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(54) **Method and apparatus for producing concrete products with a controlled degree of compaction**

Verfahren und Vorrichtung zum Herstellen von mit einem gesteuerten Verdichtungsgrad gepressten Gegenständen

Méthode et dispositif pour la production d'éléments en béton avec degré de compression contrôlé

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(56) References cited:
EP-A- 0 359 572
US-A- 3 193 902

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EP 0 541 963 B1

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Description

The present invention relates to a method according to the preamble of claim 1 capable of achieving controlled compaction of a cast concrete product by way of measuring the parameters related to the casting process.

The invention also concerns an apparatus according to the preamble of claim 8 for implementing the method.

Elongated concrete products such as hollow-core slabs are conventionally produced using extruder-type casting apparatuses. The casting apparatus is comprised of a conical feed hopper connected to one or more feed augers beneath. The feed auger is frequently followed by a shaping mandrel which is further extended as an auxiliary mandrel supporting the core cavity formed within the product. The shaping mandrel contains a vibrator or similar compacting arrangement for the compaction of the cast concrete into the shape determined by the casting mould and the mandrels. Furthermore, the casting apparatus has an upper trowelling beam forming the upper edge of the mould, and frequently, the sides of the mould are also designed to perform as the side trowelling beams. The trowelling beams compact the concrete mix during the course of the casting process and give the cast product a neat surface finish. Besides trowelling or to augment it, vibration can also be employed for compaction. Extruder-type casting apparatuses are designed to operate as continuous-casting machines, which are transferred forward on the mould top by the reaction forces imposed by the feed augers.

Extruder-type casting apparatuses are well suited for the mass production of concrete products, but the attainment of controlled strength properties for concrete products fabricated by means of conventional methods has been difficult and the production equipment employed have been prone to malfunction. Measurement of the factors affecting the quality of finished products has been attempted in several ways. The factor most typically measured has been the internal pressure of the concrete mix in the casting mould. The internal pressure of the mix has been measured either directly using appropriate sensors or indirectly by sensing the force imposed by the internal pressure of mix onto an element of the casting machine such as the feed augers, trowelling beams or other components of the machinery.

Strength variations in the finished product are principally related to the fact that the concrete mix is not compacted in an identical manner throughout the entire casting sequence. Compaction is affected by such factors as, i.a., concrete mix moisture, aggregate size and variations between the relative proportions of the mix constituents. For instance, a minor change in mix moisture can cause a major change in the degree of compaction of the final product, even if the other process variables are kept constant. Hence, the factors affecting the degree of compaction become very difficult to manage during the preparation stage of the concrete mix. In practice, the composition of the concrete mix is always very inhomogeneous and consequently compacts inconsistently in the different parts of the product even within a single product. The casting machines move on the casting bed by the reactive forces imposed by the feed augers. The transfer resistance of the casting machine can vary due to different reasons, and with an increase in the resistance, the feed augers must propel the mix with a higher force resulting in higher compaction of the cast product. Conversely, a reduction in the transfer resistance results in a lower degree of compaction. To obtain a consistent quality for the finished products, the compaction process of the concrete mix should be measurable and controllable.

Compaction of concrete has been measured indirectly by sensing, e.g., the power applied to rotate the augers or the axial force imposed on the auger. Such an implementation is disclosed in, e.g., the US patent publication 3,175,477. The GB patent 1,586,181 describes a method in which the input power to the auger or the reactive force imposed on it are employed as the control signal for adjusting the casting machine speed. The casting speed is advantageously held as steady as possible, thus achieving a consistent degree of compaction for the concrete mix in all parts of the product. The degree of compaction cannot be measured in the apparatus according to these prior art publications, and the compaction result in the final product is not controllable particularly in extruders in which the casting machine is transferred by the reactive propulsion forces of the augers.

Furthermore, direct measurement of the internal pressure in the concrete mix is conventionally employed, or alternatively, the pressure is measured indirectly from the pressure imposed by the concrete mix on an element of the casting machine. Pressure measurement is known in the art from casting apparatuses of concrete products as well as plastics extruders. The US patent 3,799,719 describes pressure measurement in plastics extruders.

In the prior-art techniques, the best approach to the control of the compaction process of a concrete product at the final production phase has been by way of methods based on pressure measurement. Such a measurement of the internal pressure prevailing in the mix during the course of the casting process is, however, difficult to implement and its transducer technology is expensive. Sensors employed for direct pressure measurement in the concrete mix being cast are easily damaged by the flow of the cast concrete. Although these drawbacks can be avoided if according to the EP-A-0 359 572 the pressure acting against the compaction surface is used as an indication for the degree of compaction of the concrete. To be precise, however, this method, too, only measures the internal pressure of the concrete mix being cast. This pressure however does not directly correlate to the degree of compaction in the final product,

because the degree of compaction is also affected by the rheological properties of the mix such as mix consistency, moisture content and a large number of other factors whose effect cannot be taken into account by any method known in the art. As the direct measurement of the degree of compaction at the casting time is impossible, the compaction effect cannot either be controlled to attain a consistently homogenous quality of the final product. By the same token, a sufficiently accurate control of the properties of the final product such as its strength and dimensional tolerances is not possible.

It is an object of the present invention to achieve a novel measurement method capable of measuring the compaction process of a concrete mix being cast and achieving the control of the casting machine on the basis of the obtained measurement result so as to attain a desired quality of the final product.

The method according to the invention is based on measuring the input power to the side or top trowelling beam of the casting machine, or alternatively, a variable related to the input power, then processing the result by computational methods, and finally utilizing the result of the computation for controlling the factors affecting the degree of compaction such as the rotational speed of the feed augers or the vibration input power and/or the mechanical trowelling movements of the mandrels or other elements of the casting machine.

More specifically, the method according to the invention is principally characterized by what is stated in claim 1.

Furthermore, the apparatus according to the invention is characterized by what is stated in claim 8.

The invention provides significant benefits.

The input power consumed by the trowelling beam, which performs the compaction of the concrete mix, correlates well with the variables characterizing the workability and rheological properties of the concrete mix. These properties are dependent on, i.a., the mix aggregate composition, binding agents and admixtures, and the amount of mix water. For instance, the aggregate size affects to a high degree the workability of the mix and the amount of compaction work required. Thus, by measuring the compaction power and adjusting the feed rate of the concrete mix on the basis of this information, or alternatively, the compaction parameters such as the input power to the vibrator or mechanical trowelling element, the internal pressure of the concrete mix and the compaction power can be set to an optimal level with respect to the mix composition and the properties desired for the final product. As the upper trowelling beam extends over a major part of the area to be compacted in the slab-like cast product, and correspondingly, the side trowelling beam extends over the area to be compacted in beam-like products, the measured input power gives an extremely realistic estimate of the total compaction power required. Hence, the power consumption of the casting machine can be optimized for each product, thereby minimizing energy costs and avoiding unnecessary loading of the machinery, thus reducing wear.

The invention is next explained with the help of exemplifying embodiments illustrated in the annexed drawing, in which

Figure 1 shows in a partially longitudinally sectional view a casting apparatus according to the invention.

Figure 2 shows a cross section of the apparatus illustrated in Fig. 1 at the trowelling beams.

Figure 3 shows an alternative cross section for the product to be cast.

Figure 4 is a block diagram outlining the control algorithm employed in the apparatus.

The apparatus according to the invention is an extruder-type casting apparatus adapted to run along the sides of a mould 13 supported by load-bearing wheels 5. The apparatus is assembled onto a frame 4. The exemplifying casting apparatus has three conical feed augers 2. The augers 2 are mounted on the frame 4 by means of a rotatable shaft 7 of the auger. Shaping mandrels 3 are placed to the trailing end of the feed augers 2 relative to the casting direction. A pull rod 6 adapted to pass through the center of each auger shaft 7 is actuated by a drive motor 9 of the compacting motion adapted to drive the rod via a crank lever mechanism 16, and the auger end is provided with a variator gear 17, via which the drive motors of the augers 2 are connected to the auger shaft 7. At the input end of the feed augers 2, the top of the apparatus carries a conical feed hopper 1. Next to the feed hopper 1, at the opposite end of the apparatus relative to the casting direction, above the apparatus, are located a top trowelling beam 11 and lower trowelling beams 12 which are located at the sides of the apparatus. The top trowelling beam 11 is connected via a crank lever mechanism 15 to the drive actuator of the top trowelling beam, and correspondingly, the side trowelling beams 12 are connected via crank lever mechanisms 22 to drive motors 10' of the side trowelling beams. A measurement signal line 19 is routed from the drive motor 10 of the top trowelling beam to a control unit 18, wherefrom control signal lines are routed to a drive motor 8 of the auger and the actuator of the compacting motion. The control of the actuators can be implemented by means of, e.g., a variator or frequency converter, or any other conventional means known in the art.

The function of the apparatus is as follows. Concrete mix poured in the feed hopper 1 flows by gravity onto the feed augers 2 rotated by the actuator 10. The rotating augers 2 propel the mix into a pressurized space continued as the shaping space delineated by the mould 13, the side trowelling beams 12 and the top trowelling beam 11. In this space the concrete mix is compressed into the space between the shaping mandrels 3, the walls 11, 12, 13 delineating the shaping

space, and is further compacted by the motion of the shaping mandrels 3 and the trowelling beams 11, 12 and the generated internal pressure, thus taking the shape of the desired finished product 14 such as a hollow-core beam. The reciprocating motion of the shaping mandrels 3 is provided by an electric motor 9 connected via a reduction gear and the crank lever mechanism 16 to the end of the pull rod 6. The motion of the top trowelling beam 11 and the side trowelling beams is implemented by means of similar combination electric motor/crank mechanisms 10, 15 and 10', 22.

The control of the apparatus is implemented by direct or indirect measurement of the input power to the drive motor 10, 10' of the top trowelling beam 11 and/or the side trowelling beam 12. The measured variable can be, e.g., the input current or hydraulic input pressure to the drive motor, and the selection of the variable is adapted according to the actuators and control technology employed. The input power to the drive motor 10 of top trowelling beam is advantageously measured for fabricating hollow-cored slabs and similar slab-like products illustrated in Fig. 2, while fabrication of products illustrated in Fig. 3 such as I-beams having a smaller width-to-height ratio is preferably carried out by measuring the power input to the drive motors 10' of the side trowelling beams.

The input power to the drive motor or a signal value relative to that appropriately correlates with the energy required for compaction of the concrete mix and the amount of energy necessary for achieving a desired final result. If the stiffness of the concrete mix becomes greater, the required input power increases, as well as the internal pressure within the compaction space. Similarly, if the aggregate size in the mix becomes greater or the proportion of aggregate in the mix is increased, mix workability becomes worse and the input power to the drive motors grows higher.

The measurement signal of the control variable is taken into the control unit 18 so that the control unit 18 can compute the necessary control signals employed for regulating the rotational speed of the augers 2 or the speed of the compacting motion of the shaping mandrels, or possibly both of these. The basic rule of the control principle is to slow down the rotational speed of the augers 2 to attain pressure reduction in the compaction/shaping space, and in a similar fashion, the speed of the compacting motion of mandrels 3 can be increased to effect pressure reduction. As a pressure reduction results in reduced input power, it is possible to establish defined relationships of the power consumption, the internal pressure and the compaction energy.

Figure 4 shows a block diagram of an exemplifying control system in which the speed of two feed augers 2 and the reciprocating stroke rate of the shaping mandrels 3 are controlled on the basis of the input current to the drive motor 10 of the trowelling beam 11. The control system is operated as a discrete state system, that is, by sampling the motor input current at certain time intervals t_p. If the measured value ml_p of the motor input current deviates outside its tolerance limits, that is, the measured value is greater than the sum of the set value I_p of the input current to the trowelling beam drive motor 10 and the nominal allowable deviation I_{ps} thereof, the program proceeds to the next step. Otherwise, the program resumes the initial state without performing any control steps. If the program decides to proceed to the next step, the time tim_r required for regulating the variator gears of the feed augers is checked to be shorter than the maximum allowable regulation time t_c. If not, the program steps to the alarm state in which the apparatus is halted and the operator is alerted by issuing an alarm. Provided that the time required for regulating the variators remains smaller than the maximum allowable regulation time, the measured value ml_p of motor input current is tested whether it exceeds the sum of the set value I_p of the trowelling beam drive motor input current and the maximum allowable deviation I_{pu} thereof. If larger, the measured value is tested whether it exceeds the absolute maximum input current; and with a positive result, the program returns to the initial state via the alarm and halt states. If the absolute maximum input current is not exceeded, the program issues a control signal to increase the reciprocating stroke rate of the compacting mandrel for a preset mandrel-regulating time t_{tt}. In the opposite case with the measured value ml_p remaining below the sum of the set value I_p and the deviation limit I_{pu}, the next program step issues a control signal to reduce the rotational speed of the augers 2 for a preset auger-regulating time t_{rt}. In the next step the program checks the relative rotational speeds of the augers 2 by comparing the absolute value of the difference of measured motor currents ml_1 and ml_2 of said augers against a preset allowable difference I_{rd}. If the absolute value of the difference remains below the set limit, the program resumes the initial state; otherwise, the rotational speed of the faster running auger is reduced for a preset regulating time t_{it} of the auger drive motors.

In addition to those described above, the invention can be implemented in alternative embodiments.

The drive elements can be any power actuators capable of delivering the required output power. In the above applications, however, electric or hydraulic motors are superior. The conversion of a rotational movement into a linear cyclically reciprocating motion can be implemented in different ways using, e.g., a crank lever or eccentric cam and follower mechanism. All drive elements can be controllable, but the simplest embodiment requires only the rotational speed of the augers 2 or the reciprocating compacting motion of the mandrels 2 to be controllable.

Concrete mix feed by means of the augers 2 can be replaced by an alternative feed method such as, e.g., ram feed. The shaping mandrels are not absolutely necessary, but rather, can be replaced by tapering mandrels when fabricating cast products with a solid core. Replacing or complementing the action of the mandrels, other compaction methods such as high-frequency

vibration can be employed. If so desired, the shaping mandrels can be mounted apart from the feed augers, whereby they operate as separate elements, allowing the augers to feed the concrete mix between the mandrels.

The control of the compacting motion or the compaction effect can be implemented by regulating the speed or stroke length of the compacting motion or the vibration input power.

Claims

1. A method for producing a concrete product with a controlled degree of compaction, in which method

   - concrete mix is fed by means of at least one rotational feed element (2) through a delineated cross section (3, 11, 12, 13) in order to fabricate a concrete product of desired shape,

   - the mix being cast is compacted by means of at least one reciprocating motion of trowelling beams (11, 12) and/or of shaping mandrels (3), and
     the reciprocating motion of the trowelling beams (11, 12) is actuated by drive means (10, 10'),

   characterized in that

   - the power consumed by the drive means (10, 10') actuating the reciprocating motion of the top trowelling beam (11) and/or the side trowelling beam (12) or a variable related to said power is measured by an appropriate method and, on the basis of the obtained measurement result, at least the compacting reciprocating motion of one of the trowelling beams (11, 12) and/or the shaping mandrels (3) and/or the rotational speed of the feed element (2) is regulated so as to attain the control of the compaction effect and pressure within the confines of the delineated cross section.

2. A method as defined in claim 1, in which method the concrete mix is compacted by moving at least one (11) of the surfaces delineating said cross section, **characterized** in that the measured power is the power consumed to move said surface (11), whereby direct or indirect measurement of the power is employed.

3. A method as defined in claim 1, in which method the concrete mix is fed through the delineated cross section (3, 11, 12, 13) and compacted by moving at least one of the mandrels (3) placed in said cross section so as to delineate said cross section, **characterized** in that, on the basis of the measurement value, both the feed and compaction of the concrete mix are regulated by controlling the motion of the mandrel (3).

4. A method as defined in claim 1, in which method the concrete mix is fed through the delineated cross section (3, 11, 12, 13) and compacted by moving at least one of the mandrels (3) placed in said cross section so as to delineate said cross section as well as moving three of the surfaces (11, 12) delineating said cross section, **characterized** in that the power consumed to move all three surfaces (11, 12) is measured in an appropriate manner and the feed of the concrete mix is regulated on the basis of the measurement values.

5. A method as defined in claims 3 and 4, **characterized** in that both the feed and compaction of the concrete mix are regulated on the basis of the measurement value.

6. A method as defined in any foregoing claim, **characterized** in that the measured variable is the input current to an electric drive motor.

7. A method as defined in any foregoing claim, **characterized** in that the measured variable is hydraulic drive fluid pressure.

8. An apparatus for producing a concrete product with a controlled degree of compaction, said apparatus comprising

   - at least one rotational feed element (2) for feeding concrete mix through a delineated cross section (3, 11, 12, 13),

   - at least one trowelling beam (11, 12) and/or shaping mandrel (3) delineating said cross section (3, 11, 12, 13) that can be brought to a reciprocating motion in order to compact the concrete mix, and

   - drive means (10, 15) for actuating the reciprocating motion of said surface,

   characterized by

   - means for measuring (19), transmitting and processing (18) the input power level to the drive means (10, 10') moving the top trowelling beam (11) and/or one side trowelling beam (12), or alternatively, a variable related to said power level so as to attain a control signal and means (20, 21) for transmitting said control signal to at least the regulating elements for the reciprocating motion of one of the trowelling beams (11, 12) and/or shaping mandrels (3) and/or the rotational speed of the feed means (2) for the concrete mix.

9. An apparatus as defined in claim 8, comprising at least one shaping mandrel (3) extending to said delineated cross section and of elements for actuating a reciprocating motion of said mandrel (3), **characterized** by means (21) suited to transmit a control signal to said actuating elements (9, 16) for the regulation of the compaction effect of said mandrel.

10. An apparatus as defined in claim 9, comprising a mould (13) surrounding said delineated cross section, two side trowelling beams (12) movable by an actuator (10'), and a top trowelling beam (11) movable by an actuator (10), and at least one shaping mandrel (3), **characterized** by means (19) suited to measure the power consumed by said actuators or said trowelling beams (11, 12), or alternatively, a variable related to said power.

Patentansprüche

1. Verfahren zum Herstellen eines Betonerzeugnisses mit einem gesteuerten Verdichtungsgrad, bei welchem Verfahren

   - eine Betonmischung mittels zumindest eines sich drehenden Förderelements (2) durch einen abgegrenzten Querschnitt (3,11,12,13) gefördert wird, um ein Betonerzeugnis von gewünschter Form herzustellen,
   - die Mischung, die geformt wird, mittels zumindest einer hin- und hergehenden Bewegung von Streichschienen (11,12) und/oder von Formungsdornen (3) verdichtet wird,
   - und die hin- und hergehende Bewegung der Streichschienen (11,12) durch Antriebseinrichtungen (10, 10') in Gang gesetzt wird,

   dadurch gekennzeichnet,
   daß die durch die Antriebseinrichtungen (10, 10'), welche die hin- und hergehende Bewegung der oberen Streichschiene (11) und/oder der Seiten-Streichschiene (12) in Gang setzen, verbrauchte Leistung oder eine zu der genannten Leistung in Beziehung stehende Variable nach einem geeigneten Verfahren gemessen wird
   und daß auf der Basis des erhaltenen Meßergebnisses zumindest die verdichtende Hin- und Herbewegung einer der Streichschienen (11,12) und/oder eines der Formungsdorne (3) und/oder die Drehzahl des Förderelements (2) derart reguliert wird, daß die Steuerung der Verdichtungswirkung und des Drucks innerhalb der Grenzen des abgegrenzten Querschnitts erreicht wird.

2. Verfahren nach Anspruch 1, wobei die Betonmischung durch Bewegung zumindest einer (11) der Flächen, welche den genannten Querschnitt abgrenzen, verdichtet wird,
   dadurch gekennzeichnet,
   daß die gemessene Leistung die Leistung ist, die verbraucht wird, um die genannte Fläche (11) zu bewegen, wobei eine direkte oder indirekte Messung der Leistung benutzt wird.

3. Verfahren nach Anspruch 1, wobei die Betonmischung durch den abgegrenzten Querschnitt (3,11,12,13) gefördert und durch Bewegung zumindest eines der Dorne (3) verdichtet wird, die in dem genannten Querschnitt derart angeordnet sind, daß der genannte Querschnitt abgegrenzt ist,
   dadurch gekennzeichnet,
   daß auf der Basis des Meßwertes die Förderung und die Verdichtung der Betonmischung durch Steuern der Bewegung des Dornes (3) reguliert werden.

4. Verfahren nach Anspruch 1, wobei die Betonmischung durch den abgegrenzten Querschnitt (3, 11, 12, 13) gefördert und durch Bewegung zumindest eines der Dorne (3) verdichtet wird, die in dem genannten Querschnitt derart angeordnet sind, daß der genannte Querschnitt abgegrenzt ist und drei der den genannten Querschnitt abgrenzenden Flächen (11, 12) bewegt werden,
   dadurch gekennzeichnet,
   daß die zur Bewegung sämtlicher drei Flächen (11, 12) verbrauchte Leistung in einer geeigneten Weise gemessen wird und daß die Förderung der Betonmischung auf der Basis der Meßwerte reguliert wird.

5. Verfahren nach Anspruch 3 und 4, **dadurch gekennzeichnet**, daß die Förderung und die Verdichtung der Betonmischung auf der Basis des Meßwertes reguliert werden.

6. Verfahren nach irgendeinem vorhergehenden Anspruch, **dadurch gekennzeichnet**, daß die gemessene Variable der Eingangsstrom für einen elektrischen Antriebsmotor ist.

7. Verfahren nach irgendeinem vorhergehenden Anspruch, **dadurch gekennzeichnet**, daß die gemessene Variable ein hydraulischer Antriebsfluiddruck ist.

8. Vorrichtung zum Herstellen eines Betonerzeugnisses mit einem gesteuerten Verdichtungsgrad, umfassend

   - zumindest ein sich drehendes Förderelement (2) für die Förderung einer Betonmischung durch einen abgegrenzten Querschnitt (3,11,12,13),
   - zumindest eine den genannten Querschnitt (3,11,12,13) abgrenzende Streichschiene (11,12) und/oder zumindest einen abgrenzen-

den Formungsdorn (3), die bzw. der in eine hin- und hergehende Bewegung versetzt werden kann, um die Betonmischung zu verdichten,

- und Antriebseinrichtungen (10,15) zur Vornahme der hin- und hergehenden Bewegung der genannten Fläche,

gekennzeichnet
durch eine Einrichtung zum Messen (19), Übertragen und Verarbeiten (18) des Eingangsleistungspegels für die Antriebseinrichtungen (10,10'), welche die obere Streichschiene (11) und/oder eine Seiten-Streichschiene (12) bewegen, oder alternativ einer Variablen, die zu dem genannten Leistungspegel in Beziehung steht, derart, daß ein Steuersignal erhalten wird, und durch Einrichtungen (20, 21) zur Übertragung des genannten Steuersignals zumindest zu den Regulierelementen für die hin- und hergehende Bewegung einer der Streichschienen (11,12) und/oder eines der Formungsdorne (3) und/oder für die Drehzahl der Fördereinrichtung (2) für die Betonmischung.

9. Vorrichtung nach Anspruch 8, umfassend zumindest einen Formungsdorn (3), der sich in den abgegrenzten Querschnitt erstreckt, und Elemente zur Betätigung bzw. Vornahme einer hin- und hergehenden Bewegung des genannten Dornes (3),
gekennzeichnet
durch eine Einrichtung (21), die geeignet ist, ein Steuersignal zu den genannten Betätigungselementen (9,16) für die Regulierung der Verdichtungswirkung des genannten Dornes (10) zu übertragen.

10. Vorrichtung nach Anspruch 9, umfassend eine Form (13), welche den genannten abgegrenzten Querschnitt umgibt, zwei Seiten-Streichschienen (12), die durch eine Betätigungseinrichtung (10') bewegbar sind, und eine obere Streichschiene (11), die durch eine Betätigungseinrichtung (10) bewegbar ist, und zumindest einen Formungsdorn (3),
gekennzeichnet durch eine Einrichtung (19), die geeignet ist, die durch die genannten Betätigungseinrichtungen oder die genannten Streichschienen (11,12) verbrauchte Leistung oder alternativ eine zu der genannten Leistung in Beziehung stehende Variable zu messen.

Revendications

1. Méthode pour la production d'un élément en béton ayant un degré de compactage contrôlé, dans laquelle :

un prémélange de béton est distribué au moyen d'au moins un élément de distribution rotatif (2) ayant une section transversale à contour défini (3,11,12,13) afin de fabriquer un élément en béton de forme désirée,
le prémélange coulé est compacté au moyen d'au moins un mouvement de va-et-vient de poutres d'égalisation (11,12) et/ou de mandrins de formage (3), et
le mouvement de va-et-vient des poutres d'égalisation (11,12) est engendré par des moyens d'entraînement (10, 10'),

caractérisée en ce que

la puissance consommée par les moyens d'entraînement (10,10') engendrant le mouvement de va-et-vient de la poutre d'égalisation supérieure (11) et/ou de la poutre d'égalisation latérale (12), ou une variable liée à ladite puissance, est mesurée par une méthode appropriée et, sur la base du résultat de mesure obtenu, au moins le mouvement de va-et-vient de compactage d'une des poutres d'égalisation (11,12) et/ou des mandrins de formage (3),et/ou la vitesse de rotation de l'élément de distribution (2), est réglé de façon à effectuer le réglage de l'effet de compactage et de la pression dans les limites de la section transversale à contour défini.

2. Méthode suivant la revendication 1, dans laquelle le prémélange de béton est compacté par déplacement d'au moins une (11) des surfaces délimitant ladite section transversale,caractérisée en ce que la puissance mesurée est la puissance consommée pour déplacer ladite surface (11), de sorte qu'on emploie une mesure directe ou indirecte de la puissance.

3. Méthode suivant la revendication 1, dans laquelle le prémélange de béton est distribué à travers la section transversale à contour défini (3,11,12,13) et compacté par déplacement d'au moins un des mandrins (3) placés dans ladite section transversale de façon à délimiter ladite section transversale,caractérisée en ce que, sur la base de la valeur de mesure, à la fois la distribution et le compactage du prémélange de béton sont régulés par commande du mouvement du mandrin (3).

4. Méthode suivant la revendication 1, dans laquelle le prémélange de béton est distribué à travers la section transversale à contour défini (3,11,12,13) et compacté par déplacement d'au moins un des mandrins (3) placés dans ladite section transversale de façon à délimiter ladite section transversale, ainsi que par déplacement de trois des surfaces (11,12) délimitant ladite section transversale, caractérisée en ce que la puissance consommée pour déplacer la totalité des trois surfaces (11,12) est mesurée d'une manière appropriée et la distri-

bution du prémélange de béton est régulée sur la base de la valeur de mesure.

5. Méthode suivant les revendications 3 et 4, caractérisée en ce qu'à la fois la distribution et le compactage du prémélange de béton sont régulés sur la base de la valeur de mesure.

6. Méthode suivant une quelconque des revendications précédentes, caractérisée en ce que la variable mesurée est le courant d'entrée d'un moteur électrique d'entraînement.

7. Méthode suivant une quelconque des revendications précédentes, caractérisée en ce que la variable mesurée est une pression de fluide hydraulique d'entraînement.

8. Dispositif pour la production d'un élément en béton ayant un degré de compactage contrôlé, ledit dispositif comprenant :

au moins un élément de distribution rotatif (2) pour distribuer un prémélange de béton à travers une section transversale à contour défini (3,11,12,13),
au moins une poutre d'égalisation (11,12) et/ou un mandrin de formage (3) délimitant ladite section transversale (3,11,12,13), pouvant être mis en mouvement de va-et-vient afin de compacter le prémélange de béton, et
des moyens d'entraînement (10,15) pour engendrer le mouvement de va-et-vient de ladite surface, caractérisé par
des moyens de mesure (19) qui transmettent et traitent (18) la valeur de puissance d'entrée appliquée aux moyens d'entraînement (10,10') qui déplacent la poutre d'égalisation supérieure (11) et/ou une poutre d'égalisation latérale (12), ou en variante une variable liée à ladite valeur de puissance, de façon à engendrer un signal de commande, et
des moyens (20,21) pour transmettre ledit signal de commande au moins aux éléments de régulation du mouvement alternatif d'une des poutres d'égalisation (11,12) et/ou des mandrins de formage (3), et/ou de la vitesse de rotation des moyens de distribution (2) du prémélange de béton.

9. Dispositif suivant la revendication 8, comprenant au moins un mandrin de formage (3) s'étendant dans ladite section transversale à contour défini et des éléments de génération d'un mouvement de va-et-vient du. dit mandrin (3), caractérisé par des moyens (21) appropriés à la transmission d'un signal de commande auxdits éléments de génération de mouvement (9,16) afin de réguler l'effet de compactage dudit mandrin.

10. Dispositif suivant la revendication 9, comprenant un moule (13) qui entoure ladite section transversale à contour défini, deux poutres d'égalisation latérales (12) déplaçables par un actionneur (10') et une poutre d'égalisation supérieure (11) déplaçable par un actionneur (10), et au moins un mandrin de formage (3), caractérisé par des moyens (19) permettant de mesurer la puissance consommée par lesdits actionneurs ou lesdites poutres d'égalisation (11,12), ou,en variante, de mesurer une variable liée à ladite puissance.

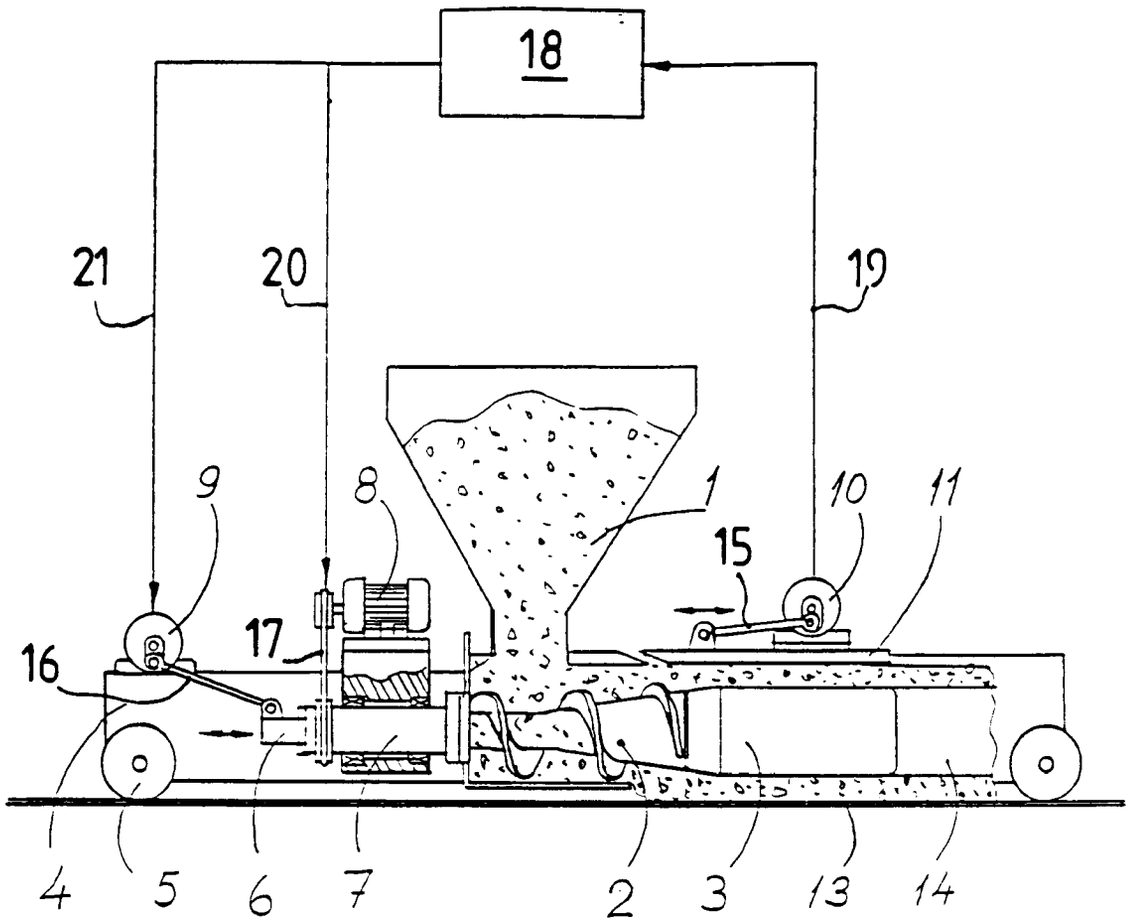

18
21
20
19
9
8
1
10
11
15
17
16
4
5
6
7
2
3
13
14

Fig 1

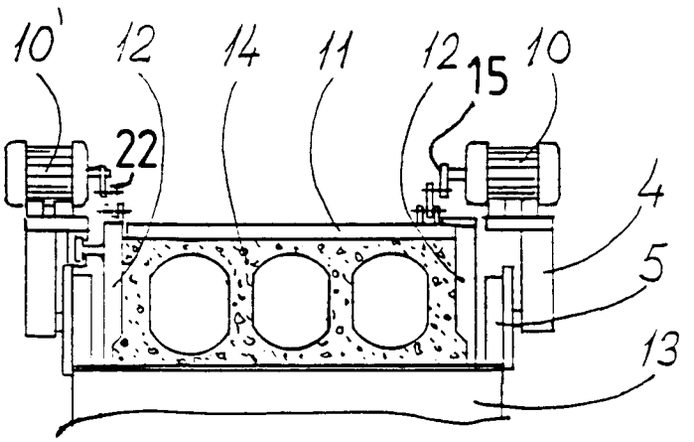

10'
12
14
11
12
15
10
22
4
5
13

Fig 2

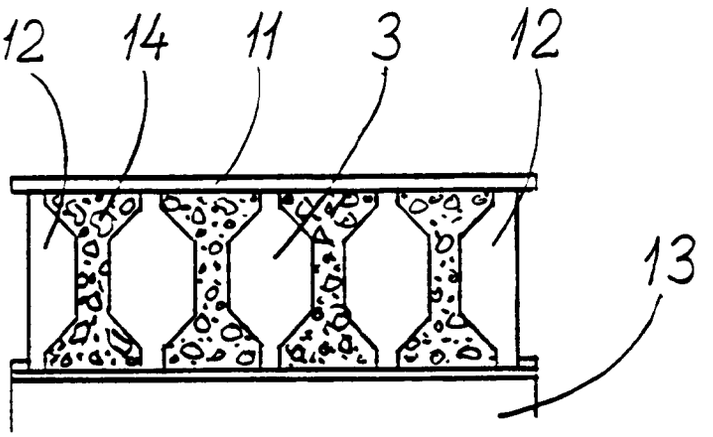
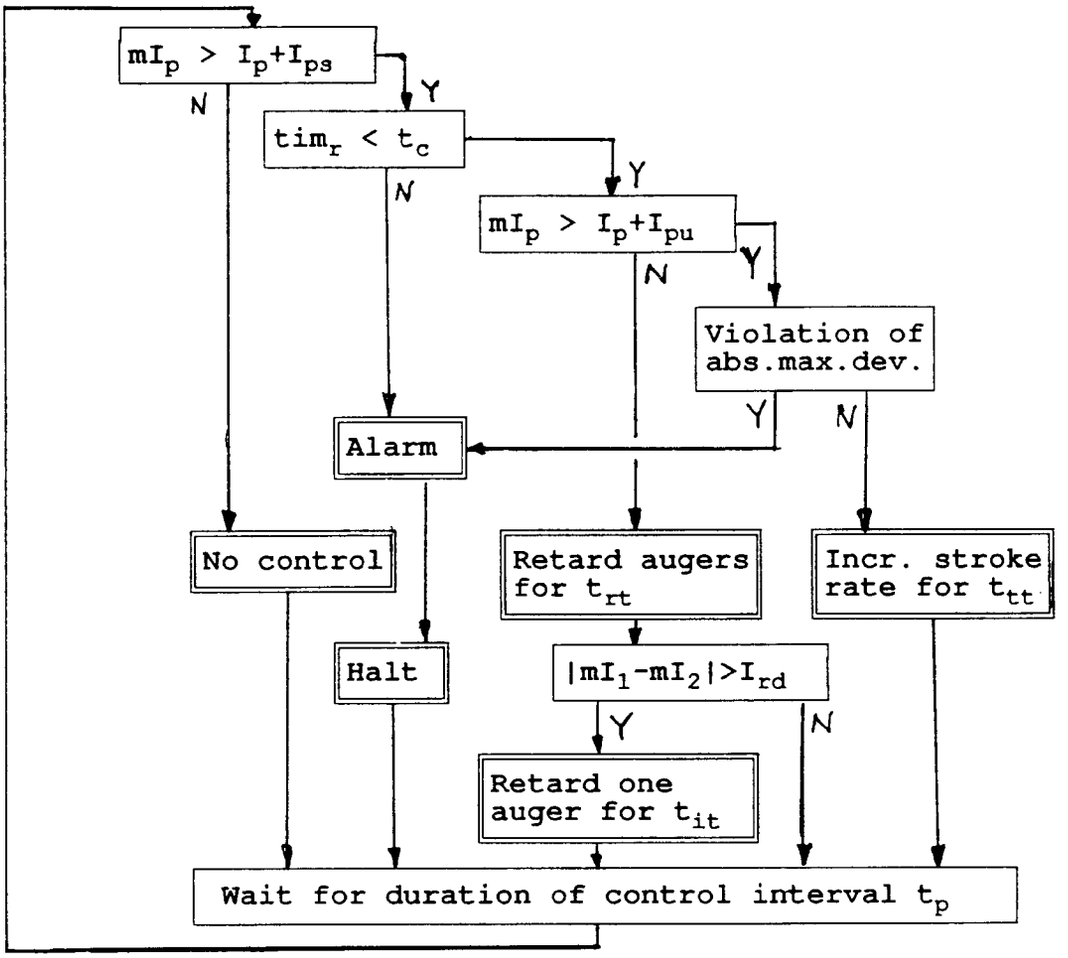


Fig 3

FIG. 4



mI_p = measured input current to trowelling beam drive motor

I_p = set value of input current to trowelling beam drive motor

I_{ps} = nominal allowable upward deviation from set value of input current to trowelling beam drive motor

tim_r = time required for controlling the variator gears

t_c = time allowable for controlling the variator gears

I_{pu} = ~~maximum~~ allowable upward deviation from set value of input current to trowelling beam drive motor

t_{rt} = allowable duration of regulation by reducing the rotational speed of augers

t_{tt} = allowable duration of regulating time for increased compaction by reciprocating mandrels

I_{rd} = difference of input currents to auger drive motors

t_{it} = allowable duration of regulating time for mutual speed equalizing of augers