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Paper

THE TECHNOLOGY AND THE MACHINE FOR QUARRYING FASHIONED SIDEWALK PARTS FROM ROCK MASSIVE BY UHPWJ

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ABSTRACT

The production of fashioned facing slabs and sidewalk parts from massive rock by the new machine is similar to the technology of the production of the wall stone of the correct form by special machine working by ultra high pressure waterjet (UHPWJ). When generatrix of these parts has a periodic contour, its reproduction is carried out by two kinematic interconnected movements of waterjet cutting heads. During cross cutting across the length of the plate, the moving head makes one or two double courses in a perpendicular direction. If the shape of the plate is uniform the heads make parallel movements and at two symmetric shapes the double heads courses in counter direction during moving across the length of a plate. In the first case the cross cutting unit of the machine is carried out with the integral body of heads and connected with the screw of perpendicular movement to one running nut. In the second case, the body of the head is carried out separately for every head and the running screw is compound with opposite direction of a coil for each pair of heads. The reversal engine of cross unit receives impulses from the angular sensor established on the forward shaft of a running frame of the machine. The amount of those impulses conforms to the kinematic connection between cross and longitudinal movements. The research showed that during apiece quarrying of the parts due to high speed of cutting, the productivity of new machine is much higher than in case of pair production with two horizontal saws. Besides, during apiece production the probability of fracture formation on plates is much lower.

1. INTRODUCTION

The technology of cutting of materials by UHPWJ is widely used in different branches of industry. The comparatively small force of UHPWJ cutting and the minimal breadth of cut does not exceed 1-3 mm, the ecological cleanliness and the universality of technology opens good perspectives for the solution of a number of engineering tasks in branch industry of building materials.

The development of technology and machine for quarrying wall stone of the correct form by UHPWJ permits to continue groundwork for quarrying shaped pavement slabs.

2. THE TECHNOLOGY OF QUARRYING SHAPED PAVEMENT SLABS

A few species of shaped pavement slabs are shown in Fig. 1, they also may be used for facing of interior. The slabs have a monotype shaped contour shown in Fig. 1 a, b, c. The slabs have a pair shaped symmetrical contours shown in Fig. 1 d, e.

The technology of quarrying shaped payment slabs from rock massive by UHPWJ is similar to the work of quarrying wall stone of the correct form [1], but it also has many serious differences. The new machine enables two subsequent operations to be carried out: during the execution of the first transversal technological operation, the distance between cutting heads is adjusted to equal the breadth **B** of the slab (Fig. 2 a). The movement of cutting heads along the slab is kinematically connected with the movement in the perpendicular direction. During the transfer the cutting heads on the length of a slab make one (for slabs shown in Fig. 1 c, d, e) or two (for slabs shown in Fig. 1 a, b) double movement with amplitude **A** (Fig. 2a). For the slabs with symmetrical contour (Fig. 1 d, e) cutting heads working by pair make movements in the opposite direction (Fig. 2 b). The simultaneous cutting of several grooves is carried out to ensure the depth of cutting equal to height **H** of the slab. To perform the next cycle the machine moves to a new position from final groove of the size of the slab breadth **B**. The transversal grooves are repeated along the length of the open trench.

During the second technological operation the slabs get rid of the rock massive (Fig. 2 c). The carriage of the machine is turned by 180^0. As the height **H** of the slabs is comparatively small (no more 100-120 mm) the head of the horizontal cut has two diamond saws of diameter approximately equal to three length **L** of slabs. For the length of a slab up to 175-200 mm, the diameter saw is 630 mm. The UHPWJ head for back cutting is aimed in the direction of movement at a distance of 0,5**D** + (5…10) mm from the diamond saw and at slab length **L** from the ledge of a trench. Both technological operations are carried out at the same time and repeated consecutively along the length of the open trench.

3. THE MACHINES

For the guarantee of the kinematically interconnected movements of cutting heads during the carried out transversal technological operation, the construction of machine [1] is modernized.

The design features of the new machine for the production of shaped pavement slabs from rock massive are indicated in the patent specification of useful model [2]. The main units of the new machine are shown in Fig.3: four-wheel automotive frame (1); the chassis (2) with high pressure pump and the supplying hydro-installations (3); a round rotary directing (4) and the support mobile carriage (5); the unit (6) of transversal cutting; the longitudinal directing (7); UHPWJ cutting heads with nozzles (9); the other side of the carriage on longitudinal directing (10); the diamond head (11) with diamond saws (12); the back UHPWJ cutting head (13). Also in Fig. 3 are shown: the body of cutting heads (8); the screw of perpendicular movement (14); the toothed gear (15); the reversal engine motor (16) for double movement; the corrugated barrier (17); the angular sensor (18) at longitudinal movement.

During the quarrying shaped pavement slabs with monotype shaped contour the unit of transversal cutting is carried out with the integral body of heads and connected with the screw of perpendicular movement to one running nut. Depending on the quantity of shaped contour – one (Fig. 1 c) or two (Fig. 1 a, b) the body (8) with cutting heads (9) from reversal engine (16) through toothed gear (15) and the screw movement (14) receives one or double movement. The reversal engine (16) received signals from angular sensor (18) established on the forward shaft of a running frame of the machine in accordance with kinematical connection between cross and longitudinal movements of cutting heads.

During the quarrying shaped pavement slabs with a pair shaped symmetrical contours (Fig. 1 d, e) the body of the head is carried out separately for every head and running screw is compound with the opposite direction of a coil for each pair of heads. The reversal engine of cross unit receives impulses from the angular sensor and guarantying during movement of machine at length **L** of slab one double movement the pair UHPWJ cutting heads with amplitude **A** to opposite direction as shown in Fig. 2 b.

The analysis of productivity of the new machine is carried out on the base of early investigation according to the determination of optimal UHPWJ cutting condition of facing slabs [1, 3]. The UHPWJ cutting slabs of size **BxHxL** = 70x60x200 mm (Fig. 1a) have been examined at piecemeal and pair quarrying by pair diamond saws with diameter of 630 mm and thickness 4.5 mm. Accordingly, for depth UHPWJ cutting 64.5 mm and 129 mm the optimum cutting speed is 1,500 mm/min and 400 mm/min at quarrying facing slabs from natural tuff. In this case the productivity of piecemeal quarrying is approximately 1.5 times more than of pair quarrying.

4. CONCLUSION

1. A technology for quarrying shaped pavement slabs from rock massive by UHPWJ has been developed.
2. A machine for quarrying shaped pavement slabs from rock massive differentiating with kinematical interconnecting movements in inter-perpendicular direction of UHPWJ cutting heads has been developed.
3. More productivity of piecemeal of quarrying shaped pavement slabs has been established.

4. REFERENCES

1. Asatryan J., (2007), "The Technology and the Machine for Cutting Wall Stone of the Correct Form by UHPWJ", Proceedings of the 2007 Waterjet Conference, WJTA, Houston, August, Paper 4 E.
2. Asatryan J., Suvaryan Kh. "The machine for quarrying slabs".-Patent of Republic of Armenia of useful model.- # 163 U.- 2009.
3. Asatryan J., Suvaryan Kh., (2009), "The Accuracy of the Kerf Width Profiles of Facing Slabs and Modernization of Edging Machines for AWJ Cutting", Proceedings of the 2009 Waterjet Conference, WJTA, Houston, August, Paper 4 A.

5. GRAPHICS

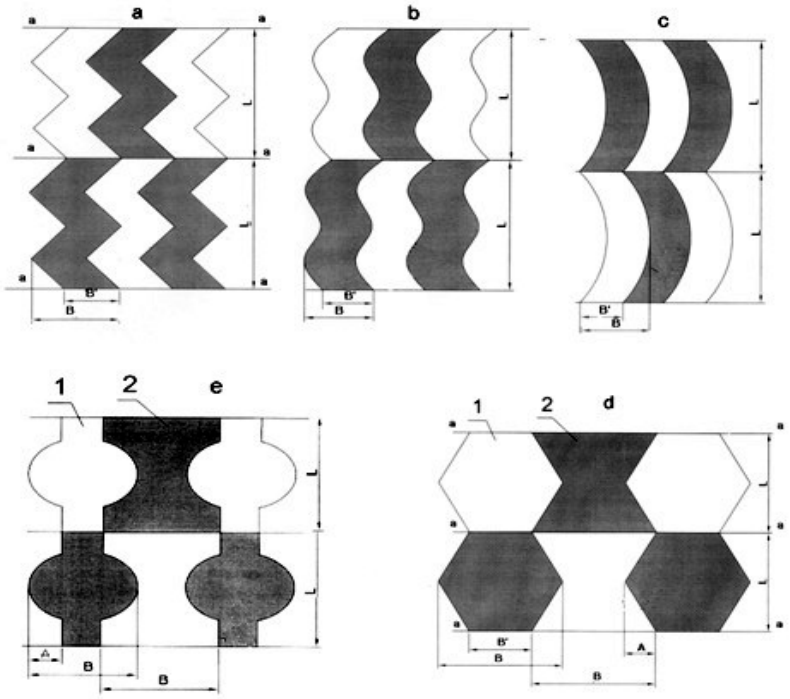

Figure 1. Profile of the docking surfaces of the facing slab and sidewalks parts

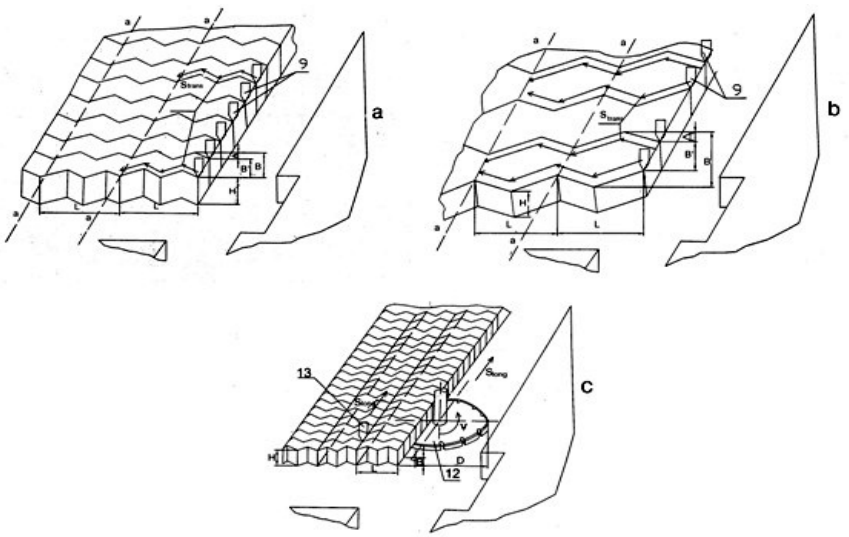

Figure 2. The transversal (a,b) and longitudinal (c) projection of a horizontal and back technological cutting operations.

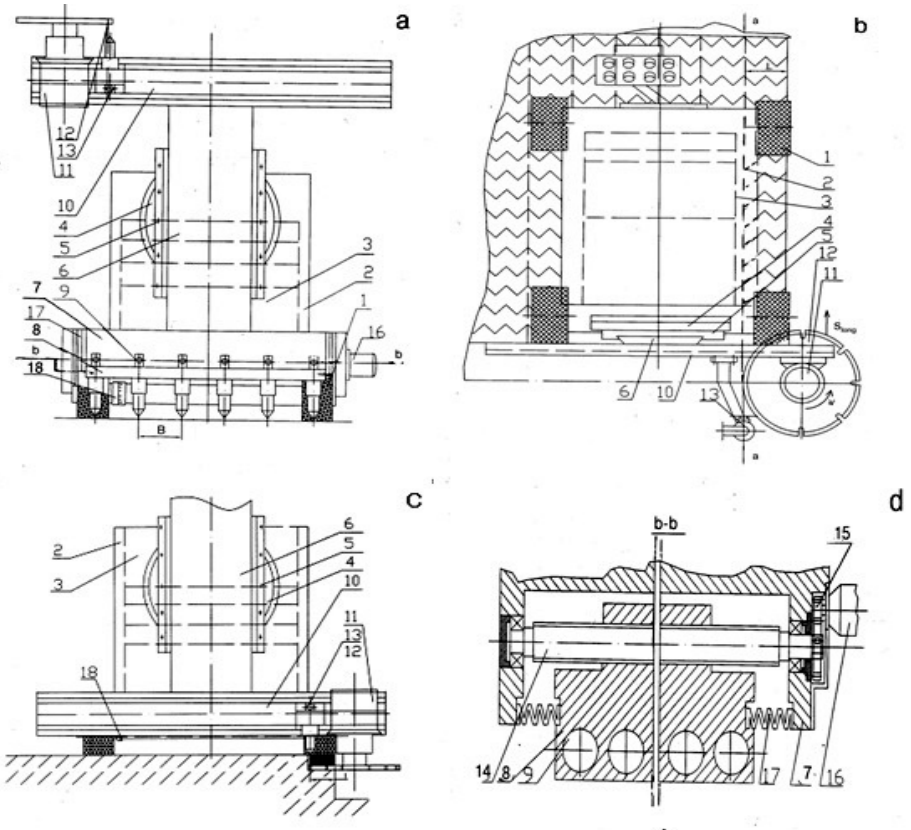

Figure 3. The front views of the machine for quarrying fashioned sidewalk parts from rock massive by UHPWJ: during transversal (a) and longitudinal (b,c) cutting and view of the section b-b (d).