railway transportation; safety; impregnation; humidity;
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EXPANSION OF A SCOPE OF METHODS PROTECTION THE RAILWAYS FROM ENTERING BY SAND

Summary. Article is devoted to expansion of a scope combined (physical and chemical) a method of fastening of sand and protection of railways in sandy deserts from a covering by sand on an example of use of connection of cotton pitch with water.

РАСШИРЕНИЕ ОБЛАСТИ ПРИМЕНЕНИЯ МЕТОДОВ ЗАЩИТЫ ЖЕЛЕЗНЫХ ДОРОГ ОТ ПЕСКОЗАНОСОВ

Аннотация. Статья посвящена расширению области применения комбинированного (физического и химического) метода закрепления песков и защите железных дорог в песчаных пустынях от покрытия песком на примере использования соединения хлопковой смолы с водой.

Working out of security measures of operation of the railways at their designing in the conditions of distribution of mobile sand includes measures on fastening of sand, as the integral element of protection of the way, having for an object safety of movement of trains.

Protection of technological systems against covering by sand in conditions (conditions) of sandy deserts is carried out by fastening and (or) a delay of the sand accordingly moved by wind on objects. These measures are known as work on fastening of sand (WFS). WFS in a broad sense means land improvement of mobile sand (LIMS) and has bank of technological decisions – the ways grouped in three groups of kinds of technologies: the biological; engineering [1,2] and combined [2,3]. Engineering methods consist of set of the ways named technical land improvement (TLIMS). TLIMS consists of mechanical and physical and chemical land improvements [1] which in the pure state are seldom materialised. They are applied to increase of productivity of the basic the most durable and biologically safe – a biological way.

The further replenishment of bank of technological decisions (ways) WFS is based on the system approach constructed on principles: ecological safety; technical possibility; savings of resources; profitability; possibilities of reception of product WFS with the set properties in a complex-mechanized way; identifiabilities building-technical characteristics a way and conditions WFS; the complex account of the factors defining reliability of protection. Realization of the named principles within the limits of a new way is complex research of the new technological decision including studying of operational stability of a protective crust to influence stream of wind with sand of natural - climatic factors (solar radiation, water, etc.) that demands time and resources.

Starting complex researches of a new way at the first stage, on purpose savings of resources, study ecological safety, then, technical possibility of reception of production.

Studying of technical possibility assumes definition of some parametres of production of the new way, allowing to judge a technological realizability and operational sufficiency of quality of production PZR, for example, for a physical and chemical method - impregnability of sand and formation protective crusts from sand and knitting substance.

Search of new variants of technologies is directed on enrichment of standard base WFS, in particular, its bank of technological decisions WFS [2].

The investigated and recommended ways make bank of technological decisions LIMS. In bank of technologies ways are represented by set of the characteristics $\{x_{jk} \subset X_{jk}\}$.

Set of special technological decisions at their grouping to signs of directions of use of materials (having watered knitting substance on a surface; forcing in sand pressure; cutting of ditches; installation of plates and etc.) forms bank of types of technologies $\{x_{j1} \subset X_{j1}\}$, and generalisation on the basis of used materials – bank of kinds of technologies $\{x_{j2} \subset X_{j2}\}$. Their crossing forms bank of the mixed combined technologies $\{x_{j1}\} \cap \{x_{j2}\} = x_{j3}$, and all set of various banks forms the set named field of technologies [2].

In available bank of technological decisions (ways) a special place ways of technical (engineering) land improvement of the sand, based on blocking of a source of a deflation by chemical substances (natural, oil and water mixes occupy, solutions). By present time of a way, having the identical purpose, possess one general sign of conditions of their realisation - are executed WFS on dry sand (humidity of 3-5%) which limits their application in a stream of an annual order of works with following from this limited use of resources - the mobile technics and people. Therefore, expansion of area of use of the developed ways, with the proved possibility of their application, will allow to add, in our opinion, methodology of working out of the new technological decisions focused on increase of efficiency of use of industrial resources (technical and human, first of all), the new factor – time factor at invariable maintenance of elastic-is viscous-plastic properties of the fixed layer (crust) [3-8] during the rainy period of year on damp sand.

Generalisation of experience of numerous researches and conditions of "work" of a layer of the sand fixed chemical knitting substance and steady against influence wind and sand stream of a stream during one vegetative term of development of plants, reveals the aggregated criteria of stability of production WFS: depth of impregnation (h_k) and plastic durability (P_m), their limiting values [7] are established. Plastic durability of optimum structure of the protective crust received from knitting, should satisfy to condition $P_m \geq (2,5 – 2,7) \times 10^3$ Pa, depth of impregnation - $h \geq 5$ mm. With increase in a steepness of a slope and reception of a continuous layer the least value of plastic durability - 5×10^3 Pa (Fig. 1).

It is proved that the technique of research of possibility of application of new technology on conformity of production WFS in in advance set parametres allows to avoid expensive researches in a wind tunnel. Application of planning of the experiment, accompanied by elimination of insignificant factors by correlation - regression methods, will allow to receive laconic dependence of operational parameters on adjustable technology factors (the expense of knitting substance, its concentration or viscosity, temperature and etc.).

In work [8] are investigated dependence of change of size of plastic durability on the expense oil and water mixes with cotton tar, concentration and differences various dimension of grains of sand. It is noticed that the maximum plastic durability P_m max is reached at the expense knitting 3,5 - 5,3 l/m^2 and concentration oil and water mixes from cotton tar of 25% (Fig. 1). However, the minimum values of indicators of criterion of stability are reached at smaller concentration and the expense oil and water mixes Under the schedule of optimum plastic durability $P_m = 2,5 \times 10^3$ Pa correspond expense oil and water mixes from cotton tar q = 1,0 - 1,6 l/m^2 that in 3-3,5 times there is less than expense oil and water mixes from cotton tar at maximum P_m.

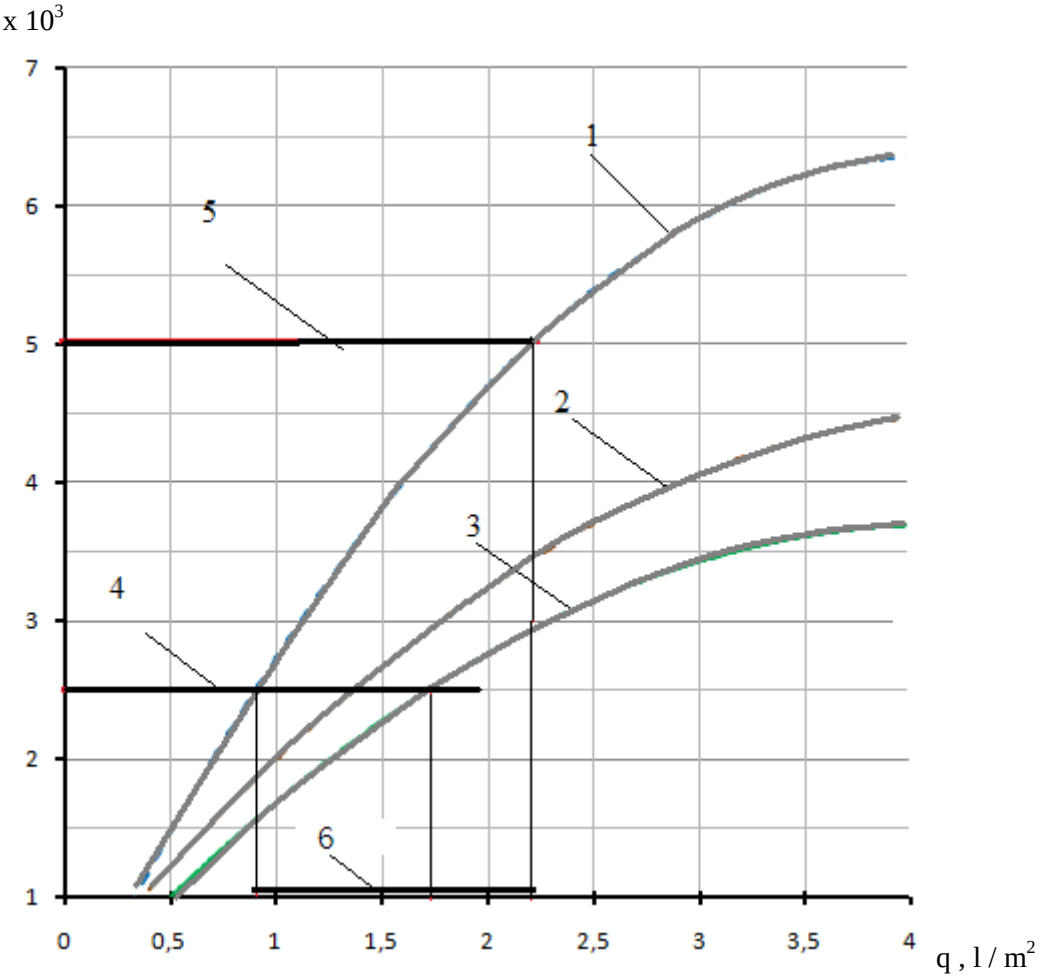

Fig. 1. Dependence P_m from q for oil and water mixes from cotton tar (according to Adylhodjaev A.I. [7]): 1, 2, 3 – schedules of dependence P_m from q, accordingly, 25, 15, 10% of concentration oil and water mixes from cotton tar; 4, 5 – limiting values P_m of a condition stability under the influence of a wind a protective crust, accordingly, for a horizontal surface and a surface with increase in a steepness of a slope; 6 - Limits of a variation of the expense q at steady to wind influence P_m

Рис. 1. Зависимость P_m от q для госсиполовой эмульсии (ГЭ) (по данным Адылходжаева А.И. [7]): 1, 2, 3 – графики зависимости P_m от q, соответственно, 25, 15, 10% концентрации ГЭ; 4, 5 – предельные значения P_m условия ветроустойчивости защитной корки, соответственно, для оризонтальной поверхности и поверхности с увеличением крутизны откоса; 6 - пределы варьирования расхода q при ветроустойчивом P_m

The author [3], having investigated a protective crust on the basis of several knitting (oil, bitumen and water mix (BWM), oil and water mixes from cotton tar, sulfur compound (SDB) and etc.)), has concluded: for maintenance of stability of a protective crust the size of plastic durability should satisfy to condition $P_m \geq 3 \times 10^3$ Pa. The critical dose cotton tar [3] for water solutions knitting corresponds 10 – 12% of concentration with the expense 1,0 – 2,5 l/m^2. However, to optimum plastic durability on schedules there corresponds the expense in 1,5 - 2 times less (q = 0,5 - 1,5 l/m^2).

The technological realizability of a way is proved in some stages by the decision of the following problem:

Studying of change of humidity of sand in the period after rain for revealing of limiting humidity of the sand, allowing to carry out impregnation by its knitting substance and receptions of the crust steady against influence of specific loading (stream of a wind with sand a).

By results of researches of dynamics of humidity of sand schedules of change of humidity of sand depending on time on depth from a day surface (Fig. 2) are constructed.

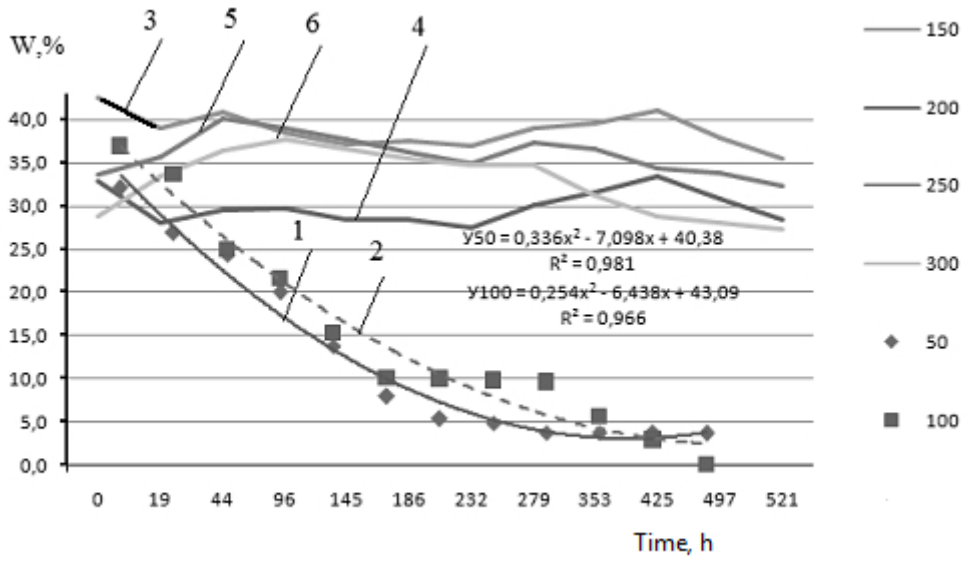

Fig. 2. Changes of humidity of sand depending on T and h: 1, 2 – a line of dependence W from T at h, accordingly, to 50 mm, to 100 mm; 3, 4, 5, 6 – schedules of dependence W from T and h, accordingly, on depths not above 150, 200, 250, 300 mm.

Рис. 2. Изменения влажности песка в зависимости от T и h: 1, 2 – линия зависимости W от T при h, соответственно, до 50 мм, до 100 мм; 3, 4, 5, 6 – графики зависимости W от T и h, соответственно, на глубинах до 150, 200, 250, 300 мм;

By researches it is revealed that in the top layers (h = 0–50 mm and 50-100 mm) law of change of humidity submits to dependences (1, 2) at approximation: $R^2 = 0{,}981$ and 0,996 accordingly.

$$Y_{50} = 40{,}38 - 7{,}098x + 0{,}336x^2, \quad (1)$$

$$Y_{100} = 43{,}09 - 6{,}438x + 0{,}254x^2 \quad (2)$$

At known limiting value of humidity at which has probably begun fastenings of sand to the data knitting and reception of a protective crust with demanded properties is defined term of the beginning of fastening of sand during the period after rain.

Other picture is observed in layers below 100 mm. However, a in type of the layer optimum for vegetation is located on depth 50 – 100 m [8], layers below 100 mm were not considered.

The maximum humidity of sand to depth of 100 mm does not exceed 35%. In first ten days humidity decrease in these layers is observed to limits in 5-10%. Further at achievement of a condition of the least moisture capacity of sand moisture reduction hardly considerable. The further movement and moisture evaporation under natural conditions is impossible. Water remains in the form of the separated congestions in places of a joint of particles of sand [8].

One of requirements of a realizability of a way is possibility of use of building knitting in existing conditions. In this case the substantiation of possibility of impregnation knitting in damp sand is necessary.

At achievement of limiting water saturation (32-35%) over sand there is a layer of water and impregnation in these conditions (Tab. 1) is impossible. For this reason impregnation was studied in the conditions of humidity below a water saturation limit.

Table 1

Definition of the beginning of impregnation of damp sand
by a mix from cotton tar in water

W,%	Possibility of impregnation of a mix of water and cotton tar, concentration in%						
	5	10	15	20	22	25	30
24,0	+	+	+	+	+	+	_
25,0	+	+	+	-	-	-	-
26,0	+	+	+	-	-	-	-
27,0	+	+	+	-	-	-	-
30,0	+	+	+				
31,0	+	+	+				
32,0	+	+	-				
33,0	-	-	-				

The following factor of possibility of impregnation of sand knitting is concentration knitting. At humidity of sand of 24% and less becomes impregnated oil and water mix to 25% of concentration. At a following stage of researches the limit of humidity of sand at which requirements of stability of a protective crust are fulfilled is established.

It was above specified that the basic properties of stability of a protective crust are elastic-is viscous-plastic properties [5, 7, 8]; a sufficient and necessary condition of stability crusts from sand and knitting substance are two characteristics: plastic durability P_m and a thickness of a crust h_k; to optimum structurization there correspond values $P_m = (2,5 – 2,7) \times 10^3$ Pa, $h_k = 5$ mm. With increase in a steepness of a slope and reception of a continuous layer the least value of plastic durability $P_m = 5 \times 10^3$ Pa.

Expansion of a scope of known methods is resulted on an example of a way of usage oil and water mixes from cotton tar, received on the basis of local raw materials - a withdrawal of production from cotton oil (pitch from cotton tar).

By results of researches of plastic durability of the crust received by covering oil and water mixes from cotton tar of sand of 11% of humidity schedules of dependence of plastic durability of a crust from concentration oil and water mixes from cotton tar and the expense oil and water mixes (Fig. 3) are constructed.

CONCLUSIONS

1. The scope of the approved way of reception of a protective crust from the sand impregnated oil and water mix from local raw materials – a withdrawal of manufacture of cotton oil (pitch from cotton tar) at the expense of its application during the damp period of the year, allowing rational use material and manpower resources within a year is expanded.
2. Possibility of maintenance of stability of a protective crust is proved a stream of a wind with sand decreases in a dose of knitting substance to 10 – 12% of concentration with the expense oil and water mixes 1,0 – 1,5 liter per square meter (l / m^2) that is much less before well-founded values on dry sand.

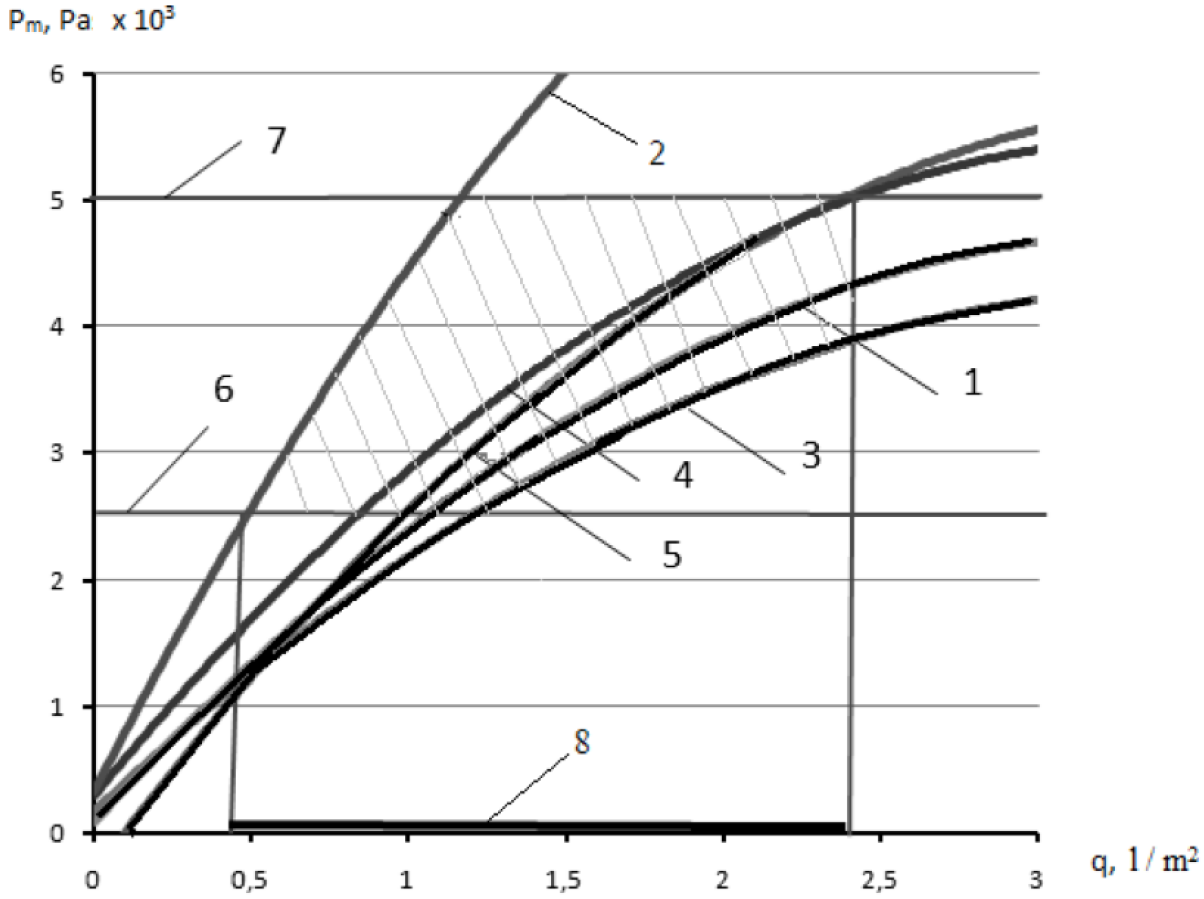

Fig. 3. Dependence P_m from q at W = 11%: 1, 2, 3, 4, 5 – schedules of dependence P_m from q at W = 11%, accordingly, for concentration oil and water mixes from cotton tar 5, 10, 15, 25, 30%; 6, 7 – limits of values P_m of a condition stability to wind influence a protective crust; 8 - Limits of a variation of the expense q at steady to wind influence Pm;

 - area steady to wind influence values.

Рис. 3. Зависимость P от q при W = 11%: 1, 2, 3, 4, 5 – графики зависимости P от q при W = 11%, соответственно, для концентрации ГЭ 5, 10, 15, 25, 30%; 6, 7 – пределы значений P_m условия ветроустойчивости защитной корки; 8 - пределы варьирования расхода q при ветроустойчивом P_m;

 - область ветроустойчивых значений.

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