No-fines building gives energy-conserving homes

A system that saves both energy and cement

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This photo shows how a no-fines concrete surface looks before it is finished with plaster.

Like many other successful ideas, no-fines construction is very simple in basic concept. No-fines concrete is a mix containing only carefully graded clean aggregate—approximately ¾ to ⅜ inch(1)* in size—and portland cement. These are combined at rates of one part of cement with 8 to 10 parts of aggregate. No fine material—either sand or gravel—is included.

Such mixtures produce an open textured cellular concrete with a high volume of voids and good insulating properties. The U-value for an external 10-inch(2) wall with an internal dry lining is 0.20 Btu per hour square foot degree F. (3) The mix is lighter than normal weight concrete and it is very strong; walls made with it are loadbearing.

Fresh no-fines concrete compacts well inside formwork under its own weight and needs no mechanical compaction. It lends itself to use in housing systems building; it has in fact been used for this purpose for about 60 years.

History of no-fines building

The first no-fines concrete houses were built in the Netherlands after World War I with crushed clinker as the aggregate. Later about 50 houses were built in Scotland using the same material.

In 1937 the Scottish Special Housing Association (SSHA) was set up to provide work for unemployed coal miners. Because the labor was inexperienced in construction, traditional methods of building were discarded in favor of the no-fines system, but the construction manager decided to use crushed whinstone—plentifully available there—instead of clinker. This gave a stronger, more uniform concrete.

About 900 houses were built by this method in Scotland before World War II and these are still in good condition. Since the end of the war the SSHA has developed the system to build houses with the minimum of labor and yet without sacrificing design standards. Most of the housing has been simple 2-story homes and 3- or 4-story apartment buildings. Twelve 10-story apartment buildings have also been built using loadbearing no-fines walls.

The SSHA builds more than 4000 houses a year, mostly of the no-fines type. The system has therefore become a significant factor in Scottish housing—thanks to a housing association rather than a contractor.

Commercial use of no-fines building

George Wimpey and Company Ltd., one of Britain's largest contractors and homebuilders, developed the no-fines system on a commercial basis and introduced it to world markets. Wimpey adopted the system after

* Numbers in parentheses refer to metric equivalents listed with this article.

Two-story no-fines homes in Eastfield Estate, Scarborough.

World War II, when there was an acute housing problem in Britain. Hundreds of thousands of houses were needed but materials and skilled labor were in short supply. Since then the company has developed the method into what has been described as Britain's most successful housing system.

The number of homes Wimpey has built with the no-fines system is approaching 400,000, for more than 400 local authorities in Britain. The company's system is notable for its flexibility. Unlike some other building systems this method can be applied to a wide range of different designs, with substantial variation in external appearance. The company also provides a flexible service, taking on complete responsibility for design and construction or working as part of a team.

Although classed as an industrialized building system, the no-fines technique uses on-site casting. The concrete is placed between inner and outer forms and, up to a height of 5 stories, normally needs no reinforced concrete frame.

For houses and bungalows formwork is erected to the full height of the building, including gable ends. In apartments with normal weight concrete floors the formwork is usually single-story height, but 2-story apartments are cast in the same way as 2-story houses. Wherever possible, houses are cast two at a time in one continuous operation, each dwelling representing one formwork box.

Construction cycle

Foundations up to the ground floor slab are built as for traditional houses. For a 2-story dwelling the construction cycle is as follows:

(1) Internal forms are erected. These have previously been fitted with window and door frames, inserts, means of providing for chases for electrical conduits and other mechanicals. Reinforcing steel and precast concrete lintels are set in position and the external formwork erected.

(2) The no-fines concrete is then placed, allowing for any construction and expansion joints. At eaves level a continuous normal weight reinforced concrete beam is cast on top of the walls, using the same formwork.

(3) The next day the formwork can be removed and the construction cycle is repeated.

For high-rise dwellings of 6 stories or more the design incorporates a traditional reinforced concrete frame and reinforced concrete floors with no-fines concrete used for external and internal walls. Single-story forms are used and the no-fines walls are placed first. After the initial set of the walls the reinforced concrete columns are placed; the no-fines walls give support to the columns, permitting removal of forms after 24 hours. The reinforced concrete floors are then placed, using suitable supports. Structures up to 27 stories high have been built in this way.

Finishes

The rough-textured face of the no-fines wall provides an excellent surface for plastering; the standard exterior finish is dry dashing, using a variety of colored dashings on a two-coat plaster of sand-lime-cement. Other exterior treatments can be incorporated—tile-hung, weatherboarded, paneled (inserts for attaching are cast into the wall), even brick.

Interior finishes depend on clients' specifications, but the most commonly used are:

- wet plastering, with a layer of expanded polystyrene incorporated to increase thermal insulation
- dry lining with plasterboard backed up by a layer of expanded polystyrene attached to the wall
- freestanding dry lining of story-height, paper-faced, cored plasterboard panels with taped joints or skim-coated with plaster, the boards being fixed at top and bottom only

Because some local authorities favor a more traditional appearance the company has now developed a composite no-fines system to give architects a wider choice of design. In this system the no-fines concrete is used only for party and end walls, traditional methods being used for the rest of the building. This gives a completion rate equivalent to the standard no-fines system at a competitive cost and with the use of any approved cladding.

Most of the no-fines construction has been housing but the system has also been used for such buildings as factories and churches.

Successful use abroad

Wimpey has a continuous program of development for the no-fines system. Although the basic concept is simple a considerable amount of organization and

know-how is necessary to get the best results. This is particularly true when the system is used in a country where conditions are different from those in the United Kingdom. Wimpey has been successful in developing the method for use abroad. No-fines has been used for housing in Canada, the Middle East, Venezuela (in a technology exchange agreement with a local contractor), Spain and West Africa.

Surprisingly, one of the company's current projects is a housing development in Hungary, where the thousandth unit has just been completed. In view of the Soviet Union's long experience with factory-industrialized building systems the Hungarians' choice of the no-fines system must be considered a tribute to its reputation.

Although the no-fines idea is 60 years old and Wimpey has been using it for 30 years, the system meets today's needs for industrialized building. It has two very contemporary advantages—it provides an energy conserving building and it does not require too much cement.

Metric equivalents

(1) 19 to 10 millimeters
(2) 250-millimeter
(3) 1.1 watts per square meter kelvin
(4) 20 meters
(5) 8 meters
(6) 2 megapascals
(7) 4 megapascals
(8) 19-millimeter
(9) 0.2 megapascals
(10) 0.3 megapascals
(11) 25 meters
(12) 13 millimeters

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WORKING WITH NO-FINES CONCRETE

A big advantage of no-fines concrete is the relatively low hydrostatic pressure it exerts on the forms—only about one-third that of normal weight concrete. This circumstance and the even grading eliminate segregation even when the material is discharged from quite a high level, and allow large formwork units to be used. Some builders cast no-fines concrete in lengths of 60 feet(4) and from heights up to 25 feet. (5)

Because of the absence of cement-sand slurry, the forms can be made of open steel mesh or expanded metal on a light timber framing provided the bracing is sufficient to withstand the pressure of the concrete without deformation. Experience has shown that expanded metal will normally withstand at least 25 reuses and the timber frame about 100 reuses.

The weight of no-fines concrete depends on the type of aggregate used but is in general only about two-thirds the weight of a normal weight concrete made with the same aggregate. Its total drying shrinkage is about half, and the rate of shrinkage is more rapid—50 to 80 percent taking place in the first 10 days, compared with only 20 to 30 percent for normal weight. This means that there is much less danger of cracking of a plaster finish on a no-fines wall. But because of these great differences in rate of shrinkage, care must be taken when using no-fines and normal weight concrete in composite construction.

Any sound aggregate that is free from clay or dust and that is rounded or roughly cubical in shape may be used for no-fines concrete. Aggregates containing soft, friable, thin, flaky, elongated or laminated pieces totaling more than 10 percent by weight should not be used. Lightweight aggregates can be used for no-fines concrete when exceptional thermal insulation or lightness is required but the strength of the mix will be reduced somewhat, so the ratio of cement to aggregate should not be greater than 1 to 6.

Water-cement ratio is more critical with no-fines than with normal weight concrete. The amount of water must be sufficient to coat each piece of aggregate with a continuous film of cement paste so that all the pieces will bond together to form an open-textured mass. An excess of water must be avoided, otherwise the paste will tend to be washed off the aggregate, weakening the mix and filling the voids. In general water-cement ratios of 0.36 to 0.40 are used. With very porous aggregates it is good practice to first spray the material with water to prevent undue absorption of mixing water.

No-fines mixes generally have a cylinder strength of 300 psi(6) at 7 days or 600 psi(7) at 28 days with ¾-inch(8) aggregate. The bending and shear strengths of a comparable mix are only 30 psi(9) at 28 days. The bond strength of no-fines concrete is low, so walls are usually designed to avoid the use of reinforcement. If reinforcement is included it should be coated with cement grout before placing in the concrete; in this way it is possible to obtain bond strength of around 40 psi, (10) which is about half that for normal weight concrete.

No-fines concrete should be placed within 20 minutes after mixing. Consequently truck mixers should be equipped to introduce the water in transit.

The only compaction needed in no-fines construction is a light rodding to ensure that the form is filled completely without bridges around obstructions and without large voids. Placing from a height of 25 feet(5) usually gives sufficient compaction by gravity alone. Placing under windows or around other obstructions requires considerable care and some ingenuity in the design of formwork.

Expansion joints are necessary only when the walls are over 80 feet(11) long. Construction joints should be avoided if possible and should never be located vertically or on a slope.

Plastering is an essential feature of no-fines construction if the structure is to be made watertight. The open texture of no-fines concrete obviously gives an excellent mechanical key for plastering but the suction of the material is negligible so the walls should not be wetted down before plastering. Plaster can be applied by trowel, in either one or two coats, to a thickness of about ½ inch. (12)

Editor's note:
This information is from "No-Fines Concrete" (Concrete Construction, July 1961, pages 196-198).