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To cite this article: S Plekhanova and N Vinogradova 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **911** 012021

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Analysis of the requirements of normative and technical documentation for piling equipment

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Abstract. The article is about piling equipment. Piling equipment is a type of construction equipment that is used to drive piles, drill holes, build a pile foundation and perform other construction work. This concept includes several types of equipment. It is classified by appointment, by power, on attachments and basic equipment, on performance. Pile driving technology is used in modern construction to carry out a wide range of construction works. Depending on the destination, it is worth choosing a piling machine of a certain power and performance.

1. Introduction

Pile driving equipment became widespread in the second half of the 20th century and, with its appearance, made significant changes in construction. After all, before its appearance, the clogging of supports to a depth of 10-12 meters for the construction of foundations in places with loose soil was almost impossible [1].

The supports clogged into the ground by a piling machine significantly compact the soil around and inside the pile field. Thanks to this, large civil and industrial facilities can be erected on soft soils.



Figure 1. Type of piling equipment



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The pile construction method is quite common, especially in the north on frozen soils, because during operation, the upper layers warm up, which can cause soil movement. When using piles in construction, part of the load is transferred to more dense layers of soil located in depth. Piles can be used to create trenches and pits to strengthen walls and prevent soil erosion. For driving piles to the desired depth, a piling installation is used. Piles prevent dangerous deformation of soils, leading to uneven subsidence of objects and the appearance of cracks.

Due to its advantages, piles have effectively proved themselves during construction on problematic soils with low strength, weakness, heaving and a large depth of freezing (for example: loam, clay, sand, sandy loam, etc.). The strength of the foundation on piles does not depend on uneven terrain and the level of groundwater. Pile foundations can be built almost everywhere. The exception is the terrain with rocky soil, because stones (or any other large impurities) will prevent the installation of piles. Piles are used not only in works with the foundation of buildings, but also for strengthening the supporting soil layer, in road construction, construction of bridges, etc.

2. Piling equipment classification

Basically, piling equipment installs reinforced concrete and metal piles [2].

There are several types of piling installations. Conventionally, there are 2 types of classification - according to the type of movement and the principle of work.

According to the type of movement, rail, tracked and wheel are distinguished. The latter are distinguished by maneuverability and a sufficiently high speed of movement. The first two types are more powerful than wheeled piling installations, however, they require additional equipment for moving.

Piling installation includes the following units: power plant, hammer and pile driver. The latter is responsible for installing the pile and keeping it in the right position, and the hammer with the power plant ensures that the pile is immersed to the desired depth.

According to the principle of operation, piling installations are: mechanical (M), steam air (P), hydraulic (G), diesel (D).

A mechanical hammer consists of a heavy metal drummer ("baba"), moving along the guides. The principle of operation of this mechanism is as follows: cable-block mechanism, raises the drummer 4 - 5 m, from where it falls under its own weight pile head.

In modern construction, mechanical hammers are rarely used because of:

- low efficiency;
- low frequency of blows;
- inefficiencies when driving piles at an angle.

Steam hammers are driven by steam or compressed air, directly affecting the shock part. Steam (or compressed air) flows through pipelines into the working cylinder of the hammer and, acting on the piston, carries out lifting and acceleration falling parts of the hammer. The energy and frequency of impacts are determined by the course and mass of the body and not are regulated. Driving down inclined piles is not very effective [3].

Team hammers have their drawbacks: low efficiency, bulky steam generating or compressor equipment.

The main advantage of this type of hammer is the environmental cleanliness of steam and compressed air.

The next type of equipment is hydraulic piling installations. They possess higher efficiency in comparison with other types of equipment. Hammer impact power amplified by pressure from the hydraulic system. It makes it easy to adjust the power impact depending on the ground. This type of equipment can be used in conditions dense buildings in the vicinity of other buildings. On par with steam hammers, hydraulic piling installations allow you to install piles not only strictly vertically, but also at an angle. Maintenance of hydraulic piling units more complex, and their cost is higher than previous types of equipment. To work with this view technicians require a highly qualified operator.

Diesel piling equipment operates as follows. Cylinder with moving up and down a baba is installed on the top of the pile. When a baba moves downwards, air is compressed, which, when compressed, heats up and ignites fuel entering the chamber. Gas forces push the baba up, and as soon as the cylinder reaches its upper limit, it begins to fall again - the cycle repeats. Further work runs automatically until the fuel supply stops.



Figure 2. Diesel piling equipment

The advantages that ensured the greatest distribution of this equipment:

- energy autonomy;
- mobility;
- simple and reliable design;
- high performance.

Disadvantages:

- soil vibration;
- difficult working conditions due to dust.

The choice of the type of piling installation is determined by the type of work, soil, climatic conditions. As well as the amount of planned work.

For large objects or objects where you need to exert great strength, suitable equipment on caterpillar or rail tracks.

Rail piling installation is the most powerful and able to provide significant impact load. However, it is also the most difficult to install and requires additional equipment to move. Therefore, crawler-mounted piling installations are used for a large amount of pile work and for driving pylons longer than 12 m.

Pile-driving installations on caterpillar tracks are more powerful than wheeled vehicles, but their speed of movement is slow, so an automobile platform will be required for fast movement over long distances. Crawler equipment helps out in areas with difficult terrain, as well as when working in confined spaces [3].

Wheel-mounted piling installations have great mobility and maneuverability. They are used when working on dispersed objects with a small volume, for example, in the construction of panel-type residential buildings or low-rise construction. They are equipped with both hydraulic and diesel hammers. The base is usually KAMAZ or the Urals. Due to the large size of the base, such a technique is difficult to apply in conditions of dense development.

Special attention should be paid to small-sized self-propelled piling units, which can work with both screw and driven piles.

Due to its small dimensions, it is convenient to transport equipment, and it can work even in cramped conditions. Due to the installed hydraulic equipment, a large working capacity is achieved without an increase in size. Self-propelled piling installations have good stability and work effectively on hard and medium soils on rough terrain.



Figure 3. Small-sized self-propelled piling units

3. Normative and technical documentation, which regulates the requirements for piling equipment

The main regulatory document governing the requirements for piling equipment is the “Technical Regulation on the Safety of Machines and Equipment” [4].

Technical regulations of the customs union are valid in five states [5].

The technical regulation contains: definitions of applicable terms; rules for circulation on the market or commissioning of technical regulation facilities; safety requirements; conformity assessment procedures for types of vehicles (chassis), single vehicles, vehicles in operation, types of vehicle components; requirements for labeling products with a single sign of product circulation on the market of the Member States of the Customs Union; protective clause; final provisions on the application of documents certifying compliance received before the entry into force of the technical regulation.

This document sets out the safety requirements for machinery and equipment during the design, manufacture, installation, commissioning, operation, storage, transportation, sale and disposal. Piling equipment is subject to mandatory confirmation of compliance with the requirements of the Technical Regulations of the Customs Union in the form of a declaration of conformity.

Safety requirements for piling equipment are established in GOST 31551-2012 "Piling equipment. General safety requirements" [6].

It reflects:

- general safety requirements for the operation of pile hammers;
- requirements for the main structural elements;
- monitoring the implementation of safety measures at the construction site;
- operating instructions;
- equipment transportation requirements.

The fulfillment of safety requirements for piling equipment of serial production is monitored during the acceptance and periodic tests in the amount determined by the regulatory documentation for equipment of a particular type.



Figure 4. Piling equipment at work

Noise characteristics of piling equipment are measured with a sound level meter. Measurement methods are made in accordance with GOST 12.2.026 "Woodworking equipment. Construction Safety Requirements".

4. Manufacturer instructions

With each piling installation, the manufacturer must provide the following instructions: instruction manual, list of spare parts, instructions for maintenance and repair, if necessary, transportation and installation instructions.

On hammers of specific models, indicators such as: mass of the shock, frequency of blows, estimated impact energy, structural weight of the hammer (dry, without headgear) overall dimensions, fuel consumption, working fluid, air or steam.

The design of the hammer must comply with GOST 31550-2012 "Pile driving hammers. General specifications". It provides:

- hammer operation in an inclined state up to 20° from a vertical position;
- reliable launch of the hammer in no more than three attempts when pile is upset per impact up to 150 mm;
- hammer control and daily maintenance by one person.

Each hammer must be affixed with a label in accordance with GOST 12969 "Plates for machines and instruments. Technical requirements".

The ability to use equipment for certain climatic parameters and the placement category of the hammer is established in accordance with GOST 15150 "Machines, devices and other technical products. Versions for different climatic regions. Categories, operating conditions, storage and transportation regarding the impact of climatic environmental factors" as agreed with the customer.



Figure 5. Installation of piling equipment

On the Russian market there are many samples of piling equipment that differs from each other in its type and operating parameters. When choosing a certain type of piling machine, it is very important to take into account the class of work to be done and the condition of the soil (climatic conditions) at the venue. The volumes of construction for which the selected unit should be designed, as well as the possibility of its repair. Only taking into account all these factors, construction work can be carried out at a high level and completed strictly according to plan. The reliability and durability of the foundation under construction depend on the correct choice of these mechanisms.

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