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54 PROCESS AND PLANT FOR THE PRODUCTION OF CEMENT-CONCRETE.

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EP-A-0 022 738
FR-A- 992 896
FR-A-1 049 272
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US-A-3 812 076 | <ul style="list-style-type: none"> 73 Proprietor: SKAKO A/S
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Description

The invention presented relates to a process for the batch wise production of cement-concrete by intimate mixing of aggregates comprising a coarse and a fine fraction, cement, optional filler, and water in a concrete mixer with proportioning means for the components of the concrete mass, mixing means, and discharge means wherein the fine fraction of the aggregates is added to and absorbed in a premixture of the remaining components, wherein the coarse fraction of the aggregates is coated with a paste, consisting of cement, optional filler, and water.

A process of this nature is described in the SE patent specification No. 7700052—9, publication No. 415 349 with the same inventor as the present application, and assigned to the present applicant. This patent specification represents a fundamental breach with traditional concrete mixing techniques, according to which the entire aggregate quantity is normally added into the concrete mixer, including both the coarse fraction (normally stone materials with particle sizes of 32—4 mm) and the fine fraction (sand with particle sizes up to 4 mm) together with the cement and mixed for a certain period of time before water is added. It also occurs that aggregates, water and cement are added in the sequence mentioned or alternatively that water and cement are mixed into a paste which is then added to the aggregates.

The process according to the above SE patent specification with the specific purpose to produce a cement-concrete mass with an elevated filler content, low cement content and an elevated content of coarse aggregates (stone), was based on the hypothesis that if the coarse fraction of the aggregates was first added to the mixer and thereafter cement, filler and water in the form of a paste, or one after the other, part of the produced filler-containing cement paste would coat the particles contained in the coarse fraction of the aggregates, while the remainder would form a free-flowing paste, and when the fine fraction of the aggregates is thereafter added by continued mixing the particles of the fine fraction would be absorbed and encapsulated in the paste, coating the particles of the coarse fraction. The fine fraction particles will increase the viscosity of the paste, which is high as it is, due to the filler content, but the paste will remain liquid. It was assumed that the compressive strength and the workability of the concrete would be increased, with an increasing quantity of fine fraction incorporated in the cement paste during the mixing.

By the process described in the patent specification it should also be possible to reduce the water/cement ratio in relation to the conventional dry mixing process with unchanged quantities of aggregates and cement, as a considerable quantity of filler was used.

It is a well-known fact that the water/cement ratio, indicating the weight proportion between water and cement in a given concrete mix, is of vital importance for the strength qualities of the concrete, and a reduced water/cement ratio would therefore also be desirable.

The drawings of the patent specification, showing the results of tests on a laboratory scale with concrete mixes each of 13 kg seem to confirm that the adding of filler and the changed mixing sequence provided the alleged improvements of the strength qualities of the concrete. This was, however, largely conditional on the addition of filler.

The mixing process, dealt with in the patent specification has, however, never been applied in practice. On the basis of the promising laboratory test, test runnings on an industrial scale were initiated in a Swedish concrete factory under application of the existing, well-tested mixing plants and concrete recipes, however, with an alteration of the adding sequence in accordance with the teachings of the patent specification, meaning that the fine fraction of the aggregate was added after the mixing of the remaining components. However, it proved impossible to absorb the entire sand quantity homogeneously in the cement paste.

Local drainings of the cement paste were observed, and even with long mixing times a heterogeneous concrete was produced, showing no improvement of the strength qualities. It was thus impossible to render probable to skilled person that the suggested change of the mixing sequence, the introduction of which in itself demanded great efforts to overcome very rooted prejudices, had any future.

French Patent FR—A—1,575,874 deals with a problem occurring during continuous concrete mixing in a slightly inclined horizontal rotary mixing drum provided with means for continuously introducing water, cement, and fine and coarse aggregates. Traditionally, streams of these components were introduced at the upper part of the mixing drum. However, it was observed that improper moisturizing of the coarse aggregates often occurred during the mixing period, i.e. during the retention time of the material in the rotating mixing drum. FR—A—1,575,874 provides an improved moisturizing of the coarse aggregates by introducing water, cement and coarse aggregates at the upper part of the drum (providing an initial premixing of these components in a premixing zone in the upper part of the drum), and separately introducing the fine aggregates at an intermediate position in the drum (providing a final mixing zone in the remaining (lower) part of the drum in which the fine aggregates are mixed with the "pre-mix" formed in the premixing zone). Based on the realistic assumption that no appreciable back-mixing occurs in the mixing drum, the mixing principle according to this patent may be considered as a special (continuous) version of the following general mixing principle: Premix water, cement and coarse aggregates to a premixture during a period of time corresponding to the retention time in the premixing zone; introduce fine aggregates; and mix the fine aggregates with the premixture during a period of time corresponding to the retention time in the final mixing zone.

European Patent Application EP—A—22738 (corresponding to US—A—4,369,066) and U.S. 3,812,076

do not actually concern concrete mixing. EP—A—22738 concerns production of mortar (i.e., a mixture of cement, sand and water) wherein cement and water are mixed by vigorous, intense stirring followed by addition of moist sand centrally in the funnel-shaped profile formed by the stirring. US—A—3,812,076 deals with effectively dispensing finely divided ethylene oxide polymers and other organic additives in a hydraulic cement-aggregate composition by a method wherein these fine organic materials are introduced into a mixing vessel as a suspension in a stream of gas. In order to prevent sticking together of the fine organic particles, they may be initially mixed with an inert, high surface area (almost colloidal) solid particulate material, such as fumed silica (with an average particle diameter in the micron range).

The present invention rests on the surprising realization that to achieve the results aspired in the above-mentioned SE patent specification it is necessary to overcome not only one but two prejudices, and further the adding of filler is not obligatory for the achievement of good strength qualities.

As proved by the mentioned, unsuccessful tests, and as it will appear from the examples, mentioned below, it is namely not adequate to change only the sequence in which the individual components of the cement-concrete mass are added. It is of vital importance for the homogeneous absorption of the particles of the fine fraction during the mixing process into the free-flowing cement paste and into the part of the paste, coating the coarse particles, that the particles are not as usual added at one time over the shortest possible period of time to start the mixing process, but on the contrary that they are added successively in a controlled flow of materials which can be provided by the application of a proportioning means for the fine fraction. The process according to the invention is therefore characterized in that the volume of the fine fraction in the premixture is increased gradually by successive addition of the fine fraction to the premixture, effected and controlled by the proportioning means for the fine fraction.

As it will appear from the following test results it is in this way possible to produce a particularly homogeneous concrete with an essential reduction of the mixing time, with a thus achieved reduction of the energy consumption and wear on the mixer, also due to the coating effect, brought about by the cement paste under the adding of the fine fraction.

The concrete, produced in accordance with the process of the invention, shows in addition to the improved homogeneity a reduced tendency to separation, and the concrete shows no sign of accumulations of free washed stones, the so-called "stone-nests", as all stones are neatly surrounded by cement paste. The concrete liberates only a reduced quantity of water before and after vibration in which way bleeding on the concrete surface and thus strength reduction are avoided. Moreover, the compressive strength measures show a reduced standard strength deviation compared to concrete produced according to the normal process. Due to the improved homogeneity of the concrete and the demonstrated reduced standard deviation of strength it will also by the process according to the invention be possible to reduce the cement content in a given concrete mix, while maintaining the strength values.

That the disadvantages, experienced by the reproduction of the SE patent on an industrial scale can be eliminated just by controlling the material flow of the fine fraction may seem obvious in retrospect. However, it is important to keep in mind that such a control constitutes a fundamental breach with the concrete mixing techniques of several decades, resting on the opinion that the mixer does the work for which reason the components of the batch should be added as quickly as possible in order to start up the mixing process.

Without the intention to accuse the concrete technologists of being more conservative than skilled persons within other fields, it appears that the inventions within the concrete field have in latest years principally concentrated on improving the effectiveness of the mechanical part of the mixing process, or on varying the grain size distribution of the fine fraction, or on adding special admixtures to produce improved products.

That it should be possible to perfect the process, rejected by skilled persons, according to the patent specification No. 770052—9 merely by modifying the proportioning means for the fine fraction, thus to achieve control with the material flow, must be considered, highly to exceed the expectations of the skilled persons.

The importance of this simple modification is better understood by a closer observation of the very mixing process. By the prevalent dry mixing process the water content in the cement paste is increased during the mixing from zero by water feeding start-up to the final value, corresponding to the requested water/cement ratio. During the mixing the concrete thus passes from a dry to a wet stage.

Contrary to this from the beginning of the adding of the fine fraction, the cement paste has the predetermined water content, and all the cement particles are preground and possibly activated by the mixing with the coarse fraction. By the successive adding of the fine fraction water is bound by the formation of water meniscus between the fine grains. By this the viscosity of the paste and the volume of fines in the mix are increased. Thus, during the mixing process the concrete passes from a wet to a less wet stage.

The qualities of the concrete mass, such as homogeneity and workability increase with increasing fine fraction volume which contributes to the above improved qualities of the ready concrete.

A particularly appropriate adding of the fine fraction is achieved by controlled vibration technique, more precisely by the application of a so-called vibratory feeder.

Such vibratory feeds have a wide field of application within the most diversified lines of material handling, from the transportation of granulated sugar in sugar factories to the charging of pellets in blast furnaces.

The application of a vibratory feeder in the process according to the invention permits an especially effective control with the material flow of the fine fraction which can be adjusted according to requirements.

An investigation of different types of concrete mixers has proved that the optimum mixing process and the best concrete mass is achieved if the fine fraction is added in a zone of the mixer in which the mass, including the paste-coated coarse fraction and the free-flowing cement paste is moved in a material flow under the influence of an external pressure from the mixing means in such a way that the material flow is pressed together and the particles thus under rolling pressed against each other. By the successive adding of the particles of the fine fraction into the material flow these are drawn into the flow, and due to the pressure between the particles of the coarse fraction and the individual movements of the particles, brought about by the mixing means, the particles of the fine fraction are "ground" into the paste coating of the coarse particles.

Considering this it will be especially advantageous to design the mixing means and arrange the curve path described so as to establish high and low pressure zones in the concrete mass during the mixing process. This can e.g. be achieved by the application of a stationary mixing pan in which the mixing shovels are driven in pairs in a planetary movement.

The successive adding of the fine fraction is advantageously adjusted so in relation to the rotation of the mixing means that the fine fraction added does not meet previously added fine fraction material, not yet absorbed in the paste, which would then form a double layer of fine fraction which it would be difficult homogeneously to work into the mass.

Despite the fact that the application of fillers, contrary to the SE patent specification No. 415 349, is not obligatory for the process in accordance with the invention it may be desirable to add filler, among other things to be able to adjust the viscosity of the cement paste. Such an adjustment could be carried out by measuring means for the determination of the viscosity of the paste, connected to the proportioning means for the filler.

It is pointed out that the designation "filler" is here used in the widest sense of the word, and not only with the meaning fine fraction material with particle sizes smaller than 1/4 mm, but also covering mineral admixtures such e.g. as silica, fly ash, puzzolanes etc., and in addition more special admixtures such as colours and inactive fillers such as fineground quartz etc. The filler materials are normally added together with the cement and/or used for later adjustments.

Any admixture for the production of concrete may be used in the process according to the invention, both

1. *Physically active admixtures* such as plasticisers, both normal and superplasticisers, and air-entraining admixtures, such as tensides, reducing the surface tension of the water by the formation of bubbles, and
2. *Chemically active admixtures* such as accelerators or retarders for the reaction between water and cement.

The adding of these admixtures will normally be effected with the last part of the water before the adding of the fine fraction which will enable the cement to react with water on its surface.

It has also turned out that to produce a concrete with optimum qualities the coarse fraction of the aggregates can with advantage be moistened with part of the water before cement, optional filler, and the remaining water quantity is added. It is also important to establish a suitable premixing time before successively adding the fine fraction. Hereby the qualities of the cement paste and thus the workability of the mass is improved.

The invention further relates to a plant for the realization of the process according to the invention comprising a mixing container with proportioning means for the components of the concrete mass, mixing means and discharge means, and the plant is characterized in that the proportioning means for the fine fraction of the aggregates is equipped with devices for the control and regulation of the flow of the fine fraction so as to gradually increase the volume of the fine fraction in the premixture.

Preferably the proportioning means for the fine fraction is a vibratory feeder, providing a very accurate control with the proportioning and which can be adjusted to provide different proportioning periods, in accordance with the composition and qualities of the concrete mass in question.

If desired, the proportioning means can be adapted to add the fine fraction on more than one zone of the mixer. E.g. this can be achieved by the application of two or more proportioning means or by a turnable proportioning device.

In the embodiment of the process according to the invention in which filler is used for the adjustment of the viscosity of the cement paste, the plant may also include means for the determination of the viscosity of the cement paste, connected to the proportioning means for the filler and control the filler flow.

In order to achieve a particularly effective mixing of the fine fraction it is of great importance that the material flow in the mixer is under the influence of an external pressure from the mixing means, thus establishing high and low pressure zones in the concrete mass, and that the fine fraction is added in a high pressure zone. In addition to the fact that the pressure can be increased or reduced in the pressure zone by an increased or reduced material flow of fines, the mixing means of the plant are primarily designed so as to establish alternating high and low pressure zones which can further be supported by adapting the mixing means to move in a curved path, e.g. a planetary movement.

The invention can be applied in the production of any type of concrete for varying purposes and with

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varying strength qualities. A person skilled in the art will be able to determine the optimum mixing process for a given type of concrete by varying the components of the mass, the grain sizes of the aggregates, the types of cement, different admixtures, mixing time etc.

5 Comparative Tests on a Laboratory Scale

In order to document the importance of a successive adding of the fine fraction of the aggregate materials (sand 0—4 mm) tests were carried out in a laboratory pan mixer with four shovels and two side scrapers by which the pan and the shovels rotated in the opposite directions. The used basic mix had the composition:

10	Rapid cement	325 kg/cbm	
	Water	150 kg/cbm	W/C ratio 0.46
	Aggregates:		
15	Sand 0—4 mm	650 kg/cbm	
	Stone 4—16 mm	1260 kb/cbm	

The following tests were carried out:

20 I Reproduction of SE Patent No. 415 349

Stone and half of the water were mixed for 5 s. to moisten the stone material. Hereafter cement and the remainder of the water, containing a plasticiser, were added, and the mix was pre-mixed for 20 s. Hereafter the sand quantity was added at a time, and the mixing was continued for 65 s. Total mixing time 90 s.

25 II Process According to the Invention (long pre-mixing time).

Stone, water, containing a plasticiser, and cement were mixed as under I. Hereafter sand was added over a period of 20 s., and the mixing was continued for 45 s. Total mixing time 90 s.

On termination of the mixing the following determinations were made:

30		I	II
	Air content	1,2%	1,3%
	Slump	0	0
	Slump (Vebe)	4 s.	2,5 s.

35 Mix I was homogeneous and had a workability, expressed by a Vebe measure of 4 s.

Mix II was also homogeneous and demonstrated an improved workability, expressed by a Vebe measure of 2,5 s.

Of both types of concrete cylinders were cast which were used for early compressive strength determinations according to standard DS 423, 1 and 2 days after completed mix, respectively.

40 The results of the compressive strength tests appear from the following table. By way of comparison, standard values for concrete produced with the same type of rapid cement according to the traditional mixing technique, are used:

Compressive Strength M Pa

45	<u>Period</u>	I	II	<u>Stand. Values</u>
	21 h		11.6	13 (24 h)
	22 h	10.6		
	44 h		30.1	23 (48 h)
50	45 h	29.3		

From the above table it is seen that test II shows improved early strength values, not least if the time differences are taken into account. It is assumed that the differences would be even more significant if a mixture providing high and low pressure zones had been used.

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Comparative Tests on an Industrial Scale

The tests have been run with a very experienced Danish manufacturer of concrete with his existing 1500 l SKAKO mixer for the production of ready-mixed concrete.

60 The mixer is a pan mixer, operating on the basis of the counter-current mixing principle, by which the mixing is effected in a fixed pan by means of 4 shovels, driven in pairs by a planetary gear box. In addition the mixer is equipped with 2 off side scrapers, incorporated with the purpose to lead the concrete to the most active mixing zone. The speed of the side scrapers is approx. half the speed of the shovels. This specific counter-current mixing principle makes the concrete mass move approx. one round per each 10—12 s. and brings about the effect that high and low pressure zones are continuously developed in the
65 concrete mass.

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The below concrete recipes have been selected for the tests, according to the standard mixing procedure and to the new mixing procedure.

5	1) 15 MN/M ² Concrete		
		Cement (Portland)	230 kg
		Water	161 l
		Sand (0—4 mm)	717 kg
		Gravel (4—8 mm)	200 kg
10		Gravel (8—16 mm)	818 kg
		Air-entraining admix	53 g
	2) 30 MN/M ² Concrete		
		Cement (Portland)	330 kg
		Water	165 l
15		Sand (0—4 mm)	668 kg
		Gravel (4—8 mm)	200 kg
		Gravel (8—16 mm)	789 kg
		Air-entraining admix	60 g
20	3) Pipe Concrete		
		Cement (Portland)	346 kg
		Water	131 l
		Sand (0—4 mm)	760 kg
		Gravel (4—8 mm)	285 kg
25		Gravel (8—16 mm)	855 kg

The below described proportioning cycle has been applied:

A. Standard Mixing Procedure

30 The stone fractions 4—8 and 8—16 mm and the sand were added at a time. After a dry-mixing period of 5 s. water was added over a period of 20 s., and after 15 s. mixing time the cement was added. The total adding lasted approx. 30 s., and hereafter the batch was mixed for approx. 30 s. The total mixing time was thus 60 s.

35 B. New Mixing Procedure, According to the Invention

The stone fractions 4—8 and 8—16 mm were added all at a time together with the water. After a 5 s. moisturing the cement porportioning was started and lasted for approx. 15 s., whereafter the batch was mixed for another 10 s. (paste mixing time). Then sand was added successively over a period of 15 s. by means of a SKAKO vibratory feeder. To reach the same total mixing time the batch was ready-mixed for 40 another 15 s., but the concrete was homogeneous already after 5 s. ready mixing.

In addition to the visual observations 3 cylinder cores were taken from each mix, all each of 1 cbm.

The cylinder cores were stored in a water bath for 14 days at a constant temperature of 21°C. The results achieved are listed in the below tables.

45 All three test runnings indicate that an essential increase of the average strength by the process according to the invention was achieved and that the standard deviation of strength and the variation coefficient was reduced.

This clearly demonstrates that by the process according to the invention considerable cement savings can be achieved, compared to the standard mixing procedure, retaining the same strength values.

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CONCRETE MIXING TEST 1				SKAKO ^A /s		
STRENGTH: 15 MN/M ²		SLUMP: 6-10		W/C: 0.8		
STANDARD MIXING PROCESS				NEW MIXING PROCESS		
A				B		
NO.	AVERAGE STRENGTH OF 3 SAMPLES PER MIX	SLUMP	AVERAGE STRENGTH CONVERTED TO SLUMP 8	AVERAGE STRENGTH OF 3 SAMPLES PER MIX	SLUMP	AVERAGE STRENGTH CONVERTED TO SLUMP 8
14	17.3	8	17.3	19.4	10.5	20.3
15	20.3	6	19.3	23.0	6	21.8
21	15.1	9	15.5	21.3	10	22.2
24	15.9	7	16.3	20.8	8	20.8
27	15.6	4.5	14.0	16.4	13.5	18.0
28	16.1	5.5	15.3	19.4	5	18.3
30	19.5	5	18.0	18.1	10	19.0
32	18.1	7	17.6	22.2	7	21.6
(MN/M ²) AVERAGE STRENGTH:		17.1		AVERAGE STRENGTH:		20.3
<p><u>AVERAGE STRENGTH INCREASE FROM "A" TO "B":</u> 18.6 %</p> <p><u>STANDARD DEVIATION:</u> $S = \sqrt{\frac{(x_1 - m)^2 + \dots + (x_n - m)^2}{n-1}}$</p> <p style="text-align: center;">S_A = 1.74 MN/M² S_B = 1.64 MN/M²</p> <p><u>VARIATION COEFFICIENT:</u> $V = \frac{S \times 100}{m}$ (%)</p> <p style="text-align: center;">V_A = 10.2 % V_B = 8.1 %</p> <p><u>CALC. CEMENT SAVING:</u> $G = K \left(\frac{1}{V/C} - 0.5 \right)$</p> <p><u>SAVING</u> = 26 KG ~ 10.4 %</p>						
DATE: 83-04-06				NAME: F. FRANSEN		

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CONCRETE MIXING TEST 2					SKAKO ^A /S	
STRENGTH: 30 MN/M ²		SLUMP: 6-10		W/C: 0.5		
STANDARD MIXING PROCESS				NEW MIXING PROCESS		
A				B		
NO.	AVERAGE STRENGTH OF 3 SAMPLES PER MIX	SLUMP	AVERAGE STRENGTH CONVERTED TO SLUMP 8	AVERAGE STRENGTH OF 3 SAMPLES PER MIX	SLUMP	AVERAGE STRENGTH CONVERTED TO SLUMP 8
16	30.9	5	29.3	33.2	5.5	33.2
18	32.3	7	31.5	36.4	6.5	36.0
19	31.4	8.5	31.4	34.0	10	35.4
20	29.4	8	29.4	30.3	10.5	31.7
22	27.4	9	28.3	33.5	6	31.8
25	38.4	6	36.8	32.6	13	36.5
29	38.0	4	34.1	37.1	5	34.3
31	35.9	5	34.2	36.0	6	34.5
(MN/M ²)	AVERAGE STRENGTH:		31.9	AVERAGE STRENGTH:		34.2
<p><u>AVERAGE STRENGTH INCREASE FROM "A" TO "B":</u> 7.2 %</p> <p><u>STANDARD DEVIATION:</u> $S = \sqrt{\frac{(x_1 - m)^2 + \dots + (x_n - m)^2}{n-1}}$</p> <p>$S_A = 2.94 \text{ MN/M}^2$ $S_B = 1.85 \text{ MN/M}^2$</p> <p><u>VARIATION COEFFICIENT:</u> $V = \frac{S \times 100}{m} (\%)$</p> <p>$V_A = 9.2 \%$ $V_B = 5.4 \%$</p> <p><u>CALC. CEMENT SAVING:</u> $G = K \left(\frac{1}{V/C} - 0.5 \right)$</p> <p><u>SAVING =</u> 20 KG ~ 5.5 %</p>						
DATE: 83-04-06				NAME: F. FRANSEN		

CONCRETE MIXING TEST 3				SKAKO ^A /S		
STRENGTH: Pipe concrete				W/C: 0.38		
	STANDARD MIXING PROCESS			NEW MIXING PROCESS		
	A			B		
NO.	AVERAGE STRENGTH OF 3 SAMPLES PER MIX	SLUMP	AVERAGE STRENGTH CONVERTED TO SLUMP 8	AVERAGE STRENGTH OF 3 SAMPLES PER MIX	SLUMP	AVERAGE STRENGTH CONVERTED TO SLUMP 8
IV	42.1	0	-	47.4	0	-
V	43.4	0	-	46.8	0	-
VI	44.2	0	-	48.1	0	-
VII	44.6	0	-	48.9	0	-
IX	46.3	0	-	47.7	0	-
X	45.9	0	-	48.6	0	-
XI	45.1	0	-	50.6	0	-
XII	41.1	0	-	46.4	0	-
(MN/M ²)	AVERAGE STRENGTH: 44.1			AVERAGE STRENGTH: 48.1		
<p><u>AVERAGE STRENGTH INCREASE FROM "A" TO "B"</u>: 9.1 %</p> <p><u>STANDARD DEVIATION</u>: $S = \sqrt{\frac{(x_1 - m)^2 + (x_2 - m)^2 + \dots}{n-1}}$</p> <p style="text-align: center;">S_A = 1.8 MN/M² S_B = 1.3 MN/M²</p> <p><u>VARIATION KOEFFICIENT</u>: $V = \frac{S \times 100}{m}$ (%)</p> <p style="text-align: center;">V_A = 4.1 % V_B = 2.7 %</p> <p><u>CALC. CEMENT SAVING</u>: $G = K \left(\frac{1}{\sqrt{f/c}} - 0.5 \right)$</p> <p><u>SAVING</u> = 26 KG ~ 6.8 %</p>						
DATE: 83-04-06				NAME: F. FRANSEN		

Claims

1. A process for the batch wise production of cement-concrete by intimate mixing of aggregates comprising a coarse and a fine fraction, cement, optional filler, and water in a concrete mixer with proportioning means for the components of the concrete mass, mixing means, and discharge means, wherein the fine fraction of the aggregates is added to and absorbed in a premixture of the remaining components, wherein the coarse fraction of the aggregates is coated with a paste, consisting of cement, optional filler, and water, characterized in that the volume of the fine fraction in the premixture is increased gradually by successive addition of the fine fraction to the premixture, effected and controlled by the proportioning means for the fine fraction.
2. A process according to claim 1, characterized in that the addition of the fine fraction to the premixture is effected by controlled vibration technique.
3. A process according to claim 1 or 2, characterized in that the fine fraction is added into a zone of the mixer in which the mass consisting of the paste-coated coarse fraction and free-flowing cement paste is moved in a material flow under the influence of an external pressure from the mixing means.
4. A process according to claim 3, characterized in that the external pressure of the material flow is so exerted that the added particles of fine fraction, are immediately absorbed in the material flow.
5. A process according to claims 1—4, characterized in that the adding of the fine fraction is adjusted in relation to the rotation of the mixing means so as to prevent the fine fraction from meeting previously added fine fraction, not yet absorbed in the paste.
6. A process according to each of the claims 1—5, characterized in that the viscosity of the paste-covered coarse fraction is adjusted by the addition of filler.
7. A process according to claim 6, characterized in that the adjustment is carried out by measuring means connected to the proportioning means for the filler.
8. A process according to any of the previous claims, characterized in that the coarse fraction of the aggregates is moistured by part of the water before cement, optional filler, and the remaining water are added, and that this mixture is pre-mixed before the adding of the fine fraction.
9. A plant for the realization of the process according to claim 1 and comprising a mixing container with proportioning means for the components of the concrete mass, mixing means, and discharge means characterized in that the proportioning means for the fine fraction of the aggregates is equipped with devices for the control and regulation of the flow of the fine fraction so as to gradually increase the volume of the fine fraction in the premixture.
10. A plant according to claim 9, characterized in that the proportioning means for the fine fraction is a vibratory feeder.
11. A plant according to claims 9 and 10, characterized in that the proportioning means is designed to add the fine fraction in more than one zone of the mixer.
12. A plant according to claim 9, characterized in that the mixing means are designed and adapted to move in a curved path so as to establish high and low pressure zones in the concrete mass.
13. A plant according to claim 9 for the realization of the process according to claim 7, characterized in that the proportioning means for the filler is connected to means for the determination of the filler content and the viscosity of the cement paste.

Patentansprüche

1. Verfahren zur satzweisen Herstellung von Zementbeton durch inniges Vermischen von Zuschlagstoffen in einer groben und einer feinen Fraktion, Zement, ggf. Füllstoff, und Wasser in einem Betonmischer mit Dosiervorrichtungen für die Bestandteile der Betonmasse, einem Mischer und einer Austragvorrichtung, bei welchem Verfahren die feine Fraktion der Zuschlagstoffe einem Vorgemisch aus den übrigen Bestandteilen zugesetzt und darin absorbiert wird, und die grobe Fraktion der Zuschlagstoffe mit einem Brei aus Zement, ggf. Füllstoff, und Wasser beschichtet wird, dadurch gekennzeichnet, dass das Volumen der feinen Fraktion im Vorgemisch durch fortlaufende Zugabe der feinen Fraktion zum Vorgemisch fortdauernd erhöht wird, welche Zugabe mit der Dosiervorrichtung für die feine Fraktion ausgeführt und gesteuert wird.
2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, dass die Zugabe der feinen Fraktion zum Vorgemisch durch gesteuertes Rütteln erfolgt.
3. Verfahren nach Anspruch 1 oder 2, dadurch gekennzeichnet, dass die feine Fraktion einer Zone im Mischer zugeführt wird, in welcher die aus der breibeschichteten grobe Fraktion und dem frei strömenden Zementbrei bestehende Masse in einem Materialstrom unter Einwirkung eines äusseren Drucks vom Mischer bewegt wird.
4. Verfahren nach Anspruch 3, dadurch gekennzeichnet, dass der äussere Druck auf den Materialstrom derart ausgeübt wird, dass die zugesetzten Teilchen der feinen Fraktion sofort vom Materialstrom absorbiert werden.
5. Verfahren nach Anspruch 1—4, dadurch gekennzeichnet, dass die Zugabe der feinen Fraktion im Verhältnis zum Umlauf des Mixers geregelt wird, um zu verhindern, dass die feine Fraktion mit der früher zugeführten, noch nicht vom Brei absorbierten feinen Fraktion in Berührung gelangt.

6. Verfahren nach einem der Ansprüche 1—5, dadurch gekennzeichnet, dass die Viskosität der breibeschichteten groben Fraktion durch Füllstoff-Zugabe geregelt wird.
7. Verfahren nach Anspruch 6, dadurch gekennzeichnet, dass die Regelung mittels einer mit der Füllstoff-Dosiervorrichtung verbundenen Messvorrichtung ausgeführt wird.
- 5 8. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass die grobe Fraktion der Zuschlagstoffe mit einem Teil des Wassers benetzt wird, bevor Zement, ggf. ein Füllstoff, und das übrige Wasser zugeführt werden, und dass dieses Gemisch vor der Zugabe der feinen Fraktion vorgemischt wird.
9. Vorrichtung zur Durchführung des Verfahrens nach Anspruch 1, umfassend einen Mischbehälter mit
10 Dosiervorrichtungen für die Bestandteile der Betonmasse, einen Mischer und eine Austragvorrichtung, dadurch gekennzeichnet, dass die Dosiervorrichtung für die feine Fraktion der Zuschlagstoffe mit Einrichtungen zur Steuerung und Regelung des Stroms der feinen Fraktion ausgerüstet ist, damit das Volumen der feinen Fraktion im Vorgemisch fortdauernd erhöht wird.
10. Vorrichtung nach Anspruch 9, dadurch gekennzeichnet, dass die Dosiervorrichtung für die feine
15 Fraktion ein Rüttelförderer ist.
11. Vorrichtung nach Anspruch 9 und 10, dadurch gekennzeichnet, dass die Dosiervorrichtung derart ausgebildet ist, dass sie die feine Fraktion mehr als einer Zone im Mischer zuführt.
12. Vorrichtung nach Anspruch 9, dadurch gekennzeichnet, dass der Mischer derart ausgebildet ist, dass sich sein Mischglied in einer gekrümmten Bahn bewegt, um in der Betonmasse Hoch- und
20 Niederdruckzonen zu schaffen.
13. Vorrichtung nach Anspruch 9 zur Durchführung des Verfahrens nach Anspruch 7, dadurch gekennzeichnet, dass die Füllstoff-Dosiervorrichtung mit einer Einrichtung zur Feststellung des Füllstoffgehalts und der Viskosität des Zementbreis verbunden ist.

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Revendications

1. Procédé pour la production en discontinu de béton de ciment par mélange intime d'agrégats comprenant une fraction grossière et une fraction fine, de ciment, d'une charge facultative et d'eau dans un
30 mélangeur à béton comprenant des moyens pour le dosage des composants de la masse de béton, des moyens pour le mélange et des moyens de décharge, dans lequel la fraction fine des agrégats est ajoutée et absorbée dans un prémélange des composants restants, dans lequel la fraction grossière des agrégats est enduite avec une pâte consistant en ciment, charge facultative et eau, caractérisé en ce que le volume de la fraction fine dans le prémélange est augmenté progressivement par addition successive de la fraction
35 fine au prémélange, effectuée et réglée par les moyens de dosage de la fraction fine.
2. Procédé selon la revendication 1, caractérisé en ce que l'addition de la fraction fine au prémélange est effectuée par une technique de vibration contrôlée.
3. Procédé selon la revendication 1 ou 2, caractérisé en ce que la fraction fine est ajoutée dans une zone du mélangeur dans laquelle la masse consistant en la fraction grossière enduite de pâte et la pâte de ciment
40 fluide est déplacée dans un courant de matières sous l'influence d'une pression externe des moyens de mélange.
4. Procédé selon la revendication 3, caractérisé en ce que la pression externe sur l'écoulement de matières est exercée de telle sorte que les particules ajoutées de la fraction fine sont immédiatement absorbées dans l'écoulement de matières.
- 45 5. Procédé selon les revendications 1—4, caractérisé en ce que l'addition de la fraction fine est réglée par rapport à la rotation des moyens de mélange de manière à éviter que la fraction fine rencontre la fraction fine ajoutée préalablement, mais pas encore absorbée dans la pâte.
6. Procédé selon chacune des revendications 1—5, caractérisé en ce que la viscosité de la fraction grossière recouverte par la pâte est ajustée par l'addition de la charge.
- 50 7. Procédé selon la revendication 6, caractérisé en ce que le réglage est effectué par des moyens de mesure reliés aux moyens de dosage de la charge.
8. Procédé selon l'une quelconque des revendications précédentes, caractérisé en ce que la fraction grossière des agrégats est humectée par une partie de l'eau avant qu'on ajoute le ciment, la charge facultative et le reste de l'eau et en ce que ce mélange est mélangé au préalable avant l'addition de la
55 fraction fine.
9. Installation pour la mise en oeuvre du procédé selon la revendication 1 et comprenant un récipient mélangeur muni de moyens de dosage des composants de la masse de béton, de moyens de mélange et de moyens de décharge, caractérisée en ce que les moyens de dosage de la fraction fine des agrégats sont munis de dispositifs pour le réglage de l'écoulement de la fraction fine de manière à augmenter
60 progressivement le volume de la fraction fine dans le prémélange.
10. Installation selon la revendication 9, caractérisée en ce que les moyens de dosage de la fraction fine consistent en un appareil d'alimentation vibrant.
11. Installation selon les revendications 9 et 10, caractérisée en ce que les moyens de dosage sont conçus pour ajouter la fraction fine dans plus d'une zone du mélangeur.
- 65 12. Installation selon la revendication 9, caractérisée en ce que les moyens de mélange sont conçus et

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adaptés pour se déplacer sur un trajet courbe de manière à établir dans la masse de béton des zones de pression élevée et de faible pression.

13. Installation selon la revendication 9 pour la mise en oeuvre du procédé selon la revendication 7, caractérisée en ce que les moyens de dosage de la charge sont reliés à des moyens pour la détermination
5 de la teneur en charge et de la viscosité de la pâte de ciment.

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