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71 Applicant: **KT-SUUNNITTELU OY**
Huhtakatu 17
SF-37600 Valkeakoski (FI)

72 Inventor: **Seppänen, Aimo**
Kannistonmäki
FI-37600 Valkeakoski (FI)

Järvinen, Lassi
Koulukatu 10 C 24
FI-37600 Valkeakoski (FI)

74 Representative: **Wolfram, Gustav, Dipl.-Ing.**
Schwindgasse 7 P.O. Box 205
A-1041 Wien (AT)

54 **Slipforming extruder for hollow-core concrete elements.**

57 This publication describes a slipforming extruder for production of hollow-core concrete elements (23), movable in respect to a casting bed (4) and comprising a frame (18) which is movable, e.g. supported by wheels (19), and provided with at least two adjacent auger flights (2, 25) with flights (5) and a core-forming mandrel (3), attached to the final end of each auger flight (2). Furthermore, the machine comprises a primary drive and power train system (7, 15, 16, 17) for rotating the auger flights (2) and a feed apparatus attached to the frame (18), e.g. a hopper (1), for feeding the auger flights (2) with the concrete mix to be cast. According to the invention, a secondary drive and power train system (8...14) moves the adjacent auger flights (e.g. 2 and 25) in a synchronized and counterphased reciprocating manner in the axial direction. Because the machine disposes of core vibration, it achieves a low level of generated noise.

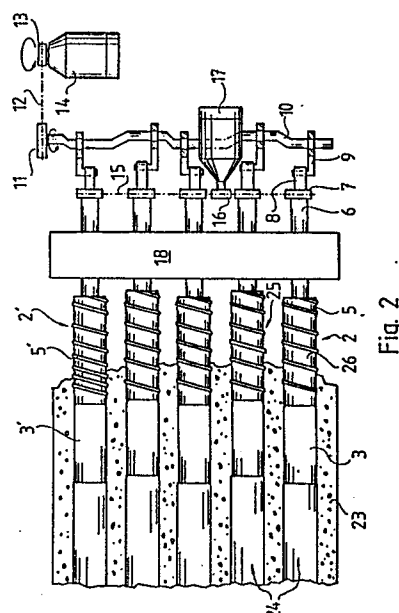


Fig. 2

Description

Slipforming extruder for hollow-core concrete elements

The present invention relates to a concrete slab extruder in accordance with the preamble of claim 1.

Casting of hollow-core concrete elements with sliding molds, especially hollow-core slabs, is based on extruding the concrete mix onto the casting bed by using one or several core-forming members, e.g. a core-forming mandrel and/or a trowel tube. The concrete mix is compacted by utilizing the pressure generated by the auger flight.

In the prior art there exist several basically similar constructions of slipforming extruders for hollow-core elements in which the concrete mix is extruded by means of auger flights. The extruder moves on rails on a bed. The auger flights are conical by their flight sections so as to make the flight expand towards the end of the flight. This kind of a construction achieves an effective compaction of the concrete. A forming member extension is provided immediately next to the auger flight, e.g., a core-forming mandrel, which is vibrated by means of a vibrator mounted inside the mandrel. In addition, a vibrator beam atop the cover part of the machine is vibrated, which combines with the vibration of the coreforming mandrels to effect the final compaction of the concrete. The core-forming mandrel is accompanied with a trowel tube, whose duty is to support the shell walls of the hollow-core slab at the final end of the extruder machinery.

Due to the high vibration frequency, however, the drawbacks of the extruder construction of the hollow-core forming mandrel type include a high noise level, high energy consumption, and a low efficiency of vibration power used for compaction.

The present invention aims to overcome the disadvantages found in prior-art constructions and to present a completely new type of extruder which is especially applicable for the compaction of a soil-wet concrete mix.

The invention is based on moving adjacent auger flights used for concrete extrusion in a synchronized and counterphased reciprocating manner in the axial direction. Then, the rotating movement of the auger flights generates a continuous and steady feed pressure at the final end of the auger flights. The auger flights in accordance with the invention, and especially their core parts, have an approximately constant diameter, thus deviating from the conventional constructions of conical shape.

In addition, the difference between the outside diameter of auger flights and the diameter of the auger core is small as compared to the conventional auger construction, which allows a relatively large diameter for the auger core. The auger length is also preferably relatively long.

A special feature of the invention proposes a decreasing pitch of flights towards the final end of the auger flight. This decrease a pitch is preferably constant, which makes the pitch progressively smaller towards the final end of the auger. Consequently, the pitch of auger flights is essentially smaller at the final end of the auger than at the initial

end of the auger.

In addition to the increasing compaction of concrete at the final end of the auger flight, the compaction is furthermore amplified by the axially reciprocating movement of the auger flights.

More specifically, the slipforming extruder in accordance with the invention is characterized by what is stated in the characterizing part of claim 1.

The invention provides remarkable advantages. Thus, the noise level generated by an extruder machine in accordance with the invention is essentially lower than in hollow-core extruders based on vibration compaction with a vibration frequency in the range of 150...250 Hz. In addition, the slipforming extruder in accordance with the invention is especially applicable to both the production of prestressed hollow-core slabs of the aforementioned type and production of steel-reinforced hollow-core concrete slabs.

In the following, the invention will be examined in more detail by means of exemplifying embodiments.

Figure 1 shows a partly schematic cross-sectioned side view of a slipforming extruder in accordance with the invention.

Figure 2 shows a partly schematic top view of a slipforming extruder with a slightly different construction from that shown in Figure 1.

In the following, the constructions shown in Figures 1 and 2 are examined in parallel using an analogous reference numbering system.

The slipforming machine shown in Figure 1 is adapted movable on a casting bed 4. The machine comprises a frame 18, which is adapted movable on rails 20 supported on wheels 19. With bearings rotatably secured to the frame 18, it has five parallel auger flights 2, 25 with relatively low-profile flights 5. Consequently, a core member 26 of the auger flights 2 has an appreciably large and approximately constant diameter in the axial direction. The flights 5 have a constant pitch over the entire length of the auger 2. Each final end of the augers 2 carries a stiffly mounted core-forming mandrel 3 and/or a trowel tube.

The drive and power train system 7, 15, 16, 17, which is provided for rotating the auger flights 2, is adapted to the movable frame 18. This drive and power train system comprises an electric motor 17, which drives the auger flights 2, 25 via a chain sprocket 16 and a chain 15 by chain sprockets 7, which are mounted onto shafts 6 of the auger flights 2, 25.

The concrete poured from a hopper 1 is adapted to flow to the initial end of the auger flights 2. A hollow-core slab 23 to be cast is bordered from below by a bed 4, from the sides by side members which are not shown, and from above by vibrating top beams 21 and 22. As the slipforming extruder machine moves from left to right during the casting operation in accordance with Figure 1, a core-forming mandrel 3 forms a cylindrical void 24.

The frame 18 also carries secondary drive and

power train system 8...14. It comprises an electric motor 14 together with a crankshaft assembly 10, which is driven by the motor and attached to shafts 6 of the adjacent auger flights 2, 25. The assembly is connected via connecting rods 9 to ends 8 of shafts 6 of auger flights 2 so as to make the adjacent auger flights 2, 25 move in a synchronized and counterphased reciprocating manner in the axial direction during the operation of the slipforming extruder machine. The frequency of the reciprocating movement of the auger flights 2, 25 is 0.3...100 Hz, preferably 5...10 Hz. The amplitude of the reciprocating movement (stroke length) is 0.5...50 mm, preferably about 10 mm.

The reciprocating movement at the final end of the extrusion phase performs an extremely effective compaction of concrete. The reciprocating movement of the augers 2, 25 creates pressure variations in the concrete by combining the constant rotation of the augers to the pushing motion at the push phase of the augers and thus imparting a transverse shear in the concrete mix. This also forces the concrete aggregates to perform a shearing flow in the direction transverse to the axial flow. The core-forming mandrel 3 as an immediate extension of the auger 2 gives the void 24 a desired form (in this case, a cylindrical form).

The aforementioned progressively decreasing pitch is exemplified in the upper auger 2' of Figure 2. In this embodiment the pitch of a flight 5' is decreased in the feed direction so as to achieve a pitch of 30...70 % at the final end of the auger 2', preferably about 50 % of the pitch at the initial end of the auger 2'.

The auger 2 has a flight profile 5 with a height of, for instance, 3...10 % of the diameter of the auger 2.

with a crankshaft assembly (10), driven by the motor and effectual on shafts (6) of the adjacent auger flights (e.g. 2 and 25).

3. A slipforming extruder as claimed in claim 1, **characterized** in that the frequency of the reciprocating movement of auger flights (2, 25) is 0.3...100 Hz, preferably 5...10 Hz.

4. A slipforming extruder as claimed in claim 1, **characterized** in that the amplitude of the reciprocating movement (stroke length) of the auger flights (2, 25) is 0.5...50 mm, preferably about 10 mm.

5. A slipforming extruder as claimed in claim 1, **characterized** by a progressively decreasing pitch of the flight (5') of each auger flight (2') in the feed direction.

6. A slipforming extruder as claimed in claim 5, **characterized** in that the pitch of the flight (5') at the final end of the auger flight (2') is 30...70 %, preferably about 50 %, of the pitch of the flight (5') at the initial end of the auger flight (2').

7. A slipforming extruder as claimed in claim 1, **characterized** in that each core-forming mandrel (3) is stiffly mounted to its respective auger flight (2).

8. A slipforming extruder as claimed in claim 1, **characterized** in that each auger flight (2) and its core member (26) have a construction of an approximately constant diameter.

9. A slipforming extruder as claimed in claim 1, **characterized** in that the profile height of the flight (5) is 3...10 % of the diameter of the auger flight (2).

Claims

1. A slipforming extruder applicable to the production of hollow-core concrete elements (23) with a movable construction in respect to a casting bed (4) and comprising

- a frame (18), which is movable and, for instance, supported by wheels (19),
- at least two augers (2, 25) with flights (5), parallel mounted on bearings in the frame (18),
- a core-forming mandrel (3) attached to the final end of each auger flight (2),
- a primary drive and power train system (7, 15, 16, 17) for rotating the auger flights (2), and
- a feeder apparatus attached to the frame (18), e.g. a hopper (1), for feeding the concrete mix to be cast onto the auger flights (2),

characterized by a secondary drive and power train system (8...14) for moving the adjacent auger flights (e.g. 2 and 25) in a synchronized and counterphased reciprocating manner in the axial direction.

2. A slipforming extruder as claimed in claim 1, **characterized** by a secondary drive and power train system comprising a power actuator (14), preferably an electric motor, together

