Studying the technological process formation of mole drainage from a mole ripper

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Abstract. In this article, a layered perforator is a pit softener construction depending on the density, hardness and moisture of the soil during the operation of the working columns normal and trial stresses and in the hole opener working unit of all working columns of the device it was found that these calculated formulas are relevant for all hole openers, taking into account that the normal and test stresses are equally affected. The spacing of the hanging holes can be changed from b1=b2=50 cm to 1.5 m, taking into account the mechanical composition of the soil and the level of salinity. It is suggested that the working bodies are layered, i.e., the 1st processing depth is from 40 to 45 cm, and the 2nd processing depth is from 80 to 90 cm.

1 Introduction

Currently, in many countries of the world, including Iran - 35-40%, Turkey - 50%, India, Syria, the Arab Republic of Egypt - 20-30% of land is saline. In Russia - 12 mln. ha, in Pakistan - 6 mln. ha, in China - 6 million ha, in Uzbekistan - 2.0 million ha. ha land is made up of saline areas.

In this regard, in the construction of the collector system and improvement of land reclamation, great positive results are being achieved in the countries of the CIS, the USA, Australia, Egypt, India, China, the countries of Central Asia, as well as in Uzbekistan.

It is known that in the current era of worsening land reclamation and water shortage in agriculture, it is necessary to use special techniques and technologies in saline and gypsum soils, as well as to carry out high-quality autumn salt washing, to remove harmful salts from the soil and improve its productivity increase is one of the urgent problems.

It was concluded that open drains, which are currently used to improve land reclamation in agriculture, are not effective in draining water in the future, that is, from the analysis of the increasing salinity of the land year by year, additional agrotechnical measures are required to be carried out in these areas.

Today, there are 4.2 million hectares of irrigated land in our Republic, of which 45% are areas with varying degrees of salinity. In our republic, salt washing is carried out on an area of more than 680,000 hectares every year:

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The irrigated areas of the Bukhara region are 275,200 hectares, of which 230,270 hectares are provided with collector-water systems; 238,000 hectares or 86.2 percent of the available irrigated land in the province consists of varying degrees of salinity. Of this, 66,932 hectares are medium and strong saline areas. Growing abundant, high-quality and guaranteed crops from agricultural crops in saline soil conditions depends to a large extent on regulating the salt-water regime in the soil; 2.0 million hectares or about 50% of the irrigated lands in our country are soils with varying degrees of salinity and salinity, due to the drying up of the Aral Sea, the irregular use of land and water resources, and in some places the presence of groundwater shrinking, global climate changes and other factors are having their effect [1].

2 Materials and methods

Therefore, in order to eliminate this problem, we have developed a new device that creates a water-efficient hole drainage equipped with sprayers that spray the biosolvent preparation used before autumn salt washing.

The technological process of the device is as follows: the device is aggregated to 3-4 class tractors and performs the technological process parallel to the central ditch and transverse to the temporary ditch during land cultivation before salt washing. During the movement of the device with the help of a tractor, the front working column cuts 40-45 cm and the rear working columns 80-90 cm of the driving layer, which is installed on doloto softens the driving layer. An auger attached to the back of the working columns by means of a steel rope, during movement through this softened layer, compacts the soil by moving it along its diameter, and a hole drainage with compacted sides is formed. In the process of salt washing, the water-soluble salts in the soil dissolve in water and are discharged into the trunk ditches.

3 Results and discussion

The device is designed simply, with a frame and three front and rear work posts installed on it, and cone-tipped cylinders are installed from its rear side through a steel rope. does.

The tensile strength of this device can be determined using the following formula [2,3].

\[
\sum F_{tc} = 3(R_{rez} + F_{sd} + F_{kts} + F_{pks} + F_{tro} + F_{ktsy} + F_{loy}) + 2(F_{opk} + F_{mar}) \quad (1)
\]

In this: \( \sum F_{tc} \) - total tensile strength of the device, kN;
\( R_{rez} \) - the resistance force of the pole-shaped work column in cutting the soil, kN;
\( F_{sd} \) - the resistance force of the wavy softening pad, kN;
\( F_{kts} \) - resistance force of cylinders with conical ends, kN;
\( F_{pks} \) - the resistance force of cone-shaped cylinders formed by the adhesion of the soil, kN;
\( F_{tro} \) - the resistance force of the chain connecting the working column and the working body, kN;
\( F_{ktsy} \) - the resistance force created by the adhesion of the soil to the working column, kN;
\( F_{loy} \) - resistance force of the working column, kN;
\( F_{opk} \) - resistance force of supporting wheels, kN;
\( F_{mar} \) - resistance force of the marker, kN.

In the process of operation, the device that creates the hole drainage is average in soils with an average mechanical composition of the soil \( \sum F_{tc} = 27 \div 33 \). The resistance force of kN was studied.
The power required during the operation of the device is determined using the following formula.

\[ N_{\text{kd}} = \frac{\Sigma F_{\text{te}} \cdot V_{\text{kd}}}{\eta_{\text{kd}}} \text{ kW; } N_{\text{kd}} = 52 \div 79\text{kVt} \] (2)

In this:
- \( N_{\text{kd}} \) - power required for the hole drainage device, kW;
- \( V_{\text{kd}} \) - working speed of the device, m/s;
- \( \eta_{\text{kd}} = 0.80-0.85 \) - useful work coefficient of the machine.

In order to organize the normal operation of the hole drainage device before the autumn salt washing, the physical and mechanical properties of the soil depend on its mechanical composition and salinity level, and the depth of processing depends on the salt washing method. It is necessary to determine the boundaries and study the dynamics of changes in the amount of harmful salts in the soil before and after salt washing.

4 Study of the stresses generated by the working device of the hole-opening gun

The holes serve to increase the porosity of the soil, to maintain the level of groundwater and to remove excess salts from the soil. Depending on the mechanical composition of the soil, the technology of processing holes can be used in the following cases.

The distance between the holes to be made can be changed from \( b_1=b_2=50 \text{ cm} \) to 1.5 m, taking into account the mechanical composition of the soil and the level of salinity. The working bodies are layered, i.e. the 1st processing depth is from 40 to 45 cm, the 2nd processing depth is from 80 to 90 cm. However, in the case of a-variant 2-hole drain, it is necessary to make its diameter larger, i.e. 100 cm, in order to save the falling water and discharge it to the collector drains. The reason is that the b-option creates a drainage hole with a diameter of 120 cm.

In the process of creating a hole drain, we find the surface of the cone part and the cylindrical part of the hole opener, and the sum of the two parts is calculated as the cone-cylinder hole opener working device.

Based on the above, the forces acting on the surface of the perforator during the formation of the perforated drainage are calculated (Figure 1).

\[ \sigma \] – Normal stress, kN/m²
\[ \tau \] - Test stress, kN/m²

![Fig. 1. Stresses generated in the tool of the hole opener.](image_url)
F_{ish}, F_{2ish} - frictional force acting on the hole opener, N
F - The pulling force of the technique, N
d - the height of the cylindrical part of the hole opener (diameter of the opened hole), m
r=0.5 m.

\[ S_k=\pi rl=A_1, \quad S_s=2\pi rh=A_2 \quad (3) \]
\[ \Delta l = r \quad r = l \sin \beta \quad \Delta l = l \sin \beta \quad (4) \]
The surface of the \( S_k \)-cone section, m²
The surface of the \( S_s \)-cylinder part, m²
A_1 - is the surface of the conical part of the hole opener, m²
A_2 - the surface of the cylindrical part of the hole opener, m²
Side length of \( l \)-cone section, m
These indicators can be used to determine numerical values in formulas.

\[ F_{ish}^1 = \mu P_1 \cos \beta \quad F_{ish}^2 = \mu P_2 \quad \beta = \frac{\alpha}{2} \quad (5) \]
P_1 is the weight of the cone part, N
P_2 is the weight of the cylindrical part, N
\( \rho \) - soil density, kg/m³
\( \mu \) - friction coefficient, %
\( \mu = 0.687-0.907 \%
\sin \beta = \sin 30^\circ = 0.5 \quad \cos \beta = \cos 30^\circ = 0.87
\]
\[ N_1 = P_1 = \rho V_1 g \sin \beta \quad N_2 = P_2 = mg \quad (6) \]
\[ V_1 = \frac{1}{3} \pi r^2 h = \frac{1}{3} \pi r^2 \cos \beta \quad V_2 = \pi r^2 h \]
N_1 is the normal force on the cone section, N
N_2 is the normal force on the cylinder part, N
V_1 - the volume of the cone section, m³ \( V_1=0.04 \) m³
V_2 - the volume of the cylindrical part, m³ \( V_2=1.96 \) m³
h - the length of the cylindrical part of the hole opener, m \( h=0.25 \) m

In this process, normal and tensile stresses occur under the influence of forces. The normal stress always occurs perpendicular to the surface and serves to compress the soil around 360° in the formation of hole drainage, and it has the following form \( \sigma, \tau \) [4,5].

According to Pascal's law, the pressure effect of external forces is transmitted equally in all directions, i.e., it spreads unchanged to every point under the influence of external forces. Based on this, the density of the hole created by the cone-cylinder-shaped working device is as follows.

\[ F = P S_{um} = \rho g h_{ch} S_{um} \quad S_{um}=A_1+A_2 \quad \rho = \frac{F}{g h_{ch} S_{um}} \quad (7) \]
F - traction force, kN
P is pressure, Pa
\( S_{um} \) is the total surface of the conical cylinder, m²
\( h_{ch} \) - processing depth of the working column, m

The normal and experimental stresses generated in the cone tip part of the working body will look like this,

\[ \sigma_1 = \frac{N_1}{A_1} = \frac{N_1}{\pi rl} \quad (8) \]
\[ \tau_1 = \frac{F_{ish}^1}{A_1} = \frac{\mu \rho V_1 g \cos \beta}{\pi rl} \quad (9) \]
The normal and experimental stresses generated in the cylindrical part of the working body will look like this
\[ \sigma_2 = \frac{N_2}{A_2} = \frac{N_2}{2 \pi r h} \]  

(10)

\[ \tau_2 = \frac{\rho V_2 g \cos \beta}{A_2} = \frac{\rho V_2 g \cos \beta}{2 \pi r h} \]  

(11)

The total normal and tensile stresses generated in the impact of the entire tapered cylinder working body will have the following form:

\[ \sigma_{um} = \sigma_1 + \sigma_2 = \frac{N_1}{\pi rl} + \frac{N_2}{2 \pi rh} = \frac{2N_1 h + N_2 l}{2 \pi rh} = \frac{\rho g (2hV_1 \sin \beta + V_2 l)}{2 \pi rh} \]  

\[ \sigma_{um} = K \left( \frac{l+2h}{V_1+V_2} \right) \left( \frac{(2hV_1 \sin \beta + V_2 l)}{2lh} \right) \]  

(12)

\[ \tau_{um} = \tau_1 + \tau_2 = \frac{\mu \rho V_1 g \cos \beta}{\pi rl} \left( \frac{2 \pi r h}{l} \right) = \frac{\mu \rho g (2hV_1 \cos \beta + V_2 l)}{2 \pi rh} \]  

\[ \tau_{um} = \frac{\pi r l}{\omega F} \left( \frac{2hl}{(V_1 + V_2)} \right) \]  

\[ K = \frac{\omega F}{A_1 + A_2} = \frac{\omega F}{\pi rl + 2 \pi rh} \]  

(13)

\[ \pi r = \frac{K \left( \frac{l+2h}{V_1+V_2} \right)}{\omega F} \]  

(14)

K-soil hardness, MPa

<table>
<thead>
<tr>
<th>Soil test results by depth (cm)</th>
<th>Place and time of experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>normal voltage, kN/m²</strong></td>
<td><strong>Test voltage, kN/m²</strong></td>
</tr>
<tr>
<td>0.756</td>
<td>0.862</td>
</tr>
<tr>
<td>0.62</td>
<td>0.671</td>
</tr>
<tr>
<td>0.497</td>
<td>0.718</td>
</tr>
</tbody>
</table>

Based on the parameters of the experimental field, the working columns were determined at the maximum depth of processing, and the normal and test stresses were determined using the formulas.

In this process, depending on the density, hardness and moisture of the soil normal and experimental stresses were studied. The hole opener of all working columns of the punching machine is in the working unit taking into account that the normal and test stresses are equally affected, these calculated formulas were considered to be relevant for all hole openers [6,7].

**5 Conclusion**

Today, one of the important factors that have a negative impact on agriculture and the environment in our country, as well as the deterioration of land reclamation, the destruction of the soil structure, and the decrease in water reserves of our natural wealth, is the high level of salinity of the land. The solution to this problem is the mechanized method of using the above-mentioned preparations that easily wash away the salt.
Our device is layered, and the shape of the working columns is inclined, so that the hole can serve for a long time under the influence of water without being blown from the top.

References

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