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ПЛАНУВАННЯ ЕФЕКТИВНИХ СХЕМ ДОСТАВКИ МЕТАЛОКОНСТРУКЦІЙ БАШТОВИХ ГРАТЧАСТИХ ОПОР ЛЕП АВТОТРАНСПОРТОМ У СКЛАДІ ППР

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Анотація. У статті визначено вимоги щодо розробки Проекту Транспортної Схеми Доставки Металевих Конструкцій (ПТСДМ), обґрунтовано необхідність розробки ПТСДМ у складі ППР на монтаж металевих ґратчастих баштових опор ЛЕП як способу мінімізації загальних витрат на будівельно-монтажні роботи. Проаналізовано вітчизняний та зарубіжний досвід реалізації перевезень металоконструкцій, структура транспортного процесу, розглянуті схеми і способи доставки металоконструкцій опор ЛЕП автотранспортом. Визначено та розглянуто основні фактори, що впливають на тривалість і вартість перевезення МК.

Ключові слова: ефективні схеми доставки металоконструкцій баштових ґратчастих опор ЛЕП, автотранспорт, будівельно-монтажні роботи, промислові методи будівництва, Проект Транспортної Схеми Доставки Металевих Конструкцій.

ПЛАНИРОВАНИЕ ЭФФЕКТИВНЫХ СХЕМ ДОСТАВКИ МЕТАЛЛОКОНСТРУКЦИЙ БАШЕННЫХ РЕШЕТЧАТЫХ ОПОР ЛЭП АВТОТРАНСПОРТОМ В СОСТАВЕ ППР

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Аннотация. В статье определены требования для разработки Проекта Транспортной Схеми Доставки Металлических Конструкций (ПТСДМ), обоснована необходимость разработки ПТСДМ в составе ППР на монтаж металлических решетчатых башенных опор ЛЭП как способа минимизации общих затрат на строительные-монтажные работы. Проанализирован отечественный и зарубежный опыт реализации перевозок металлоконструкций, структура транспортного процесса, рассмотрены схемы и способы доставки металлоконструкций опор ЛЭП автотранспортом. Определены и рассмотрены основные факторы, влияющие на продолжительность и стоимость перевозки МК.

Ключевые слова: эффективные схемы доставки металлоконструкций башенных решетчатых опор ЛЭП, автотранспорт, строительные-монтажные работы, промышленные методы строительства, Проект Транспортной Схеми Доставки Металлических Конструкций.

THE PLANNING OF EFFECTIVE DELIVERY SCHEMES OF METAL FRAME TOWER LATTICE SUPPORTS WITH THE HELP OF MOTOR TRANSPORT AS A PART OF PRODUCTION PROJECT WORKS

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Abstract. In the paper the requirements for the development of projects of transport schemes delivery of metal constructions, the necessity of development as part of production project works PTSDMC in installation of metal lattice tower transmission towers as a way to minimize the total cost of construction and installation work, have been determined. The native and foreign experience in transportation of metal structures, the structure of the transport process has been analyzed, and examined schemes and methods of delivery of metal transmission towers road have been considered. The main factors, affecting the duration and the costs of MC transportation have been determined and considered. Factors and the choice of technology, the size and weight of units shipped metalwork, form a unit load, the degree of utilization of transport units, as well as the selection of traffic schemes have been also determined.

Keywords: effective delivery schemes, metal frame tower lattice supports, motor transport, production project works, industrial methods of construction, Scheme of Transport Project Delivery Metal Construction.

The formulation of the problem

With the increasing of metal constructions' volume, in particular, the supports of TPL, and the development of industrial methods of construction increases the value logistics component of the general construction process. Construction linearly extended objects is compared with construction of other industrial facilities are some significant differences.

Construct transmission lines have a greater length, separated from each other, production bases for construction of roads and communications. With a large volume works across the picket line at each time is comparatively small amount work accordingly to each delivery point is relatively small batches.

In the process of delivering CPD schedule reflected on the receipt to constructions, products and materials; schedule needs major construction machinery [1,4]. Question of choice of transport technology, the definition rational route, way of loading and unloading, and storage of elements of metal is not considered. These features make it necessary to solve many problems, in particular inclusion in the PPR **Project Transport Schemes Shipping Metal**

Structures (PTSDM), optimize the delivery process of structural elements on picket minimizing costs, development and planning of effective delivery schemes.

Analysis of studies and publications

Logistics presented a wide range of methods developed under different disciplines belonging to its scientific basis. Mathematics: Theory probabilities, mathematical statistics, theory of random processes; theory fuzzy sets and other operations research: linear, nonlinear and dynamic programming, game theory, statistical decision theory, theory queuing, inventory management theory, method of network planning and management, theory of efficiency and other economic cybernetics theory optimal planning, theory of effectiveness, functional and cost analysis, methods of marketing research, management, decision theory, production management, strategic and operational planning, pricing, quality management, personnel management, project management, investment management, social psychology, Economics and organization of transport, warehousing, trade, etc [7, 8, 11, 12].

As the delivery of metal pickets on linearly extended objects is not a trivial task, often general recommendations are little applicable. It can be concluded that, except for the normative literature, question are not considered systemically.

The purpose of the study

This article discusses the rationale for the development of the Project Transport Schemes Shipping Metal Construction comprising production design works and the study of transport and technological schemes Delivery of steel transmission line vehicles. Also identified factors and the choice of technology, the size and weight of units shipped metalwork, form a unit load, the degree of utilization of transport units, as well as the selection of traffic schemes.

Work tasks

The rationale inclusion of the Scheme of Transport Project Delivery Metal Construction in production of design works. Determination of the main factors influencing on the duration and cost of transportation MK transmission towers. Development of recommendations to optimize the delivery process of structural elements on the picket with the costs minimizing.

Design and delivery of metal transmission towers road Reliance power lines – is the spatial structure consisting of 300–600 elements of the angle profile (depending on the height and type of support) is usually bolted, riveted or welded. Transportation of transmission towers implemented standardized units prefabricated elements in assembly, mounting blocks or loose.

Type of freight (metalwork):

- packaged goods – consignment consisting of general cargo in containers or without the trim packages (film), pallets, block and sling packs;
- packaged and custom-made packing: one piece with a mass less than 500 kg, heavy with the weight of one place more than 500 kg, lengthy and cumbersome – the length of more than 3 m, width 2.6 m, height 2.1 m, oversized – height above 4 m, width 2.5 m and extending beyond the rear edge of the platform or aboard the SS more than 2 m.

Delivery of steel from the place of production to the place of installation is important stage in the process of construction is [6, 9].

Studies have shown that delivery has significant structural impact on the timing of installation facilities, labor and installation costs as a whole. Fuel delivery systems for installation of metal transmission towers in averaged more than 25 % of the total value of construction work, and labor costs – about 40 % of the total workload [2, 3].

From the list of existing methods of delivery of metal most preferred in the situation existing at the present time in Ukraine is vehicles, as having maximum mobility, large maneuver ability and the ability to carry freight at high speed the required distance without intermediate overloads (figures 1–3).

Transportation – departure stamps in bulk to increase downloads transport leads to higher installation and increase the period construction. This contradiction calls for critical analysis of existing methods of delivery of steel structures, and development appropriate technological solutions tailored to all aspects of the problem. Given the chosen method of installation for each specific support in production of design works encouraged the development of projects in transport delivery scheme of Metal Construction, which will reflect all aspects of metal delivery.

From the standpoint of workability in the mounting process it is generally advisable design to deliver maximum picket prefabrication, in prefabrication, or, at least, the large-format. But the process of transporting such goods entails several difficulties. Permit, the development route, due to incomplete appreciation of vehicle load. For example, the capacity utilization rate of railcars for transmission towers (ratio of submerged structures to the load capacity of the car) – 0.17. Matching route oversized and heavy cargo takes time; practice shows that up to 10 days, depending on the category of goods. Resolution is available for a surcharge, the amount of which depends on the size and complexity of shipping route. For oversized loads additional surcharges levied at the rate of 50 to 300 % of the basic fare.

Therefore, despite the rise in the cost of installation and increase the period of construction, we can recommend the use of the mode of transportation MC bulk.

For transportation of different types of metal, there are different kinds of transport. Heavy and

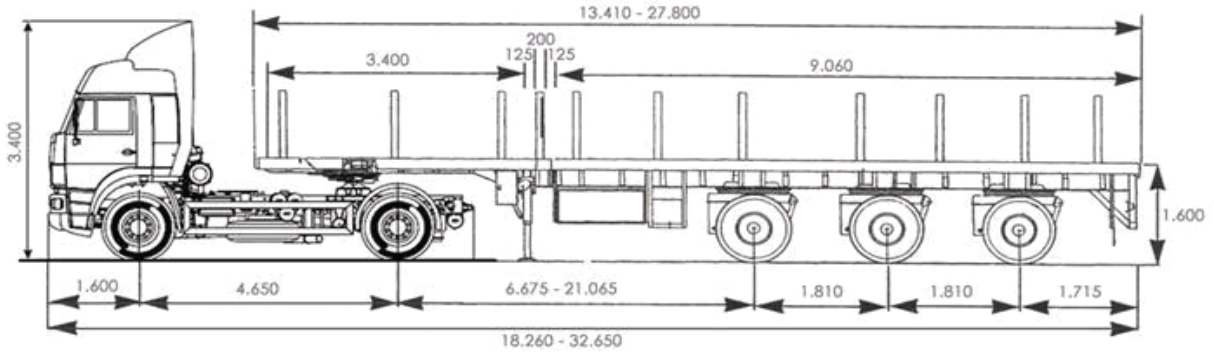


Figure 1. Tractor-trailer and truck-trailer load capacity 35 t:
 Platform length – 13.4–27.8 m;
 Platform width – 2.5 m;
 Loading platform height – 1.6.

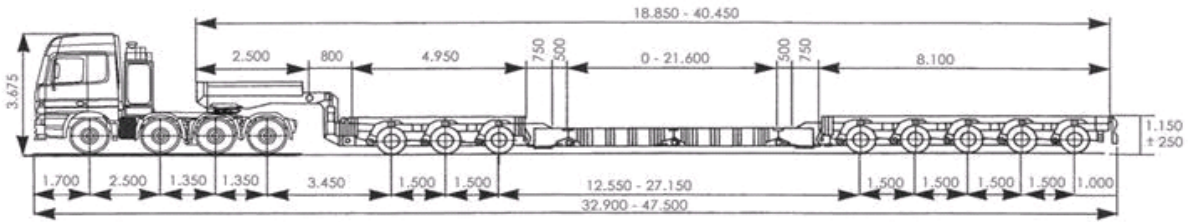


Figure 2. Tractor-trailer and truck-trailer load capacity 100 t:
 Platform length – 21.6 m;
 Platform width – 2.5 m;
 Loading platform height – 0.9 m.

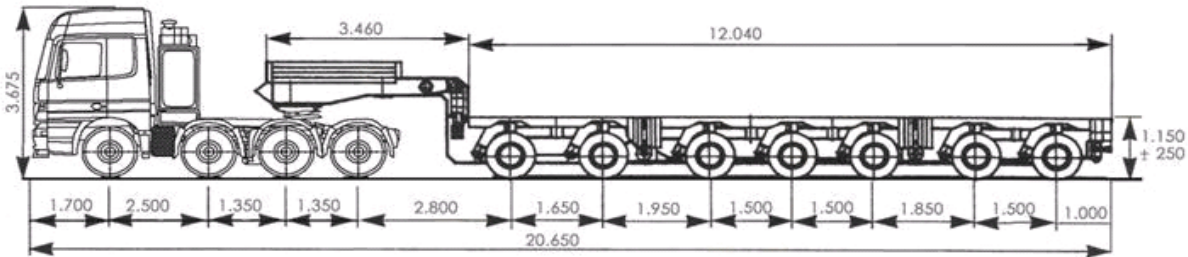


Figure 3. Tractor-trailer and truck-trailer load capacity 120 t:
 Platform length – 12 m;
 Platform width – 2.5 m;
 Loading platform height – 0.9 m.

long designs require special technology, which will be evenly distributed lateral axis and the load on the suspension, and the weight of metal will be no more limits. Transport of metal that have great weight and length, produced using low loader flat-bed semi.

All sections metal firmly laid and pull a soft wire, but then it all loaded into the car. Already in the

back of these packs fixed tensioners (special locks with straps). Latticed steel structures when loading on vehicles rely places nodes.

Constructions, which are not particularly great length and weight, are transported heavy trucks or universal mobile trailers. For the safe transport they should be installed on the vehicle professionally additional fixing equipment.

Transportation of metal great lengths organized through trawls low loaders with telescopic sliding platform. All elements of metal firmly fixed on the platform with special belts, chains and devices conics. Accelerating delivery structures for construction and installation site, use elements of a comprehensive mechanization of loading and unloading is also an important task of rationalizing the process of installation [13].

Some types of vehicles and their schematic representation of transportation of bulky cargoes.

Structure of transport – technological schemes of delivery of metal, in particular transmission towers, for construction and mounting pad may be classified by the following features:

1. The number of suppliers of metal.
2. Character delivery structures:
 - unloading on -site warehouse, followed by transport to installation;
 - delivery and unloading at the picket site pre-assembly, or accumulation with subsequent use;
 - submission of construction in the area of assembly and installation of the crane with wheels;
3. Traffic scheme:
 - circular traffic pattern;
 - pendulum movement scheme.
4. The type of traffic organization:
 - shuttle type of vehicular traffic;
 - poluchelnochny type of vehicular traffic;
 - pendulum type of vehicular traffic.

PTSDM also necessary to consider the following questions:

Definition of transportation and technological scheme (choosing the correct transport for a particular method of installation of power transmission poles) and a method of placement in handling post; the choice of means and methods of loading and handling; development schemes installation material handling mechanism and rolling stock on the loading and unloading station; schedule of working cycle load handling mechanism; determining the duration of down time rolling stock for loading and unloading operations, through put ability to post and item resource needs of mechanization; project development securing cargo to the vehicle; methods of preparing highway sand loading and unloading areas; the need for obtaining a permit and approvals of road services and the traffic police; development and study of the alleged route survey of road infrastructure, measuring work bridges, overpasses, road signs and other objects; assessment dimensions,

strength and capacity of engineering structures on a particular route [2, 3, 5].

Transportation project should be coordinated with the operation of services contact – cable networks owned road infrastructure, traffic police. Parameters affecting the route selection:

1. Class road.
2. Geometric parameters of the road.
3. Tolerance control vehicles to operate.
4. Road conditions coating.
5. Single level crossing with w/d ways.
6. Traffic intensity transport.
7. Speed mode.
8. Ratio of cars and truck son the route.

Basic criteria methodology for determining the travel route is:

1. Consideration of the existing scheme of movement of goods from the «source» to the items final disposition.
2. Possibility of partial using of public roads for transporting MC.
3. Possibility of movement of heavy and large vehicles.
4. Minimizing possible distance of transportation from the place of shipment to the final destination.

The basis of the project is to determine the transportation needs vehicles. Upon delivery of the MC transmission towers warehouse number of vehicles N_{tr} defined by the formula

$$N_{tr} = \frac{V}{T_i \cdot P_{tr}}, \text{ pcs.} \quad (1)$$

where V – volume assembly work, t;

T_i – installation time in shifts.

P_{tr} – performance of the transport unit per shift, t/cm:

$$P_{tr} = \frac{Q_{tr} K_c t_{wt}^{tr} \cdot 60}{T_i^c}, \text{ t/cm,} \quad (2)$$

where Q_{tr} – load transport unit, t;

t_{wt}^{tr} – the duration of the work's time in day of the transport unit (7.7 h);

K_c – utilization of the transport unit carrying capacity, defined by the formula:

$$K_c = \frac{g_e \cdot n}{Q_{tr}}, \quad (3)$$

where g_e – is the mass of a single element, vehicles, t;
 n – the number of transported items, determined by the formula:

$$n = \frac{Q_{tr}}{g_e}, \text{ pcs}; \quad (4)$$

T_t^c – the duration of transportation cycle is determined by the formula:

$$T_t^c = t_l + \frac{2L_{tr}}{v} \cdot 60 + t_u, \text{ min}, \quad (5)$$

where t_p, t_u – duration of loading and unloading, min. (assumed 3–10 min. one element);

v – vehicle speed, km/h (taken 30–40 km/h).

L_{tr} – distance transportation structures km.

Conclusion

Tasks that should be addressed through PTSDM can be identified by the following paragraphs:

1. PTSDM should include preliminary design of optimal shortest possible route of the vehicle; tips on how to speed mode motion, keeping the Crossing crossings, overpasses, steep turns, pas-

sages under bridges and existing transmission lines; organizing and facilitating the movement means warnings and alerts.

2. Dimensions-departure stamps transmission towers must fit into the existing dimensions of the available vehicles, both on direct and on the curvilinear road sections; must provide the highest possible degree of loading of the vehicle.
3. Departure stamps and items carried structures must be adapted to ensure breakout in transit, as well as for loading and unloading.
4. PTSDM should include a feasibility study for the shipping method; choose the type of vehicle based on actual road conditions and terrain (availability) of roads; availability of cargo handling equipment at necessary points of the route.

The main task during transportation PTSDM transmission towers should be considered to minimize the shipping cost (the cost of the prevailing loading operations, proper transportation, unloading and, if necessary, storage).

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Горохов Евгений Васильевич – д. т. н., профессор, заведующий кафедрой металлических конструкций, ректор Донбасской национальной академии строительства и архитектуры. Президент Украинской ассоциации по металлическим конструкциям, иностранный член Российской Академии строительства, академик Академии Высшей школы и Академии строительства Украины. Член Международного комитета по изучению воздействия ветра на здания и сооружения. Научные интересы: эксплуатационная надежность строительных металлических конструкций, климатические нагрузки на строительные конструкции.

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