A shown in the drawings are identical each being a polyhedron having 26 sides, the principal cross-sections of which are octagonal. As the cells are regular, the side elevation and end elevation are similar to the plan of the assembly shown in FIGURE 2. Any row of cells defines with the neighbouring row a series of passages or ducts of rectangular cross-section. There are, in fact, three series of such ducts in the three principal planes, these being shown in solid form in FIGURES 3, 4 and 5 the centre lines being indicated in dot and dash lines at B_1 (vertical), B_2 (horizontal in one direction) and B_3 (horizontal and perpendicular to B_2). As the intercellular spaces form a regular three-dimensional grid system concrete can be cast over and around the cells shown in FIGURES 1 and 2 to produce the structure shown in FIGURE 3, 4 and 5.

The unwelded area of the bag is formed of a series of contiguous octagons **18** as shown by the dotted lines in FIGURE 6. If the bag is inflated (through the inlet **19**) the octagonal areas **18** will be swelled into intercommunicating cells or swellings which approximate to the polyhedral cells A of FIGURES 1 and 2.

If a number of inflated bags are laid on top of each other, the square holes **10** will form ducts which correspond to the ducts B in FIGURE 2, similar ducts running the length and breadth of the bags being formed between the cells **18**, and each cell has at least point contact with adjacent cells.

By pouring concrete into the said ducts, a monolithic structure will be produced corresponding to that shown in FIGURE 3.

The inflatant of the bags can be any fluid such as air or water and can be exhausted after it has served its primary purpose of forming the cells or it can be left in the bags or tubes. In the case in which it is desired that the structure be of great weight, water can be used as the inflatant and be left in the cells after the concrete cast round them has set.

If desired, the inflatant can be kept circulating through the bags (the latter being provided with an outlet **36** FIGURE 6). For example, by the circulation of hot or cold water, the temperature can be regulated as required for conditioning the concrete.

The inflatant can also be used for vibrating the concrete to ensure the desired degree of compactness of the cast mass. Its pressure can be increased after casting and before setting of the concrete for the same purpose.

The cells formed by the bags can also be used to contain substances such as cemenet grout which will set and fill them permanently. By so filling the cells in selected portions of a structure, those portions can be made specially strong.

It will be appreciated that the cells could be filled with concerete and the three-dimensional duct system remain void.

In this case, the cells must, of course, intercommunicate as in the bag and tube examples described above. This system has special advantages. For example, the concrete is protected by the cells during setting and its setting rate can be substantially lengthened or otherwise controlled. The protection afforded by the cells is of particular value in construction underwater or on boggy or swamped sites as, apart from preventing pollution it makes the use of rapid hardening cement unnecessary.

It will also be appreciated that the relative and absolute dimensions of the cells and ducts can be varied within wide limits and that if desired, steel reinforcing rods can be arranged in the ducts.

I claim:

1. A one-piece structure of a castable material having a regular series of cells defined by sheet material, said cells being arranged symmetrically both vertically and horizontally on a rectangular grid within the said structure, each cell having at least point contact with adjacent cells, and the material of the structure present between the cells extending in three mutually perpendicular directions along the lines of a rectangular grid; the cells being defined by inflatable elements with the cells in any one horizontal plane intercommunicating, and the cells in each layer being connected together by sheet material extending in the median of the cells, the sheet material having holes in it between the cells through which holes the solid matter of the structure passes.

2. A one-piece structure as claimed in claim 1 in which the cells have a shape approximating to a polyhedron.

3. A one-piece structure as claimed in claim 1 in which the cells in one horizontal plane are interconnected with the corresponding cells in an adjacent horizontal plane.

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