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TERMS AND EFFICIENCY OF PREFABRICATED COVERINGS USED AT TEMPORARY FOREST ROADS

The article describes the conditions and the effectiveness of application of prefabricated coverings at forest roads, such as concrete slabs, wooden shields, band coverings and others. Their advantages and disadvantages have been considered. Prefabricated coverings have found a wide application in the transport development of forests located on the water-logged lands. They have high technical-economic indicators. The specific resistance of the vehicle movement is 2–3 times lower than at soil roads. They also reduce the consumption of fuel and lubricating materials. They reduce financial expenses for road maintenance.

Introduction. Forest roads have several specific features in comparison with a public road. One of the main features is a finite exploitation term, specified by a liquid stock of wood in forest, one-way traffic of goods, and a variety of soils with low-bearing capacity. Regarding these reasons, different types of road beds, coverings are used in construction of forest roads. Practice shows that one of the most economical coverings is prefabricated covering [1].

The main part. For the construction of forest roads various types of coverings are used: gravel, soils stabilized by skeletal additives; soils stabilized by organic and mineral binders, optimal soil and gravel mixtures. [1] However, one of the most economical is prefabricated covering (reinforced concrete slabs, wooden shields, etc.) [2].

Widespread use of prefabricated coverings can be attributed to the high technical, economical and operational factors. Thus, the specific resistance movement is 2–3 times lower than on soil roads, resulting in increased speed of the motor transport and reducing the costs materials, reducing the cost of fuel and lubricating maintenance of the vehicle fleet. The advantages of prefabricated coverings should be attributed to the high performance and durability, the ability to make maximum use of the specified coverage of local building materials, ensuring the accelerated time of construction all-year-round.

The advantage of prefabricated coverings is also the possibility of immediate traffic movement and simplification of the process of construction, the construction work is mostly limited to installation.

Of all the prefabricated coverings, reinforced concrete slabs have the best exploitation characteristics. They may have a 3 – or 6-meter length and 1-m width. They are compact, celled, and grid. Experience shows that the best exploitation characteristics have six-meter slab with a pre-stressed technology. However, its production is limited by a weak industrial base, the shortage of cement, metal, gravel. Therefore the use of such shields in the construction of forest roads is recommended in areas which lack local road construction materials (sand, gravel and other materials). Such coverings, despite relatively high initial investments, are highly profitable, they reduce the time of road con-

struction, greatly increase reliability, improve the operational exploitation characteristics of vehicles. Concrete slabs are shifted 8–10 times, so their initial cost is reduced by 8–10 times. Therefore, it reduces the cost of construction of other forest roads. One of the problems is to decrease weight of prefabricated constructions, and to make road slabs without gravel. Its solution can be achieved if we use artificial filler agglomerite, which is produced by firing clay or loam, instead of crushed stone in their fabrication. Application of agglomerite as a filler reduces the weight of concrete slab by 20–25%. Production tests showed good exploitation characteristics of such slabs in road constructions under action of a moving load.

In the forestry sector the proportion of the construction of temporary roads with a lifetime of 1 month to 5 years is 80%. Experience of logging and forestry enterprises shows that soil temporary roads do not guarantee effective vehicles work.

Regarding this, there is a need for such structures, which would require minimal cost to build and maintain temporary roads and ensure the movement of modern heavy-duty trucks with a calculated speed. Given the above mentioned, the Department of Forestry Transport of BSTU has developed a number of prefabricated coverings: band covering of BSTU, compact rolled covering; combined covering; shield prefabricated covering; track shield prefabricated covering. Wide distribution in the forest industry has been found by such coverage as the LP-11, nail-connected shields, band coverage LD-5, wooden soil track coverage. Their technical characteristics are shown in Table 1.

The choice of construction of temporary forest roads can be made depending on the type of train and the degree of terrain moisture (Table 2), and on the basis of technical and economic calculations.

The economic efficiency of forest roads construction should be defined by discounting (reduction to the initial moment) or kompondiring (bringing to the end point).

Ratio of costs and benefits at the basic time point is done by multiplying them by a discount factor α_t , defined for a constant discount rate by the formula E (1), where t is the ordinal number of temporary periods of income, E is a constant discount rate (discount rate).

Table 1

Technical characteristics of wooden coverings for construction of temporary forest roads

Indices	Type of coverage					
	combined	rolled	Shields LP-11	Nail-connected shields	Elastic band	BSTU band
1. Shield parameters:						
length	6.0	10.0	6.1	6.0	0.7	11.0
width	1.0	3.5	1.1	1.0	1.1	0.98
thickness	0.18	0.16–0.18	0.18	0.20	0.12	0.14
2. Timber expenditure per 1 km of road, m ³	350	550	345	371	248	280
3. Metal expenditure per 1km of road, t	6.0	8.0	13.0	4.4	27.5	6.0
4. Weight per 1 shield, kg	750	4,000	750–800	750–800	60	100–120
5. Number of re-layings	up to 6	up to 6	over 10	8	10	6
6. Number of shields per 1 km of road, units: basic connecting	334	100	328	334	2,666	200
	–	–	–	–	–	–

Table 2

The choice of forest roads construction

Type of coverage	Type of base depending on type of location			Road train based on automobile
	I	II	III	
Reinforced slabs	Planned soil	Earthwork	Brushwood bed or complete bed soil filled	ZIL, MAZ, KrAZ
Wooden shields	–	Sleepers	Longitudinal logs and sleepers	–
Wooden bands WB-5, etc	–	Brushwood bed	Brushwood bed upon complete floor made of small diameter timber	ZIL, MAZ
Soil	–	Soil upon brushwood bed	Complete soil filled bed with or without brushwood bed	ZIL, MAZ
Gravel or improved	–	Brushwood bed	Brushwood bed	ZIL, MAZ, KrAZ

To compare investment options and select the best of them, the following indicators are used:

- net discount income (NDI) or NVP (net present value);
- Internal Income Rate (IIR) – discount rate;
- profitability index (PI);
- investment payback period (current).

The construction of forest roads requires “long-time costs – long-time road” principle, i.e. investment is not the same all the time, but in parts during several time periods (months, quarters, years) and the net discount income is calculated by formulas:

$$NPV = \sum_{t=0}^T \frac{R_t - C_t}{(1+E)^t} - \sum_{t=0}^T \frac{k_t}{(1+E)^t}, \quad (2)$$

or

$$NPV = \sum_{t=0}^{T_0} \frac{P_t}{(1+E)^t} - \sum_{t=0}^{T_c} \frac{k_t}{(1+E)^t}, \quad (3)$$

where t is the period of the investment project ($t = 0, 1, 2, \dots, T$); R_t – results achieved at the t -step of the calculation; C_t – costs exercised at the same step; P_t – annual net sum of money in the t -th year, T_c – the year of completion.

Thus, if we compare two projects, more effective (beneficial) one is the project, which has a greater net present income, calculated according to the formulas (2) and (3).

The payback period is obtained by the formula

$$T_{pb} = \frac{K}{D - Z + A} = \frac{K}{P + A},$$

where K – initial investment, D – annual income, Z – annual costs, and A is sum of amortizing allocations for a full recovery, P – expected net profit.

Conclusions. 1. The use of prefabricated coverings in the construction of temporary forest roads provides accelerated rates of construction of forest transportation network.

2. Reinforced slabs have the best exploitation characteristics of all the prefabricated coverings.

3. Concrete slabs coverings are recommended for the construction of forest roads in the areas where there are no local construction road materials.

4. The economic efficiency of application of prefabricated forest road coverings is determined by number of re-layings of the coverings (shields, bands, etc.) from one construction site to another, which reduces construction costs by 30–40%.

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