MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL AVIATION UNIVERSITY
FACULTY OF ARCHITECRURE, CONSTRUCTION AND DESIGN
COMPUTER TECHNOLOGIES OF CONSTRUCTION DEPARTMENT

TO ADMIT TO GUARD

Head of the Department

_____O.I. Lapenko

“_____” _____ 2020

MASTER THESIS

(EXPLANATORY NOTE)

Topic: Reconstruction of production shops of the existing enterprise for the premises of the logistics complex

Performed by: Student of group 205ma, Al-Asadi Alhareth
(student, group, last name, first name, patronymic)

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Kyiv 2020

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ
НАВЧАЛЬНО-НАУКОВИЙ ІНСТИТУТ АЕРОПОРТІВ
КАФЕДРА КОМП'ЮТЕРНИХ ТЕХНОЛОГІЙ БУДІВНИЦТВА

ДОПУСТИТИ ДО ЗАХИСТУ

Завідувач випускової кафедри

_____О.І. Лапенко

"_____" _____2020 р.

ДИПЛОМНА РОБОТА

(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ МАГІСТРА

ЗА СПЕЦІАЛІЗАЦІЄЮ «ПРОМИСЛОВЕ І ЦИВІЛЬНЕ БУДІВНИЦТВО»

Тема: Реконструкція існуючого промислового підприємства під приміщення логістичного комплексу

Виконавець: студентка групи 205м Аль-Асаді Альхарет
(студент, група, прізвище, ім'я, по батькові)

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Київ 2020

НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ
Факультет архітектури, будівництва та дизайну
Кафедра комп'ютерних технологій будівництва
Спеціальність: 192 «Будівництво та цивільна інженерія»
Освітньо-професійна програма: «Промислове і цивільне будівництво»

ЗАТВЕРДЖУЮ
Завідувач кафедри
_____О.І.Лапенко
«____»_____2020 р.

ЗАВДАННЯ
на виконання дипломної роботи

Аль-Асаді Альхарет
(П.І.Б. випускника)

1. Тема роботи Реконструкція існуючого промислового підприємства під приміщення логістичного комплексу
затверджена наказом ректора від «__» _____2020р. № .

2. Термін виконання роботи: з 15 вересня 2020р. по 15 листопада 2020р.

3. Вихідні дані роботи:
Будівлі, призначені для здійснення виробничих і технологічних процесів, пов'язаних з виробництвом певного виду продукції, називаються промисловими.
Реконструкція існуючої одноповерхової промислової будівлі та її розширення для виробництва та упаковки макаронних виробів та круп із подальшим зберіганням.

4. Зміст пояснювальної записки:
Реферат
4.1. Науково-аналітична частина……...___
4.2.Архітектурний розділ……..___
4.3. Розрахунково-конструктивний розділ……___
4.4. Основи і фундаменти……...___
4.5. Охорона праці……..……..…….___
4.6. Охорона навколишнього середовища ……..…___

Список використаної літератури…….___

5. Перелік обов'язкового ілюстративного матеріалу: таблиці, рисунки, діаграми, графіки.

6. Календарний план-графік

№ з/п	Завдання	Термін виконання	Підпис керівника
1.	Розробка архітектурного та розрахунково-конструктивного розділів	вересень 2020– листопад 2020	
2.	Проведення розрахунків основ і фундаментів, аналіз технічної експлуатації будівлі	жовтень 2020– листопад 2020	
3.	Опис та аналіз технології та організації будівництва	листопад 2020– грудень 2020	
4.	Виконання розділу «Охорона праці» та «Охорона навколишнього середовища»	листопад 2020– грудень 2020	
5.	Наукові дослідження	листопад 2020	

7. Консультація з окремих розділів:

Назва розділу	Консультант (посада, П.І.Б.)	Дата, підпис	
		Завдання видав	Завдання прийняв
Охорона праці	Доцент Коваленко В.В.		
Охорона навколишнього середовища	Доцент Радомська М.М.		

8. Дата видачі завдання: «_15_» _вересня___ 2020 р.

Керівник дипломної роботи: _____ Білокуров П.С

Завдання прийняв до виконання: _____ Аль-Асаді Альхарет

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Introduction (preview)

1.1 Analytical review

The increase in the flow of goods and globalization has made logistics services more important and their quality may be one of the key factors of company success.

Development of logistics and distribution centers started around the 1980s. At that time, Western Europe, which is considered the developed part of Europe, recorded increased demand for logistics services, especially in distribution and transport. Numerous companies are looking for ways to reduce the costs associated with supply, storage, distribution, and further processing of goods, which results in their cooperation with logistics distribution centers.

Growing significance of logistics in the modern society has enabled logistics distribution centers to become an essential component of logistics networks. The proximity of major European or state roads, the proximity of sea ports, river ports and airports, and accessible railways are crucial for smooth provision of logistics services and the management of logistics distribution centers.

The aim of this paper is to analyze the characteristics of logistics distribution centers and, on the basis of the examples of logistics distribution centers of the European Union member states, explore the prospects for the development of logistics distribution centers of Ukraine.

This paper consists of five connected parts. After the Introduction presenting the aim of the research and paper structure follows the second part that presents previous research on logistics distribution centers and their role. Logistics distribution centers in Ukraine are analyzed in the third part, while the fourth part presents the analysis of logistics distribution centers in Western and Central Europe. The fifth part, the conclusion, is the synthesis of the entire paper and provides concluding remarks.

Logistics activities have expanded beyond traditional transport and storage activities that include packaging, labeling, assembly, procurement, distribution, etc.

Modern logistics activities, often referred to as “low end” and “high end” logistics service values, add value to products and generate revenue for distribution centers and storage facilities. Logistics distribution centers are one of the most important elements of each country’s economy.

They are an important factor in economic development that influences the flow of goods and contributes to increasing the efficiency of the logistics channel, and may also have an influence on the development of cities or regions in which they are located. A logistics distribution center is a part of a logistics network, a logistics system is a strategic link between the production itself and the market, i.e. the end users. Each logistics network has its essential elements shown in the following scheme.

The scheme clearly shows that the key elements ofeach logistics network are logistic mesh, logistics network nodes, and logistic mesh bars. Nodes, which are part of the logistics network, represent logistic centers, logistic mesh bars include roads, railways, shiplines, etc., and bars represent a transportation network.

Logistics distribution centers consist of infrastructure, suprastructure, human resources, and technology. If logistics distribution centers are observed in the narrow sense, they can also exist within a company for its own purposes. Logistics distribution centers may also be defined as “modern facilities in which goods for further distribution to customers are selected, stored, upgraded, and prepared”.

Logistics distribution centers are part of a more complex structured logistics network. Namely, logistics networks may be structured very simply, as shown in Scheme 1 and such a logistics network directly connects suppliers with end users.

When a logistics network has a more complex structure and multiple levels, suppliers and end users are divided with at least one intermediate point and this structure.

This intermediate point may be a point, i.e. a transhipment location, a shop or a logistics cente. In this case, logistics centers are an important link in the whole process, because they provide continuous delivery. They represent macrocomplexes of specialized and universal warehouses and terminals, customs zones, freight

transport, freight distribution, and retail trade centers.

Notteboom points out that the choice between different types of distribution, i.e. distribution centers, depends, inter alia, on the product type and delivery frequency hose purpose is to supply a wider international area, and there are also national and regional logistics distribution centers and those that can supply larger urban areas.

They are mostly located in ports where they have a connection with the customs and freight forwarding offices and are well-connected in terms of transportation.

Ukraine has a few logistics distribution centers covering the national territory, and they are mostly owned by foreign companies. These centers are located near major roads and large cities in Croatia, by which they can provide services to more inhabitants and companies.

The need for the establishment of logistics distribution centers in the Republic of Croatia The favorable geo-traffic location of Croatia was recognized back in 1997 at the Pan-European Transport Conference in Helsinki. Longitudinal and transverse traffic routes that pass through the territory of Ukraine are shown on Map 3. Corridor X and branches of corridor V – Vb and Vc are important corridor routes passing through Croatia.

Taking into consideration larger branches, it is fair to say that four corridor routes actually pass through the territory of the Republic of Croatia. In addition to the three aforementioned routes, the fourth is the Danube River that is a part of corridor VII.

This indicates the favorable geo-traffic location that enables Croatia to build and manage the operations of logistics distribution centers in the best and optimal way. There are several functional logistics distribution centers in Croatia.

They are mostly located around larger cities; most of them in the vicinity of the City of Kyiv. Thanks to its optimal geo-traffic location, logistics distribution centers make their owners competitive and foster the development of the region and development of the infrastructure. Namely, their construction facilitates the

expansion of the railway network to enable better and faster services, and this is supported by the proximity of roads and access to the airport. These advantages of Croatia’s location clearly show that there is a need for the establishment of such types of centers and that they are necessary for Ukraine to be and remain part of the European logistics network.

Changing the philosophy of the market Growth of international trade, growth of freight flows Coming to the market of international corporations Development of virgin land This period is characterized by the development of distribution and trading companies. They performed the functions of promotion, transportation and distribution of goods throughout the country. Later, the first logistics operators began to emerge from distribution and trading companies. First of all, to meet the needs of professional logistics services of international brands.

Gold Rush The period from 2006-2008 was quite successful for all players in the logistics services market. The turnover of logistics operators has been actively growing in proportion to the growth in demand for their services.

During this period, developers enter the warehouse real estate market. At the same time, several large projects for the construction of logistics complexes are starting. Crisis or natural selection in practice The financial crisis has been a real challenge for all market operators.

Following the reduction in supplies and purchases in almost all areas in the first quarter of 2009, the number of logistics market operators began to decline, construction projects were frozen, and inevitable reductions took place. The "survivors" worked on the verge of profitability, and often at a loss. Today Today the logistics market of Ukraine is at the stage of stabilization. He becomes more civilized, open and professional.

Participating companies are interested in the development of their business and the Client's business, boldly go to the implementation of innovative solutions and IT products, looking for new methods to optimize logistics costs.

There are new highly specialized areas in logistics. Transport operators not only develop their competitive advantages, but also cooperate. Industry associations,

unions, and communities are actively working. This is a stage of active exchange of experience to obtain a synergistic effect for each participant. Ukrainian business appreciated the role of logistics. In an effort to optimize the relevant business costs, increase customer loyalty, gain strategic advantages over competitors, managers are increasingly resorting to improving the efficiency of logistics throughout the supply chain.

The influence of global trends on the growth of the share is also felt sales in online channels and the penetration of information technology as in business and life of the average consumer. The market needs better quality Services: Delivery should be fast, in the most convenient for the buyer place, with the possibility of returning the goods and additional service. One of trends in logistics today - Out-sourcing, but it does not yet have one widespread use in Ukrainian business, as in European companies, because there are no quality offers on the market of logistics services of Ukrain

To increase the efficiency of logistics requires an understanding of and the desire to cooperate with both the supplier and the retail, which backed by real opportunities, such as consolidation cargo, to increase / decrease the minimum batch of deliveries, frequency supplies, etc. This will manage logistics costs throughout the whole supply chain. You also need to constantly look for new ideas, the source of which is practice. Every day logistics management faces new challenges and challenges.e so many.

At the same time it is necessary be aware of how other logisticians work, with what problems face and how they are solved, it is better when these logisticians are not only local, but also global. The most effective tool is managerial meetings composition in a common arena to discuss innovations and exchange experiences.

But there are other ways to improve the situation in logistics, namely:

– at the macro level: the modern approach of the state to solving problems

logistics, which consists in the economic stimulation of active participants optimization of trade flows and ensuring the appropriate legal framework for this

process; creation of an all-Ukrainian center for training professionals in the sphere of coordination of the movement of goods on a regional and sectoral scale;

improvement of the customs control system for international transportation;

- introduction of world experience in creating a single all-Ukrainian transport and logistics system in order to accelerate the promotion of inventory flows and ensure their continuity;
- at the micro level: strengthening the innovation component in infrastructure logistics systems; improving the accounting and control system logistics costs to identify reserves to improve results logistics activities; building flexible organizational structures enterprises adapted to modern changing market conditions; strategically orientation of logistics activitiescooperation between market participants relations, etc.

2. Architectural part

2.1. General architectural and planning structure of the production building.

Buildings designed for the implementation of production and technological processes associated with the production of a particular type of product are called industrial.

Reconstruction of the existing one-storey industrial building and its expansion for the production and packaging of pasta and cereals, with its subsequent storage.

The frame of a one-storey building consists of transverse frames hinged to the floor by rafter structures. Transverse rigidity of the building is provided by the columns rigidly clamped in the base and a covering disk.

In houses with a roof, which is arranged on a solid floor of large reinforced concrete slabs, the operating conditions of individual frames are facilitated by the partial transfer of loads of "rigid" roof to adjacent frames.

Buildings with a roof of slabs laid on the girders are in less favorable conditions, so the independence of the deformation of individual frames under the action of local loads on them can lead in some cases to deterioration of the performance of the building.

Therefore, when designing buildings with overhead cranes of significant capacity, as well as crane-free, with a large height, it is necessary to provide longitudinal connections along the upper belts of the rafter structures, to some extent uniting the work of frames in the transverse direction.

Ensuring the rigidity of the building in the longitudinal direction only due to the columns is economically justified only for crane-free buildings: with spans $L \leq 24$ m and heights $H \leq 8.4$ m, as well as for buildings with $L = 30$ m and $H \leq 7.2$ m. buildings of high height and buildings with bridge cranes must provide vertical ties of rigidity in the longitudinal direction. Such connections are arranged between the columns and, if necessary, to cover the building.

The transfer of wind loads from the end walls to the columns and vertical connections through the roof structures is appropriate only for buildings of certain spans and heights. In large-span buildings of more or less significant height, such use of the roof makes it difficult to attach the rafters to the columns, complicates the structures that ensure the stability of coatings, and in some cases can not be done without violating the integrity of the roof, the strength of its attachments to the rafters.

The end walls of such buildings should be designed with the use of horizontal wind trusses and with the transfer of most of the wind load on them. Roofs made of relatively small products laid on the girders can absorb wind loads from the end walls and transfer them to the columns only if they are separated by a system of horizontal transverse connections along the upper belts of the rafter structures. Conditions of application of such, and also other secondary designs (vertical communications between trusses, struts, extensions) depend on building parameters.

Steel frame construction is a building technique that is comprised of vertical steel columns and horizontal I-beams, or girders, in which the members are connected in a skeleton-like rectangular grid, which supports the roof, floors, and walls of the building. The steel members are connected in various ways including gusset plates, welds, bolt connections, bracing, and so on.

The goal of a steel framed structure system is to transfer all of the present loads towards the perimeter of the building and down to the ground, where they are, in turn, dispersed into the earth. The advantage of the steel frame structure is that all of the members work together efficiently to passing the load from one beam and column to another until the load at hand is transmitted to the ground. Concrete and concrete slabs are very important components of steel frame construction, however, we will only touch on the steel components of the structure.

The existing building is intended to accommodate warehouses, premises for auxiliary and engineering services, administrative and utility rooms.

An individual project has been developed for the construction of the building. The building is one-storey with dimensions in the axes 387.0 x 96.0 m, a grid of columns 12x24 m.

The height of the building is variable: from 12 m to 13.6 m (in the ridge). The roof slope is 5 °. The roof of the building is pitched, combined, with light aeration lanterns and smoke removal devices

The building is divided into four fire compartments.

Premises for engineering services and administrative and utility rooms are located in outbuildings at elev. +3,300; +6,000; +10,000 in the A-B axes. In the built-in buildings, the usual C1 staircases are provided.

3. Structural part decision

3.1. Characteristics of construction site.

The construction site refers to II in the climatic region and is characterized by the following data and are summarized in Table 1.

- design winter outside air temperature - 24 °C below zero;
- characteristics snow loads for the urban settlement. Kiev region - 1460Pa;
- characteristics wind loads for the urban settlement. Kiev region - 470Pa;
- normative depth of soil freezing according DBN"Construction climatology and geophysics" - 90cm;
- seismicity of the area - up to 6 points.

3.2. Geological servey information.

The geological section of the site is heterogeneous and consists of the following engineering and geological elements:

• IGE 1 - light, silted, soft-plastic loam (aI IV);
• IGE 2 - plastic sandy loam (fg II dns);
• IGE 3 - heavy, tough-plastic loam (g II dn);
• IGE 4 - medium-grained sand (fg II dni);
• IGE 5 - medium hard plastic (fg II dni);
• IGE 6 - semi-hard clay (N2 ps).

Ground waters are found at a depth of 0.9-2.1 m.

According to chemical analyzes, groundwater is non-corrosive to concrete.

The standard depth of seasonal soil freezing is 1.08 m.

The relief of the site is flat, calm, with a general slope to the northwest.

The difference between the black marks within the site is 4.0m

Characteristics of structural elements

Warehouse buildings B1-B4, C1, C2, D2, F1 are identical.

The main supporting structures of the frame are transverse frames made of welded I-beams of variable cross-section. Frame step 12m. Coupling of columns of frames with foundations is hinged. The frame elements are connected to each other -

rigid flanged on high-strength bolts. The stability of buildings is ensured by the system of vertical and horizontal ties and the work of the frames.

At the ends of the building, the vertical and horizontal load is taken by the load-bearing timber frame. The half-timbered posts are rigidly connected to the foundations. Spatial rigidity and stability of the building is ensured by the joint work of transverse frames, struts and vertical ties along the columns and horizontal ties along the roof. Roof purlins are made of bent galvanized "Z" - shaped profiles. Wall purlins from "Z" - shaped profiles are made according to the split scheme.

Built-in rooms are provided within one frame step. Overlappings are arranged at elev. 3.3; 6.0; 10.0 m for industrial premises and administrative and household.

Floor beams are designed from rolled and welded I-beams.

A profiled flooring is laid on the floor beams, performing the functions of a permanent formwork, on which a monolithic reinforced concrete slab is laid. Anchors are installed to connect the floor beams with a monolithic slab

3.3. Design of pile foundation

Foundations are load-bearing elements of buildings, they must have sufficient strength, stability, consist of factory-made structures and be as economical as possible.

The design of the foundations is the choice of material, type, size and methods of the device.

Pile foundations are supporting structures of deep occurrence. Piles that pass through weak layers of soil and rest on solid soil are called piles - racks. Piles that do not reach strong ground, but strengthen weak layers, are called hanging. Hanging piles absorb the load from the building due to the friction forces that occur between their side surface and the ground.

According to the method of immersion in the ground piles are driven and stuffed. The driving piles are immersed by driving, pressing or vibrating. Stuffed piles are formed by pre-drilling wells and sequentially filling them with concrete.

Nowadays, driving piles made in factory conditions or on landfills have become widespread. In cross section, they are square, square solid and hollow or round. By design - solid or folded. The lower part of the saw may have a pointed end or a tubular open, in which case the soil is removed from the inner cavity of the pile, and then filled with concrete. For weak and medium soil density, prismatic piles are appropriate.

Effective use of prismatic piles with local expansion, if there is a layer for support under a layer of weak soil. In weak soils it is possible to use piles without the pointed end. Pre-loading allows you to increase the length of the pile to 24 m.

On top of the piles are connected with a reinforced concrete grid. The width of the grille is taken to be equal to the wall thickness, but not less than 300 mm at a height of 400-500 mm. According to the method of production of works, the grille can be monolithic or prefabricated.

The location of the pile under the building is determined by the configuration of its foundation in the plan and depends on the magnitude of the loads, soil conditions and the nature of the pile in the ground.

It is recommended to place hollow piles of annular section only in one row. Short piles can be placed in one row, for piles longer than 6-7 m single-row placement is not recommended due to possible skew piles. The step of piles under bearing walls, is accepted, as a rule, identical.

Each pile receives its serial number in the project, and the axes of the pile rows are tied to the design axes of the walls. The distance between the axes of the hanging piles must be at least three diameters, but not less than 70 cm. The minimum number of piles in the foundation of the columns is 3, the maximum is not limited.

Grid on piles is carried out, as a rule, from prefabricated reinforced concrete elements. The height of the grille must be at least 300 mm, the width at a single row of piles is taken equal to the width of the plinth, and in the absence of the plinth - the thickness of the walls of the first floor, but not less than 400 mm.

Pile foundations are used not only in the construction of buildings on weak soils, but also on sufficiently strong soils. The construction of pile foundations

instead of strip foundations of heavy large blocks significantly reduces the amount of earthworks and reduces the cost of foundations, and hence the structure as a whole.

Checking the sufficiency the size of the foundation which is operated

Check the adequacy of the depth of laying.

Depth of laying the foundations for building with technical underground or basement depends, basically, from their height, ie. adopted by constructive reasoning. In our case the depth of laying the foundation from the level of pure floor 1st floor is: $d_к = 0{,}3 + 1{,}6 + 0{,}5 = 2{,}4m$, where 0,3 m – height of the overlapping above technical floor; 1,6 m – height of the technical floor; 0,5 m – distance from the level technical floor to the foundation base. Determine an altitude of the sole foundation: $d_a = 132{,}50 - 2{,}4 = 130{,}10m$, where 132,50 m – an altitude of pure floor 1st floor of the existing building. Thus, as the largest the depth of occurance of a bulk soil is situated on the mark 130,50 m, thus the base for foundation serve fine little wet sand, of dense bedding, with the calculated resistance $R_0 = 400kPa$.

Determine the load on at the sole of foundation.

First determine the load on the top ledge of foundation.

Load from covering, overlap and walls accept from preliminary calculations with the necessary corrections. Since we have the shallow foundation calculate the area of 1 r.m. of foundation. The cargo area: $A_в = 1{,}0 \cdot 6{,}0 = 6{,}0m^2$.

Load on the 1 running meters of foundation:

- from covering:

normative at $q^n_{\text{cov}} = 6{,}6\,kN/m^2$: $N^n_{\text{cov}} = q^n_{\text{cov}} \cdot A_в = 6{,}6 \cdot 6{,}0 = 39{,}6\,kN/m$,

estimated at $q_{\text{cov}} = 8{,}1kN/m^2$: $N_{\text{cov}} = q_{\text{cov}} \cdot A_в = 8{,}1 \cdot 6{,}0 = 48{,}6\,kN/m$;

- from the overlap:

normative $q^n_{\text{ove}} = 8{,}1kN/m^2$: $N^n_{ove} = q^n_{ove} \cdot A_в = 8{,}1 \cdot 6{,}0 = 48{,}6\,kN/m$,

calculated $q_{\text{ove}} = 9{,}6\,kN/m^2$: $N_{ove} = q_{ove} \cdot A_в = 9{,}6 \cdot 6{,}0 = 57{,}6\,kN/m$;

- from its own weight the wall

normative $N_w^n = n \cdot h \cdot H_{tot} \cdot \rho \cdot 1,3 = 3 \cdot 0,38 \cdot 3,3 \cdot 18 \cdot 1,3 = 88,0\,kN/m$,

calculated $N_w = n \cdot h \cdot H_{tot} \cdot \rho \cdot \gamma_f \cdot 1,3 = 3 \cdot 0,38 \cdot 3,3 \cdot 18 \cdot 1,1 \cdot 1,3 = 96,8\,kN/m$.

- total value of the longitudinal force on the trim of the foundation:

normative $N_1^n = N_{\text{cov}}^n + n \cdot N_{ove}^n + N_w^n = 39,6 + 3 \cdot 48,6 + 88,0 = 273,4\,kN/m$,

calculated $N_1 = N_{\text{cov}} + n \cdot N_{ove} + N_w = 48,6 + 3 \cdot 57,6 + 96,8 = 318,2\,kN/m$.

Determine the gravity load of the foundation:

normative $N_2^n = 1,8 \cdot 0,4 \cdot 25 + 0,3 \cdot 1,2 \cdot 25 = 27,0\,kN/m$.

Determine the load on the weight of soil on ledges of foundation:

normative $N_3^n = 0,2 \cdot (1,2 - 0,4) \cdot 22 = 3,5\,kN/m$.

The total regulatory load on the level of sole foundation:

$N^n = N_1^n + N_2^n + N_3^n = 273,4 + 27,0 + 3,5 = 303,9\,kN/m$.

The average stress at the level of sole foundation:

$$\sigma_{mt} = \frac{N^n}{b \cdot 1,0} = \frac{303,9}{1,2 \cdot 1,0} = 253,25kPa,$$

where $b = 1,2m$ - width of the soles existing foundation.

Estimated resistance of soil:

$$R = R_1 = \frac{\gamma_{c1}\gamma_{c2}}{k}\left[M_\gamma k_z b \gamma_{II} + M_q d_1 \gamma'_{II} + (M_q - 1) d_b \gamma'_{II} + M_c c_{II}\right] =$$

$$= \frac{1,3 \cdot 1,1}{1,0}(1,34 \cdot 1,0 \cdot 1,2 \cdot 19,1 + 6,34 \cdot 0,56 \cdot 18,6 + (6,34 - 1)0,7 \cdot 18,6 + 8,55 \cdot 4,0) = 286,9kPa,$$

where:

$\left.\begin{array}{l}\gamma_{c1} = 1,3 \\ \gamma_{c2} = 1,1\end{array}\right\}$ - coefficients of working conditions, when $L/H = 52,4/12 = 4,4$

$k = 1$ - coefficient, at the strength characteristics of the soil (φ and c) determined by direct testing,

$\left.\begin{array}{l}M_\gamma = 1,34 \\ M_q = 6,34\end{array}\right\}$ - coefficients,

$k_z = 1$ - when $b < 10\text{m}$,

$b = 1{,}2m$ - width sole foundation,

$\gamma_{II} = 19{,}1kN/m^3$ - the average estimated value of the share of of soil, that lying below the foundation base,

$\gamma'_{II} = \frac{\gamma_1 \cdot h_1 + \gamma_2 \cdot h_2}{h_1 + h_2} = \frac{16{,}7 \cdot 1{,}0 + 19{,}1 \cdot 3{,}8}{1{,}0 + 3{,}8} = 18{,}6\,kN/m^3$ - the same as lying above the soles,

$c_{II} = 4kPa$ - the calculated value of the specific adhesion of soil, which lies directly under the sole foundation,

$d_1 = 0{,}15 + 0{,}35\frac{22{,}0}{18{,}6} = 0{,}56m$ - the depth of occurance foundations from the basement floor,

where $0{,}15m$ - the thickness of the soil layer above the soles,

$0{,}35m$ - the thickness of the constructions basement floor,

$22{,}0\,kN/m^3$ - calculated value of the share of the construction basement floor,

$d_b = 0{,}7m$ - basement depth, distance from the level of planning to the floor basement.

Check the condition:

$\sigma_{mt} \le R$, $253{,}25кПа < 286{,}9kPa$

Condition is satisfied, the building can be operated.

Calculat the sedimentation of the foundation:

$$S = A_0 \cdot b \cdot \frac{\sigma_{mt}}{E} = 2{,}1 \cdot 1{,}2 \cdot \frac{253{,}25}{37 \cdot 10^3} = 0{,}007\,м = 0{,}7cm,$$

where $A_0 = 2{,}1$ - coefficient that depends on the lateral expansion of the soil, form and brutality of foundation and the method for determining E, adopted as a cruel strip reinforced concrete foundation.

Check the condition:

$S \le S_u$, $0,7см < 8,0cm$,

where $S_u = 8,0cm$ - allowable values of subsidence.

Condition is satisfied. Subsidence does not exceed the permissible value.

3.4. Calculation of strengthening existing foundations

Conditions of reconstruction, which influence on strengthening the base and foundation of structure

Subject to reconstruction the load on the top ledge of foundation significantly increased by increasing the number of floors.

Gravity load the walls will be:

normative $N_w^n = n \cdot h \cdot H_{tot} \cdot \rho \cdot 1,3 = 5 \cdot 0,38 \cdot 3,3 \cdot 18 \cdot 1,3 = 146,7\,kN/m$,

calculated $N_w = n \cdot h \cdot H_{tot} \cdot \rho \cdot \gamma_f \cdot 1,3 = 5 \cdot 0,38 \cdot 3,3 \cdot 18 \cdot 1,1 \cdot 1,3 = 161,4\,kN/m$.

- total value of the longitudinal force on the top ledge of foundation:

normative $N_1^n = N_{\text{cov}}^n + n \cdot N_{ove}^n + N_w^n = 39,6 + 5 \cdot 48,6 + 146,7 = 429,3\,kN/m$,

calculated $N_1 = N_{\text{cov}} + n \cdot N_{ove} + N_w = 48,6 + 5 \cdot 57,6 + 161,4 = 498,0\,kN/m$.

The total regulatory load on the level of sole foundation:

$N^n = N_1^n + N_2^n + N_3^n = 429,3 + 27,0 + 3,5 = 459,8\,kN/m$.

The average stress at the level of sole foundation:

$$\sigma_{mt} = \frac{N^n}{b \cdot 1,0} = \frac{459,8}{1,2 \cdot 1,0} = 383,2kPa$$

Estimated resistance of soil:

$$R = R_1 = \frac{\gamma_{c1}\gamma_{c2}}{k}\left[M_\gamma k_z b \gamma_{II} + M_q d_1 \gamma'_{II} + \left(M_q - 1\right)d_b \gamma'_{II} + M_c c_{II}\right] =$$

$$= \frac{1,3 \cdot 1,1}{1,0}\left(1,34 \cdot 1,0 \cdot 1,2 \cdot 19,1 + 6,34 \cdot 0,56 \cdot 18,6 + \left(6,34 - 1\right)0,7 \cdot 18,6 + 8,55 \cdot 4,0\right) = 286,9kPa,$$

Check fulfill the condition:

$\sigma_{mt} \le R$, $383,2kPa > 286,9kPa$

The condition is not met, requires strengthening of foundation.

Amplification coefficient $k = \frac{\sigma_{mt}}{R} = \frac{383,2}{286,9} = 1,336$, ie. necessary to increase the bearing capacity of foundation on the 33,6%.

Possible options to strengthen the foundations

Considering the overstrain on the sole existing foundation, it can be strengthened in several ways. The choice of method strengthening and reconstruction of shallow foundations depends on the cause, which requires such strengthening, design features of existing foundations and soil conditions of the site. As a rule, applying such methods:

- strengthening the foundations by sylicatisation,
- by increasing the width of the sole,
- by increasing the depth of laying,
- by transfer to the pile,
- Placing of new foundations.

In our case, accept strengthening strip foundations by increasing the width of the sole, because it is the easiest to performance.

Strengthening of the foundation is made by extending its foot on both sides at the concreting reinforced concrete strips. For the, to make these new areas involved in the work of foundation, over them impose traverse - double cantilever beam, embedded on fine concrete to the body of foundation. In advance over existing foundation pillow in blocks punch holes , usually with a step 1,0-1,5 m, through which the wind traverses. They are made of a pair of channels or T beams and after concreting bands also concreted so they are not subjected to corrosion.

Calculation of strengthening of foundation.

Since the foundation is tape, counting area of foundation with length $l = 100 cm$.

Determine the desired width of the sole foundation:

$$b_1 = \frac{N^n}{R \cdot l} = \frac{459,8}{286,9 \cdot 1,0} = 1,60m$$.

Specify regulatory load from its own weight of foundation:

$$N_2^n = 1,6 \cdot 0,4 \cdot 25 + 0,5 \cdot 1,6 \cdot 25 = 36\,kN/m$$.

Load from the weight of the soil on ledges of foundation not will $N_3^n = 0$.

The total regulatory burden at the foot of foundation:

$$N^n = N_1^n + N_2^n + N_3^n = 429,3 + 36,0 + 0 = 465,3\,kN/m$$.

The average strain at the foot of foundation:

$$\sigma_{mt} = \frac{N^n}{b \cdot 1,0} = \frac{465,3}{1,6 \cdot 1,0} = 290,8kPa$$

Estimated resistance of the soil at the $d_1 = 0,5m$:

$$R = R_1 = \frac{\gamma_{c1}\gamma_{c2}}{k}\left[M_\gamma k_z b \gamma_{II} + M_q d_1 \gamma'_{II} + (M_q - 1) d_b \gamma'_{II} + M_c c_{II}\right] =$$

$$= \frac{1,3 \cdot 1,1}{1,0}(1,34 \cdot 1,0 \cdot 1,6 \cdot 19,1 + 6,34 \cdot 0,5 \cdot 25 + (6,34 - 1)0,7 \cdot 18,6 + 8,55 \cdot 4,0) = 320,2kPa,$$

Check fulfill the condition:

$\sigma_{mt} \le R$, $290,8kPa < 320,2kPa$.

Condition is satisfied, the width of the sole foundation is sufficient.

The safety margin is $\frac{R - \sigma_{mt}}{\sigma_{mt}} \cdot 100\% = \frac{320,2 - 290,8}{290,8} \cdot 100\% = 10,11\%$.

Calculates subsidence of foundation:

$$S = A_0 \cdot b \cdot \frac{\sigma_{mt}}{E} = 2,1 \cdot 1,6 \cdot \frac{290,8}{37 \cdot 10^3} = 0,026m = 2,6cm$$.

Check the fulfill condition:

$S \le S_u$, $2,6cm < 8,0cm$,

where $S_u = 8,0cm$ - allowable values of subsidence.

Condition is satisfied. Draught does not exceed the permissible value.

We develop the construction of foundations strengthening.

Accept a step travers $l_1 = 1,2m$, the height of the amplifying concreting 0,5 m.

The width bands concreting of foundation on each side:

$$b_c = 0{,}5(b_1 - b) = 0{,}5(1{,}60 - 1{,}20) = 0{,}20м = 20{,}0cm,$$

The load, that is perceived a foundation from the reactive soil pressure $\sigma_{гр} = R = 290{,}8кПа = 290{,}8 \cdot 10^{-4}\ kN/cm^2$ on the width $b_c = 20{,}0cm$ and length $l_1 = 120cm$ equal:

$$R_{b_c} = \sigma_{гр} \cdot l \cdot b_c = 290{,}8 \cdot 10^{-4} \cdot 120 \cdot 20 = 69{,}8kN.$$

This load is perceived by each console traverse and causes in it bending moment:

$$M_{b_c} = R_{b_c} \cdot l_n = 69{,}8 \cdot \left(\frac{1{,}6 - 0{,}4}{2}\right) = 41{,}88kN \cdot m.$$

Accept the cross section of traverses with T beam. Required moment of resistance Wtr equal:

$$W_{tr} = \frac{M_{b_c}}{R} = \frac{418800}{2350} = 178{,}2cm^3,$$

where R - calculated resistance of steel VSt3ps.

Accept traverse of two channel bar №16:

$$W_x = 93{,}4 \times 2 = 186{,}8cm^3.$$

New band of foundation with width b_c work as a continuous reinforced-concrete beams. They perceive reactive ground pressure and lean on top of traverse.

Estimated moment in this beams is equal:

$$M = \frac{q_{gr} \cdot l_1^2}{12} = \frac{58{,}16 \cdot 1{,}2^2}{12} = 6{,}98kN \cdot m,$$

where $q_{gr} = \sigma_{gr} \cdot b_c = 290{,}8 \cdot 0{,}2 = 58{,}16\ kN/m$.

We set the height of the of foundation strengthening (reinforced concrete strips) 30 cm and a protective layer of concrete to the working reinforcement 70 mm, concreting from concrete class B15 ($R_b = 0{,}9 \cdot 8{,}5 = 7{,}65MPa$), armature class A 400C ($R_s = 365MPa$).We have a working the height of the cross section beam $h_0 = 300 - 70 = 230mm$.

Determine $A_0 = \frac{M}{R_b \cdot b_c \cdot h_0^2} = \frac{698}{0{,}765 \cdot 20 \cdot 23^2} = 0{,}086 < A_R = 0{,}44$.

Find the coefficients $\eta = 0{,}9545$ when $A_0 = 0{,}086$.

Required sectional area of armature:

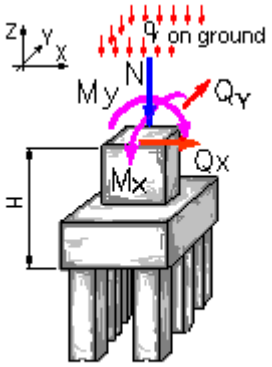
$$A_s^{nes} = \frac{M}{R_s \cdot h_0 \cdot \eta} = \frac{698}{36{,}5 \cdot 23 \cdot 0{,}9545} = 0{,}87 cm^2$$

From constructive reasons when $b_c > 150 mm$ accept two frames with the upper and lower armature from ∅8A 400 C ($A_s = 2 \times 0{,}503 = 1{,}01 mm^2$),transverse rods of the armature from ∅6 A 240 C with a step 250 mm.

Calculate the width of the base of the foundation using the software package Foundation 12.9.
Calculation results

Foundation type:
Columnar on a pile base

1. - Source data:

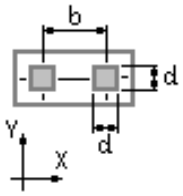


The method of determining the bearing capacity of the pile
Calculation (coefficient of reliability on the ground Gk = 1.4)
Pile type
Hanging hammer
Type of calculation
Selection of the unified grille on the 1.41-1 series
Method of calculation
Calculation of vertical load and pull-out
Source data for calculation:
The bearing capacity of the pile (excluding Gk) (Fd) is 400 kN
Pulling capacity of the pile (without Gk) (Fdu) 50 kN

The diameter (side) of the pile is 1.4 m
Foundation height (H) 1.7 m
Maximum dimensions (along the axes of the extreme piles) along the length of the grille (b max) 3.8 m
Maximum dimensions (along the axes of the extreme piles) along the width of the grille (a max) 5.8 m Расчетные нагрузки:

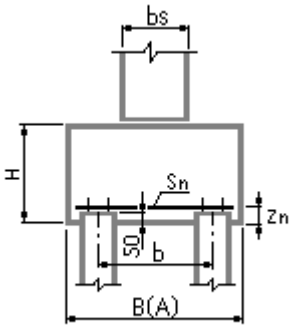
Наименование	Величина	Ед. измерения	Примечания
N	448.5	кН	
My	50	кН*м	
Qx	0	кН	
Mx	0	кН*м	
Qy	0	кН	
q	0	кПа	

2. - Conclusion:



Required grid characteristics: b = 1.2 m Number of piles (n) 2 pcs. The maximum load on its 323.76 kN The minimum load on the pile is 190.43 kN The accepted coefficient of reliability on soil Gk = 1.4

3. – Design results:



Geometrical parameters of foundation:

	denotation	Value	Measurements
Name	(A)	0.6	м
Specified sole length	(B)	2	м
Specified width of the sole	(bs)	0,54	м
Column (wall) support area along X	(as)	0,54	м
Column (wall) support area along Y	(zn)	30	см
Protective layer of sole reinforcement	(ba)	0,4	м
Distance between anchor bolts along X	(aa)	0,4	м
Distance between anchor bolts along Y	(n)	4	шт.
Number of bolts	C 235		
Concrete class	(Rb)	C15/20	

Pile cap rectangular Calculation for local crushing Load transfer area along Y 0.6 m Load transfer area along X 0.6 m According to the calculation for punching by piles, the bearing capacity of the grillage is ENOUGH. Sole of a columnar grillage of rectangular section Working reinforcement along X 10Ø 6 A-III In terms of strength along the normal section, the reinforcement is SUFFICIENT.

Sole of a columnar grillage of rectangular section

Work fittings along Y 10Ø 6 A-500c

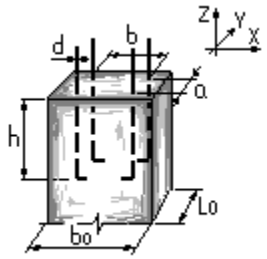
In terms of strength along the normal section, the reinforcement is SUFFICIENT.

We recommend anchor bolts with bends, embedded in concrete (h) at least 250 mm

Anchor bolts required by design 4 Ø 10 mm

Nets in the area of transfer of the load to the grillage are not required for local crushing.

Design loads: Basic combinations



3.5. Determination of the estimated burden, perceiving the foundation to strengthen

a) terms of the strength of normal section to the effect of reactance soil.

The relative height of the compressed zone

$$\xi = \frac{R_s \cdot A_s}{R_b \cdot \gamma_{b2} \cdot b \cdot h_0},$$

where $h_0 = h - a = 900 - 75 = 825\,\text{mm},\ \xi = \dfrac{365 \cdot 1357}{8{,}5 \cdot 0{,}9 \cdot 2300 \cdot 825} = 0{,}034$

The values for $\xi = 0{,}034$ on the table. add. 8 [27]

Technical maintenance and reconstruction of buildings: textbook for high school; we find υ = 0,978

Bending moment is perceived intersection foundation.

$$M_{сеч} = R_s \cdot h_0 \cdot A_s \cdot \nu,$$

$M_{сеч} = 365 \cdot 10^3 \cdot 0{,}825 \cdot 1357 \cdot 10^{-6} \cdot 0{,}978 = 399{,}64$ кН·m.

Reactance soil, perceived intersection foundation

$$P_1 = \frac{M_{пер}}{0{,}125\left(a_f - h_c\right)^2 \cdot b},$$

where a_f – ширина підошви фундаменту.

$$P_1 = \frac{399{,}64}{0{,}125\left(2{,}3 - 0{,}825\right)^2 \cdot 2{,}3} = 638{,}92\,\text{кН/m}^2.$$

Calculated load, perceived foundation

$$N_1 = P_1 \cdot A_f,$$

where A_f – square foot basement

$$N_1 = 638{,}92 \cdot 2{,}3^2 = 3379{,}88\,\text{kH}$$

b) terms of the strength of the foundation of the body to push

Reactance of the soil at the base of the foundation.

$$P = \frac{N_{mp}}{A_f},$$

where N_{mp} – total estimated load on the foundation.

$$P = \frac{2104{,}28}{2{,}3^2} = 397{,}78\,\text{kH/m}^2;$$

Calculated load, perceived foundation

$$N_2 = \left(R_{bt} \cdot \gamma_{b2} + P\right) \cdot \left[2 \cdot h_0 + 0{,}5\left(b_c + h_c\right)\right]^2,$$

where γ_{b2} - Concrete structures introduced to the calculated value R.

$$N_2 = \left(0{,}75 \cdot 0{,}9 + 397{,}78\right) \cdot \left[2 \cdot 0{,}825 + 0{,}5\left(0{,}3 + 0{,}3\right)\right]^2 = 3236{,}45\,\text{кН}.$$

c) Conditions of admissible deformations of the soil at the base of the foundation.

$$N_3^n = A_f \left(R_0 - \gamma_{mt} \cdot H_f\right),$$

where γ_{mt}=20 кН/м^3 - the average density of the body of the foundation and the soil on its ledges;

H_f – depth of laying the foundation.

$N_3^n = 2{,}3^2 \left(0{,}39 \cdot 10^3 - 20 \cdot 1{,}245\right) = 1331{,}38$ кН.

Same as the estimated load.

$N_3 = N_3^n \cdot \gamma_{fm} = 1931{,}38 \cdot 1{,}15 = 1531{,}1$ кН.

The value of the load that has to be transferred into the design to strengthen the foundation $N_y = N_{mp} - N_{\min}$,

where N_{min} – the smallest value of the components N_1, N_2, N_3.

$N_y = 2104{,}28 - 1531{,}1 = 573{,}18$ кН.

Conclusion: the need to strengthen the foundation. Considering the features of the building (strengthening work must be carried out in the buildings), it is advisable to use the reinforce existing piles hanging from the basement to the grillage using anchors. This will avoid a full excavation of the existing foundations, almost without changing the properties of the soil foundation, and is one of the least expensive ways to gain.

3.6. Calculation of anchor devices and grillage

Pre specifies the number and size of piles. Since $N_y \le 1200$ кН it is sufficient number of piles n=2 diameter 300mm drilled shallow.

Wonder diameter anchor that hold the pile grillage with conditions d_a> 18 mm . We accept d_a= 20 mm . Assign the anchors of steel grade C235 (R_y = 230 MPa).

Efforts sees one anchor diameter 20 mm (f_a =3,142 см^2),

$$N_a = K \cdot R_y \cdot f_a,$$

wheree K= 0,8 - coefficient of working conditions anchor.

$N_a = 0{,}8 \cdot 230 \cdot 10^3 \cdot 3{,}142 \cdot 10^{-4} = 57{,}81$ кН.

Find the required number of anchors:

$$n_a = \frac{N_y}{N_a},$$

$$n_a = \frac{573{,}18}{57{,}81} = 9{,}9$$

Adopts n_a = 10 pc., The conditions prevent the occurrence of torsional moment n_a > 4 pc. performed.

Calculation of flexural strength grillage on normal crossing

Find calculated bending moment (pic.4.2).

$$M = N_{св} \cdot l_0$$

where $N_{св} = \frac{N_y}{n} = \frac{573{,}18}{2} = 286{,}59$ кН – load per pile.

$M = N_{св} \cdot l_0 = 286{,}59 \cdot 1{,}3 = 372{,}57$ кН.

We specify a class of concrete grillage B20 (R_b=11,5 MPa; R_{bt}=0,9 MPa; E_b=27·10^3 MPa).

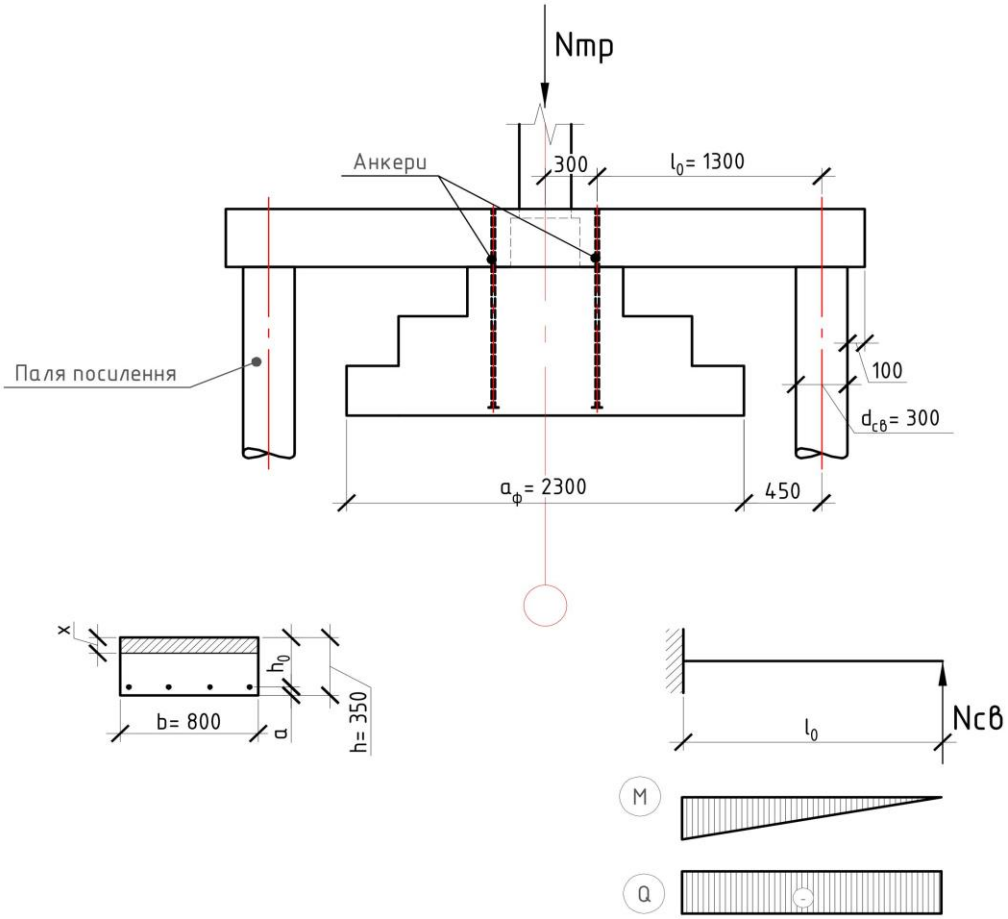
Find the intersection of the necessary effective height grillage with a coefficient α_0=$\alpha_{0(опт)}$=0,3

$$h_0 = \sqrt{\frac{M}{\alpha_0 \cdot R_b \cdot b}},$$

$$h_0 = \sqrt{\frac{372{,}57}{0{,}3 \cdot 11{,}5 \cdot 10^3 \cdot 0{,}8}} = 0{,}3 \text{ м}.$$

Full height cross section grillage

$h = h_0 + a = 0{,}3 + 0{,}05 = 0{,}35$ m.



Pic.4.2. Design model and the intersection of grillage

For the adopted coefficient α_0 find the coefficient υ=0,815.

Find the required number of working-class fixtures A400C:

$$A_s = \frac{M}{R_s \cdot h_0 \cdot \nu},$$

$$A_s = \frac{372{,}57 \cdot 10^4}{365 \cdot 10^3 \cdot 0{,}3 \cdot 0{,}815} = 38{,}7\ \text{cm}^2.$$

We accept 4ø25A400C + 4ø25A400C (A_{sf}=39,8 cm^2).

Checking the strength of grillage on an inclined strip concise

Find the estimated lateral force:

$Q = N_{св} = 286{,}59$ кН.

Assign transverse reinforcement grillage 4 ø10A240C (A_{sw}= 3,14 cm^2, R_{sw}=175 MPa; $E_s = 21 \cdot 10^4$ MPa). Step transverse rods S = 200 mm.

Determine the coefficients:

$$\mu_w = \frac{A_{sw}}{b \cdot S} = \frac{3{,}14}{80 \cdot 20} = 0{,}002;\ \alpha = \frac{E_s}{E_b} = \frac{21 \cdot 10^4}{27 \cdot 10^3} = 7{,}78;$$

$$\varphi_w = 1 + 5\alpha\mu_w = 1 + 5 \cdot 7{,}78 \cdot 0{,}002 = 1{,}08;\ \varphi_b = 1 - 0{,}01R_b = 1 - 0{,}01 \cdot 11{,}5 = 0{,}89.$$

Check the condition.

$$Q \le 0{,}3\varphi_b \cdot \varphi_w \cdot R_b \cdot \gamma_{b2} \cdot b \cdot h_0$$

$$286{,}59кН \le 0{,}30{,}89 \cdot 1{,}08 \cdot 11{,}5 \cdot 10^3 \cdot 0{,}9 \cdot 0{,}8 \cdot 0{,}3 = 698{,}3кН.$$

Condition is satisfied.

Calculates the strength of grillage on an inclined crack. Find design parameters at the value of the coefficient $\varphi_{b2} = 2$:

$$M_b = \varphi_{b2} \cdot R_{bt} \cdot \gamma_{b2} \cdot b \cdot h_0^{\,2},$$

$$M_b = 2 \cdot 0{,}9 \cdot 10^3 \cdot 0{,}9 \cdot 0{,}8 \cdot 0{,}3^2 = 109 \text{ кН·m}$$

$$c = \frac{2M_b}{Q} = \frac{2 \cdot 109}{286{,}59} = 0{,}76м \ge 2h_0 = 0{,}6m.$$

We accept C=0,6m, $Q_b = \frac{M_b}{c} = \frac{109}{0{,}6} = 181{,}7кН \le Q = 286{,}59кН$.

Running effort that sees transverse reinforcement.

$$q_{sw} = \frac{0{,}5 \cdot Q}{c} = \frac{0{,}5 \cdot 286{,}59}{0{,}6} 238{,}83 \text{ кН/m}.$$

Necessary steps transverse reinforcement:

$$S = \frac{R_{sw} \cdot A_{sw}}{q_{sw}} = \frac{175 \cdot 10^3 \cdot 3{,}14 \cdot 10^{-4}}{238{,}83} = 0{,}23м \ge S = 0{,}2м.$$

3.7. Design of pile

Determine the bearing capacity of piles borestuffing diameter of 0.3 m, which is embedded in the ground at 3 m below the top of the foundation.

Carrying capacity *Fd*, кН, hanging bore stuffing piles working on compressive load should be determined as the sum of the calculated resistances soil foundation under the lower end of the pile and on its lateral surface of the formula (7.8) [СП 50-102-2003. Проектирование и устройство свайных фундаментов.- М.:2004.]

$$F_d = \gamma_c \times \left(\gamma_{cR} \cdot R \cdot A + U \cdot \sum_{i=1}^{n} \gamma_{cf} \cdot f_i \cdot h_i \right),$$

where γ_c - coefficient of working conditions pile accepted equal 1;

R - estimated resistance of the soil under the lower end of the pile, kPa,

A - area on the ground leaning piles, m^2,

U- outer perimeter of the cross section of the trunk of the pile, m;

f_i - estimated resistance of the first soil layer on the side of the base of the pile, kPa,

h_i- thickness of the 1st soil layer in contact with the lateral surface of the pile, m;

γ_{cr}, γ_{cf} - factors operating conditions of the soil respectively at the lower end and the lateral surface of the pile, taking into account the effect of the method for calculation of immersion piles support soil.

$$R = 0,75\alpha_4(\alpha_1\gamma'_1 d + \alpha_2\alpha_3\gamma_1 h);$$

$$R = 0,75 \cdot 0,245(60 \cdot 16,7 \cdot 0,3 + 107,3 \cdot 0,68 \cdot 16,7 \cdot 2,5) = 1814,98 \text{kPa};$$

$$F_d = 1 \cdot (1 \cdot 1814,98 \cdot 0,07 + 1 \cdot 0,7 \cdot 58 \cdot 3) = 298,85 \text{ кН} > N_{св} = 286,59 \text{ kH}$$

We specify a class of concrete piles B30 (R_b=17 Мпа; R_{bt}=1,2 MPa)

The area of longitudinal reinforcement of labor is calculated as:

$$A'_s = \frac{N}{\eta \cdot \varphi \cdot R_{sc}} - A \cdot \frac{R_b}{R_{sc}},$$

where $\varphi = \varphi_b + 2 \cdot (\varphi_r - \varphi_b) \cdot \frac{R_{sc}}{R_b} \cdot \mu = 0,894 + 2 \cdot (0,894 - 0,894) \cdot \frac{365}{17} \cdot 0,015 = 0,894 -$ factor for the flexible element, the duration of the load, the nature of the reinforcement.

$$A'_s = \frac{286,59 \cdot 10}{1 \cdot 0,894 \cdot 365} - 706,85 \cdot \frac{17}{365} = 10,13 \text{ cm}^2.$$

We accept 4ø18A400C, A_s=10,18 cm^2.

According to the Resolution of the Cabinet of Ukraine from 05.05.1997 year, № 409 "On ensuring safe and reliable operation of buildings, structures and utilities" State Building of Ukraine adopted a series of regulations aimed at improving the maintenance of building structures, ensuring serviceability of buildings, structures

and utilities of the parameters of physical and technical conditions, durability and obsolescence.

Shall be provided with **four main groups** of qualities projected building:

- functional - the building has to meet its mission in the best way, and therefore should be done periodically redevelopment, modernization and reconstruction;
- technical - premises must withstand internal and external influences, be remontoprydatnoyu; therefore necessary to monitor the technical condition of structures, making protection, strengthening, if necessary - replacement;
- architectural - building must comply with the provisions in the best way in building an object given its people as its external appearance must always be in perfect suitable purpose, location in the building, etc..;
- economic - construction and operation of buildings should be carried out with minimal effort and funds.

The building is subject to reconstruction, according to the defining operational requirements:

- high reliability, ie, they perform set functions in certain operating conditions for a given time, while maintaining its core values of the parameters within the specified limits;
- Is a convenient and safe to operate, which is achieved by rational planning of rooms and location entrances, stairways, elevators, fire fighting vehicles, and for the repair and replacement of large-processing equipment in the house provided by hatches, openings and mounting;
- Is a convenient and easy in maintenance and repair, that enables it to possibly large number of sites is convenient approach to construction, commissioning of installations without removing and dismantling for inspection and maintenance of extremely low cost to support operations, allows you to apply advanced techniques labor, advanced automation and mechanization, collapsible apparatus for remote maintenance of structures, as well as a means for mounting cradles, power sources, etc..;

- is remontoprydatnoyu, ie building structure adapted to perform all types of maintenance and repair without destruction of adjacent elements and cost of labor, time, materials;
- is the best possible and close equivalent to the entire design turnaround service life;
- more economical in operation, which is achieved by using materials and structures with increased service life and minimal costs for heating, ventilation, air-conditioning, lighting and water supply;
- has the architectural look that suits its purpose, location in the building, as well as pleasing to view.

Maintenance and repair (technical operations) building is a continuous dynamic process, implementation of these complex organizational and technical measures of supervision, care and repair of all types to maintain them in good, usable by application state in the course of a given lifetime.

In buildings regulated by provisions of a preventive maintenance: provision for CPD residential and public buildings. Стройиздат, 1964; Provision for CPD industrial buildings. Стройиздат, 1974. They defined the principles of operation of the main types of БіС, All these are classified into groups and set them average lifespan, types, frequency of inspection and repair, as well as work related to the current and capital repairs.

Of paramount importance in the operation of buildings is timely control of their technical condition, check the functioning of structures and engineering equipment. This regular, not only visual, but (if necessary) and instrumental control prevents premature exit house down, can reasonably plan and carry out preventive measures for their savings.

When designing the building performance determined the choice of materials, calculation of structures, space-planning decisions, engineering equipment as directed building, building codes and regulations (БНіП) and allocated appropriations.

When erecting the building taken in the project settings performance materialize , their likelihood of being verified by the devices and their numerical values can be confirmed that the constructed building complies conceived the project. When operating the building main task is to support and materials provided by the project during the construction of performance at a given level . They must fully meet the purpose building, provided certain building structures and engineering equipment.

Thus, setting parameter values performance and the development of technical instruction operation is completed the design of buildings, using the project produced supervised their construction; according to the actual values of the project brownies taken into operation and by support at a given level is their technical operation for a specified period of service.

The efficiency of the operation and its efficiency depends on many factors, including large extent on training individuals carrying it, on their ability to build operation on a scientific basis.

Persons engaged in the operation and repair of buildings, should be familiar with its device designs working conditions , technical standards for materials and construction required for repair. They are using the instruments, as well as the appearance and signs should be able to at least approximately evaluate the technical condition of the building and some of its structures , to be able to identify vulnerabilities , including its destruction can begin to choose the most effective ways and means of prevention and remedy , not violating the possible use of the building for other purposes.

Efficient operation of buildings, ie constant skilled supervision, periodic evaluation of their technical condition (diagnosis of lesions) in the initiation of damage, timely preventive and regenerative repair is possible only in the study of the construction of structures, the characteristics of the device and its operation, operational requirements and the degree of their actual satisfaction, ability to identify vulnerabilities, of which perhaps the beginning of damage, etc..

Employees operational services should carefully study the design of the house; during construction to control the quality of all work, study received from builders

execution drawings and instruction manual building, keep building on each passport logbook technical condition (ZHTS) and other documents required in the operation of BiS.

In the project home as required by building regulations stipulated requirements for reliability, kapitalnosti, durability and set conditions for the overall building and some of its elements, compounds and bases of structures; This is achieved by the choice of materials and structures, special protective measures for fire resistance, cold resistance, corrosion resistance, anti-condensation moisture and rot, water drainage, ventilation and etc.

When designing and building structures in general accordance with the requirements of building regulations provided for measures to reduce the negative impact of factors caused the proceedings papers. Requirements of building regulations boil down to the fact that the value of effort, stress, strain, displacement, crack opening , and value the efforts of other factors and impacts do not exceed the limits set by the rules . In the calculations take into account the possible adverse properties of materials and the possible beneficial values and communication loads and impacts, as well as operating conditions and features of the structures and foundations , subject to all the requirements of regulations , standards , technical conditions offered to the quality of materials, products, proceedings work and to the operation of BiS.

Advances structures limit states set standards, not dangerous to humans, but is below , on reaching home on which can no longer be used for their intended use without special regenerative work. To better take into account the features of the actual work materials, components and structures of compounds and bases , and the building as a whole, is introduced in the calculation of the coefficient of working conditions n, and to compensate for the lack of knowledge of the work of boundary conditions of certain types of structures and foundations , we introduce safety factor kN , unfavorable combinations of factor loadings and impacts of the book , overload coefficient KP , etc., numerical values are established by the normative documents for the design of structures, foundations , bis.

To use the buildings for other purposes are to be maintained , the temperature - volohistni conditions and defined comfort that provided not only serviceable building structures , but existing systems, heating and sanitation. To create an environment in buildings and support structures and engineering equipment in good condition aims at operational service.

The methods of control of physical and technical parameters of the homes include: observation of cracks in structures , control of local and general strain and definition: the strength of structures ; thickness in pipelines for corrosion control ; moisture content of wood and other materials; thickness of paint coatings ; air permeability of joints and structures; shielding quality construction : insulating ability of protecting designs ; places hidden damage waterproofing.

4. Technical maintenance of building and structures.

4.1 Introduction to technical maintanance

"The combination of (all technical and assorted administrative actions) any action carried out to retain an item in order or restore it to a state in which it can perform its required function."

"Building maintenance is work undertaken to keep, restore or improve every facility, i.e., every part of a building, its services and surrounds to a currently acceptable standard and to sustain the utility and value of the facility."

Aim of Maintenance of Building:

Maintenance is, thus, construction with a difference in approach, the chief aim being:

1. To preserve the operating condition of machinery and building services, structures, etc.

ADVERTISEMENTS:

2. To restore them back to their original standards.

3. To improve the facilities depending upon the development that is taking place in the concerned/relevant engineering.

A building stands exposed in weather and is used for all possible purposes. Further, there would be various in-building arrangements inviting various decaying agencies to act. Decay causes damage and, again, damage invites further decay followed by damage again and, ultimately, reducing it to an unserviceable and dilapidated structure.

Types of Maintenance of Building:

Maintenance of buildings may be broadly classified in three categories:

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1. Routine maintenance,
2. Preventive maintenance, and
3. Remedial maintenance/measure or repair.

1. Routine Maintenance:

ADVERTISEMENTS:

Routine maintenance of the structure is essential to keep it functional and protect it against early decay. A building is made of different parts in different locations and made of different materials. These are all susceptible to natural decay due to ageing. While designing, the life of the members is assumed with normal maintenance. For instance, a timber member is assumed to be painted at regular intervals.

With this assumption, timber is considered to lose 40 % of its strength in 5 decades. Now, if the timber is left without maintenance, i.e., without renewal of surface painting, the timber member would show signs of decay early and its strength after 5 decades would be much less than was assumed. Routine maintenance includes cleaning, servicing, oiling, greasing, renewal of plastering, painting walls, painting woodworks, etc.

There are various items of work which fall under routine maintenance and are expected to be attended regularly for up-keeping of the building some of the items need be attended daily, some weekly, while some at regular interval.

Routine maintenance is post construction activity which is required to be attended for up-keeping of the building to resist its early decay causing severe damage to it and saving it from becoming non-functional.

These may be enumerated as below:

a. Items of work which need be attended daily:

1. Cleaning of the floors and walls, etc. not only by brushes but also swabbing daily and regularly as may be required, twice and even thrice in cases of hospitals. Non-cleaning would allow dirt and dust to be accumulated causing early decay.
2. Water closets should be cleaned by brushes and at least once in a week by acid or by other commercially available cleaning chemicals.
3. Cleaning of the sanitary installations and premises must be followed by spreading detergent powder or by detergent liquid on hygienic ground.
4. Glass panes of doors and windows are to be cleaned properly and at least once in a week with the help of liquid cleaners available commercially.

b. Items of work which need be attended weekly:

1. The roof top should be cleaned weekly as otherwise dust and rubbish would block the outlets causing accumulation of rain water on the roof, which ultimately would find way through the roof causing severe structural damage.
2. Bathrooms and bathing places should be cleaned by flushing with 2/3 buckets of hot water at least once in a week. This will loosen up oil and fat particles clogging the trap. Earth and ashes should not be used for cleaning the utensils as this would cause chokage of the trap and, ultimately, shorten its life.
3. The doors and windows may give uneasy sound of hinges indicating oiling is required. The hinges should be oiled once in a week.
4. The ventilation installations need be checked, cleaned and oiled once in a week.
5. There may be electric pumps and motors installed. These need be checked weekly and their performance noted in the log book. The tube-wells, if there be any, shall be checked regularly and their yield measured and entered in the log book.
6. Heavy electrical installations like transformers, switch gears, etc. need be examined by a qualified engineer regularly and checked for their performance. In case of oil-based transformer, the level of oil must be checked.
7. The decorations inside and outside are to be cleaned properly at least once in a week.

c. Items of work which need be attended periodically:

1. Leaks may be observed in soil pipes, waste water pipes and rain water pipes, specially in portions running horizontally. This may be due to leakage through the joints. The portion of the pipe leaking should be closed and damaged joint opened and cleaned. The joint then shall be redone as before. In case of C.I. pipes, the joint should be by lead caulking and in case of asbestos pipes, the joint shall be by cement

2. The water supply lines are to be checked and, in case of any leakage observed in the line, the portion is to be taken out and cleaned by dilute commercial acid and brush and finally washed by clean water and re-fixed.
3. Cleaning of the water reservoirs, both at ground and overhead, is essential for hygienic reasons. These should be periodically cleaned at intervals of not more than three months.

ADVERTISEMENTS:

1. Narrow hair cracks may be observed in the walls. These should be dug up and filled with cement mortar. This would prevent further damage of the affected portion. These filled-up cracks shall be kept under observation.
2. Growth of small plants may be observed on the wall. These should be stopped when they are small, as otherwise they would create cracks in the adjoining portion of the wall and would lead to major trouble in future. The plants should not only be removed but should be uprooted and the place should be treated with copper sulphate solution or acid for permanent eradication.
3. Plastering on the walls both internal and external and ceiling may, at places, show bulging or cracks. These areas must be checked thoroughly by beating with a light wooden hammer. The portions emitting dull sound indicate separation of the plaster from the surface.

These portions should be taken out in regular shape and re-plastered with mortar of same proportion after raking out the brick joints and cleaning the surface.

4. Painting internal and external surfaces of building is essential for various reasons hygienic, protection of structure and aesthetic. The rendering on the surface protects the structure. But it is porous and absorbs moisture which causes permanent damage in the walls and ultimately affects the structure seriously.

The external painting (cement-based paint or colour wash with lime base) seals the pores of the plaster and protects the structure. Renewal of the internal wall painting is desired annually and that of the external walls every fourth year.

5. Painting of doors and windows and water supply and drainage lines is to be done periodically at intervals of not more than four years.

6. The insulations either sound or heat, if exist, are to be checked against any leakage. If observed, should be repaired immediately.
7. Electrical installations, internal wiring, switches, fans, water-heater, etc. are to be checked to find out if there is any leakage spot which is common in old buildings. These are to be cleaned at regular interval. The wiring is to be replaced once in two decades to prevent any hazard caused by short circuit.
9. The illuminating bodies should be cleaned once in a month to maintain the value of maintenance factor (P), so that the illumination of the bodies does not fall.
10. Plinth protection around the building need be maintained properly so that there may not be any passage for the surface water to percolate to the foundation threatening its settlement.
11. There may be installations like lifts, escalators service elevators for vertical transportation of persons or goods. After installation of these, Servicing and Maintenance Contracts are entered with the firms installing these. They do the maintenance job at regular intervals.
12. Cleaning of the premises, i.e., compound of the building including cutting and removal of unwanted plants, shrubs, etc. and removal of garbage, are to be done at regular intervals to keep the area clean and pleasant. This would improve the aesthetic sense of the occupier/user and grow sense of responsibility and better living and induce good habits.

2. Preventive Maintenance:

Preventive maintenance comprises of activities which are essentially required to make the structure strong and sound and capable of resisting early decay or damage. Preventive maintenance of a structure means improving the quality of construction and makes it more durable and functional.

Preventive Action Prior To Commencement of Construction:

Soil investigation, collection of information about climatic condition of the site including possible seismic danger and taking action by strengthening the structure accordingly against all probable future eventualities, fall under the preventive maintenance action.

Unless this information is collected and the designer is fed with these particulars, the structure would remain vulnerable to future disaster.

Preventive Action during Construction:

Even when the above information is collected and the structures are well-designed, they may be susceptible to early decay due to lack of preventive measures during construction.

Preventive measures needed during construction for ensuring quality and durability of the structure are:

- Selection of right material for construction and using those in proper way as per specification and according to I.S. Code.
- Improvement of workmanship by engaging trained workmen.
- Cement concrete is one of the main items which need the most preventive action to make it weather proof, sound and durable. Lime concrete, specially when it is used for providing water proofing course over the R.C.C roof, also need preventive action.

Steel members which are used in building construction and remain exposed to weather are susceptible to early corrosion and need preventive measure for protecting them from early decay.

Timber used in building construction in various ways is susceptible to early decay and decomposition. This may be prevented by right selection of timber. Timber need be from matured wood protected by seasoning, treating and painting and, thus, prevented from early weather action.

Natural Calamities:

During the lifetime of the structure, it may have to sustain certain natural calamities like earthquake, storm, flood, etc. Suitable preventive measures need be incorporated in the design and construction to enable the structure to withstand these.

3. Remedial Maintenance:

In spite of taking all possible preventive measures and providing routine maintenance, a structure may undergo decay and damage, which would require to be ameliorated by remedial measures.

Remedial maintenance or repairs is removal of any decayed or damaged part of the structure or removal of any defect in the structure. Due to some reasons, the structure may show sign of damage or distress. Action for repairs or restoration work should be taken up without allowing increase of the possible defect causing further damage to the structure.

5. Construction technology.

5.1. Methods of steel structure assembling.

The steel-framed building derives most of its competitive advantage from the virtues of prefabricated components, which can be assembled speedily at site. Unlike concreting, which is usually a wet process conducted at site, steel is produced and subsequently fabricated within a controlled environment.

This ensures high quality, manufacture offsite with improved precision and enhanced speed of construction at site. The efficiency of fabrication and erection in structural steelwork dictates the success of any project involving steel-intensive construction.

Current practices of fabrication and erection of steel structures in India are generally antiquated and inefficient. Perhaps, this inadequate infrastructure for fabrication is unable to support a large growth of steel construction. In India, the fabrication and erection of structural steelwork has been out of the purview of the structural designer.

Nevertheless, in the future emerging situation, the entire steel chain, i.e. the producer, client, designer, fabricator and contractor should be able to interact with each other and improve their efficiency and productivity for the success of the project involving structural steelwork. Hence it becomes imperative that structural designers also must acquaint themselves with all the aspects of the structural steel work including the “fabrication and erection,” and that is the subject matter of the present chapter to briefly introduce good fabrication and erection practices. 2.0

FABRICATION PROCEDURE Structural steel fabrication can be carried out in shop or at the construction site. Fabrication of steelwork carried out in shops is precise and of assured quality, whereas field fabrication is comparatively of inferior in quality. In India construction site fabrication is most common even in large projects due to inexpensive field labour, high cost of transportation, difficulty in the transportation of large members, higher excise duty on products from shop. Beneficial taxation for site work is a major financial incentive for site fabrication. The methods followed in site fabrication are similar but the level of sophistication of

equipment at site and environmental control would be usually less. The skill of personnel at site also tends to be inferior and hence the quality of finished product tends to be relatively inferior. However, shop fabrication is efficient in terms of cost, time and quality.

Structural steel passes through various operations during the course of its fabrication. Generally, the sequence of activities in fabricating shops is as shown in Table1. The sequence and importance of shop operations will vary depending on the type of fabrication required. All these activities are explained briefly in the subsequent parts of the section.

Table 1: Sequence of activities in fabricating shops

S.No.	Sequence of Operation
1.	Surface cleaning
2.	Cutting and machining
3.	Punching and drilling
4.	Straightening, bending and rolling
5.	Fitting and reaming
6.	Fastening (bolting, riveting and welding)
7.	Finishing
8.	Quality control
9.	Surface treatment
10.	Transportation

2.1 Surface cleaning Structural sections from the rolling mills may require surface cleaning to remove mill scale prior to fabrication and painting. Hand preparation, such as wire brushing, does not normally conform to the requirements of modern paint or surface protection system.

However in some applications manual cleaning is used and depending on the quality of the cleaned surface they are categorised into Grade St-2 and Grade St-3. Blast cleaning is the accepted way of carrying out surface preparation in a well-run fabrication shop. Abrasive particles are projected on to the surface of the steel at high speed by either compressed air or centrifugal impeller to remove rust and roughen the surface before applying the coating.

By using shot or slag grits, both of which have an angular profile, surface oxides are removed and a rougher surface is obtained to provide an adequate key for metal spraying or special paint. Depending upon the increase in the quality of the cleaned surface, the blast cleaning is categorised into Grade – Sa2, Grade – Sa2½ and Grade Sa- 3.

Flame cleaning is another method of surface cleaning. In this method the surface is cleaned using an oxy-acetylene torch which works on the principle of differential thermal expansion between steel and mill scale. In another method called ‘ the steel piece is immersed in a suitable acid and the scale and rust are removed. 2.2 Cutting and Machining Following surface preparation, cutting to length is always the first process to be carried out, and this is done by any of the following methods.

2.2.1 Shearing and cropping Sections can be cut to length or width by cropping or shearing using hydraulic shears. Heavy sections or long plates can be shaped and cut to length by specialist plate shears. For smaller plates and sections, machines featuring a range of shearing knives, which can accept the differing section shapes, are available.

2.2.2 Flame Cutting or Burning In this method, the steel is heated locally by a pressurised mixture of oxygen and a combustible gas such as propane, which passes through a ring of small holes in a cutting nozzle.

The heat is focussed on to a very narrow band and the steel melts at 15000 C when a jet of high-pressure oxygen is released through a separate hole in the centre of the nozzle to blast away the molten metal in globules. The desired cuts are obtained quickly by this process. However due to a rapid thermal cycle of heating and cooling, residual stresses and distortion are induced and hence structural sections that are fabricated using flame cutting are treated specially in the design of structural steelwork.

2.2.3 Arc Plasma Cutting In this method, the cutting energy is produced electrically by heating a gas in an electric arc produced between a tungsten electrode and the workpiece. This ionises the gas, enabling it to conduct an electric current. The high-velocity plasma jet melts the metal of the work piece. The cut produced by

plasma jet is very clean and its quality can be improved by using a water injection arc plasma torch. Plasma cutting can be used on thicknesses upto about 150 mm but the process is very slow.

2.2.4 Cold Sawing When a section cannot be cut to length by cropping or shearing, then it is normally sawn. All saws for structural applications are mechanical and feature some degree of computer control. There are three forms of mechanical saw - circular, band and hack.

The circular saw has a blade rotating in a vertical plane, which can cut either downwards or upwards, though the former is more common. Band saws have less capacity. Sections greater than 600 mm X 600 mm cannot be sawn using band saws. The saw blade is a continuous metal edged, with cutting teeth, which is driven by an electric motor. Hack saws are mechanically driven reciprocating saws.

They have normal format blades carried in a heavy duty hack saw frame. They have more productivity than band saws. 2.3 Punching and Drilling Most fabrication shops have a range of machines, which can form holes for connections in structural steelwork.

The traditional drilling machine is the radial drill, a manually operated machine, which drills individual holes in structural steelwork. But this method has become too slow for primary line production. Therefore, larger fabricators have installed NC (Numerically Controlled) tooling, which registers and drills in response tokeyed in data. These can drill many holes in flanges and webs of rolled steel sections simultaneously.

It is also possible to punch holes, and this is particularly useful where square holes are specified such as anchor plates for foundation bolts. While this method is faster compared to drilling, punching creates distortion and material strain hardening around the holes, which increase with material thickness. Its use is currently restricted to smaller thickness plates.

In order to reduce the effect of strain hardening and the consequent reduction in ductility of material around punched holes, smaller size (2 mm to 4 mm lesser than final size) holes are punched and subsequently reamed to the desired size. 2.4

Straightening, Bending and Rolling Rolled steel may get distorted after rolling due to cooling process. Further during transportation and handling operations, materials may bend or may even undergo distortion. This may also occur during punching operation.

Therefore before attempting further fabrication the material should be straightened. In current practice, either rolls or gag presses are used to straighten structural shapes. Gag press is generally used for straightening beams, channels, angles, and heavy bars. This machine has a horizontal plunger or ram that applies pressure at points along the bend to bring it into alignment.

Long plates, which are cambered out of alignment longitudinally, are frequently straightened by rollers. They are passed through a series of rollers that bend them back and forth with progressively diminishing deformation. Misalignments in structural shapes are sometimes corrected by spot or pattern heating.

When heat is applied to a small area of steel, the larger unheated portion of the surrounding material prevents expansion. Upon cooling, the subsequent shrinkage produces a shortening of the member, thus pulling it back into alignment. This method is commonly employed to remove buckles in girder webs between stiffeners and to straighten members.

It is frequently used to produce camber in rolled beams. A press brake is used to form angular bends in wide sheets and plates to produce cold formed steel members. 2.5 Fitting and Reaming Before final assembly, the component parts of a member are fitted-up temporarily with rivets, bolts or small amount of welds.

The fitting-up operation includes attachment of previously omitted splice plates and other fittings and the correction of minor defects found by the inspector. In riveted or bolted work, especially when done manually, some holes in the connecting material may not always be in perfect alignment and small amount of reaming may be required to permit insertion of fasteners. In this operation, the holes are punched, 4 to 6 mm smaller than final size, then after the pieces are assembled, the holes are

reamed by electric or pneumatic reamers to the correct diameter, to produce well matched holes.

Fastening Methods

The strength of the entire structure depends upon the proper use of fastening methods. There are three methods of fastening namely bolting, riveting and welding. A few decades back, it was a common practice to assemble components in the workshop using bolts or rivets. Nowadays welding is the most common method of shop fabrication of steel structures. In addition to being simple to fabricate, welded connection considerably reduce the size of the joint and the additional fixtures and plates.

However, there is still a demand for structural members to be bolted arising from a requirement to avoid welding because of the service conditions of the member under consideration. These may be low temperature performance criteria, the need to avoid welding stresses and distortion or the requirement for the component to be taken apart during service e.g. bolts in crane rails or bolted crane rails. 2.7 Finishing Structural members whose ends must transmit loads by bearing against one another are usually finished to a smooth even surface.

Finishing is performed by sawing, milling or other suitable means. Several types of sawing machines are available, which produce very satisfactory finished cuts. One type of milling machine employs a movable head fitted with one or more high-speed carbide tipped rotary cutters. The head moves over a bed, which securely holds the work piece in proper alignment during finishing operation. Bridge specifications require that sheared edges of plates over a certain thickness be edge planed. This is done to remove jagged flame cut edges and the residual stresses at the edges. In this operation, the plate is clamped to the bed of milling machine or a planer. The cutting head moves along the edge of the plate, planing it to a neat and smooth finish. The term finish or mill is used on detail drawings to describe any operation that requires steel to be finished to a smooth even surface by milling, planing, sawing or other machines.

6. Organization of construction

8.1. Terms of organization and construction

A good contractor always tries to keep his site staff to a minimum for economic construction. To achieve this, the right type of men must be used, and they must be given freedom and responsibility to act on their own initiative. They must have quick communication with each other, and their areas of action must be clearly defined.

A contractor cannot afford to tolerate ineffectiveness in any of these responsible positions.

Key Site Personnel for Contractor In the site organization of a contractor, the key five persons are:

a) the agent

b) site engineer

c) office manager

d) general foreman

e) plant manager (foreman) f

) Contract manager on large jobs

However on small jobs, the duties of the agent and site engineer may be combined, and the general foreman may also be the plant foreman. On large jobs, a contract manager may be appointed over the agent. His job being managerial rather than technical and executive control.

a) The Agent: The agent is responsible for directing and controlling the whole of the construction work on site, and he will have wide powers to enable him to employ men, hire machinery and equipment, purchase materials, and employ subcontractors. His power to do these things without reference to his firm's head office will depend on the size of the job, its nature and distance from head office, the policy adopted by his firm, and of course his standing within his firm. An agent must display a number of talents. He must be knowledgeable in the civil engineering

construction, he must be able to command men and be a good organizer and administrator. He also needs sound business sense, because his job is not only to get the work built properly to the satisfaction of the engineer, but also to make a profit for the contractor. If things go wrong with an intended plan and this is an almost daily occurrence the agent must be informed immediately. All the information are centralized upon him. Once the agent has made up his mind to make changes, it is the office manager and sub-agent's job to see that the necessary instructions get through the right person without delay.

b) b) The Site Engineer: The site engineers and his staff is responsible for seeing that the works are constructed to the right lines and levels. Their responsibility will also extend to advise the agent on all design and engineering matters. Their duties will include taking site levels; lining in and leveling construction work; planning temporary access, roads and bridges; dealing with powers supply, water supply, drainage; concrete batching plant foundation and so on. They are also responsible for keeping of progress and quality records. Each engineer will, in addition, normally have a section of the work to look after, measuring up the work in his section weekly or monthly. On small jobs, the site engineer may act as sub-agent.

c) c) The Office Manager: Within the site office, the agents' principal administrator is the office manager. His responsibility covers carrying out most of the paper works-correspondence issuing of orders for materials, receiving and checking and checking accounts, making up pay sheets etc. Normally under him there are other persons such as, pay clerk, order clerk, correspondence secretary, and accounts clerk. He also controls other staff, such as, invoice checker, storekeeper, messengers, tea boys, staff car drivers and night watchmen.

If there is no a separate site cashier, the office manager will also have to handle the workmen's pay.

d) General Foreman: The general foreman is the agent's right-hand man for the execution of the works in the field. His work is to keep the work moving ahead daily as the agent has planned it. He has to be a man of wide practical knowledge and long experience, so that he can, if needed be demonstrate personally how things should be done. He should spend alot of his time outside, visiting all parts of the work under his control.

He is the one who contributes most of the changing ttejob from a set of plans into a finished structure. The foreman must be able to read engineer's drawings. He has to be boss of the workmen not in title but in an actual way. Finally a general foreman must possess foresight and planning ability.

e) Plant Manager: The position of plant engineer is normally separately designated from that of general foreman, even on small jobs. His job is to maintain and service the plant and to have it available as required. He is advised by the agent in long-term planning, and by general foreman for day to day planning. He controls the fitters and welders, and it is his job to maintain power supplies to the site- i.e. to run the site generator.

8.2. Decision on technological sequence and methods of the work

The goal of this technical analysis is to examine the possibility of reducing or accelerating the schedule by several months focusing primarily on the steel erection sequence paired with the use of a precast façade system. With the existing brick façade system, brick work begins after topping out of structural steel. By allowing façade construction to begin as structural steel is still occurring will allow earlier turnover to occur possibly at the start of the school year to reduce impact on students.

This would allow the Ambridge Area School District to move furnishings and equipment over the summer break period and allow students to begin the 2007-2008 school year in the new facility rather than transitioning to the new building half way through the year. The schedule reduction should decrease general conditions costs without forcing increased costs in structural steel work.

Methodology

1. Examine steel erection and façade sequencing used on project
2. Determine alternative sequence to reduce schedule
3. Model alternative sequence using 4-D modeling
4. Compute any additional costs attributed to overlapping façade and steel erection
5. Compute reduced general conditions costs after reduction in overall schedule

8.3. The volume of construction works and their complexity

The average ratio of actual time to the agreed time for road work is 1.0351. The ratio varies between a maximum value of 2 and a minimum of 1/3. The following stage of the analysis involved modelling the relationship for civil engineering and different types of building contracts.

The two samples were classified according to type of project, form of contract and type of competition. Seven groups were modelled and tested visually for the difference in these relationships. The type of competition was found to have no effect on the relationship. Finally, six groups were modelled and the results of the constants of the relationships are listed. Public buildings and civil engineering projects were shown to fit accurately, while private buildings varied considerably. Interesting conclusions were drawn on the logic behind these differences.

8.4. Normative duration of construction

In most scheduling procedures, each work activity has an associated time duration. These durations are used extensively in preparing a schedule. For example, suppose that the durations shown in were estimated for the project diagrammed in Figure 9-0. The entire set of activities would then require at least 3 days, since the activities follow one another directly and require a total of 1.0 + 0.5 + 0.5 + 1.0 = 3 days. If another activity proceeded in parallel with this sequence, the 3 day minimum duration of these four activities is unaffected. More than 3 days would be required for

the sequence if there was a delay or a lag between the completion of one activity and the start of another.

Normative duration of reconstruction – 14 months

Including the duration of the preparatory period – 1 months.

Remodeling – February 2021 year.

In the preparatory period, which aims to create the necessary conditions for the continuous construction of buildings and structures to perform the work associated with the development of construction site organization and building industry. In preparing the construction site to predict the following work:

- study foreman, craftsmen, engineers and technical staff of the technical department of construction documents and details regarding the conditions of the;
- surrender decision-geodetic framework for building surveying and stakeout work for laying of utilities, construction of roads and buildings (structures);
- planning area;
- re-lining of existing and new utilities;
- placement of permanent and temporary roads (in the permanent placement of roads used for construction purposes, roadway do without asphalt);
- inventory placement of temporary construction site fence;
- placement cell (inventory) of buildings and facilities for production, storage, support, community, public purpose;
- broken ground handling structures and materials.

Completion of the preparatory period expires signing "Act out area works and inter work and willingness object (house) before construction" - permission to start construction, with the assistance of the State Inspector that oversees construction in the territory.

8.5. Schedule of works

Schedules of work (or schedule of works) are 'without quantities' instructional lists often produced on smaller projects or for alteration work. They are an alternative

to bills of quantities, allowing the pricing of items, such as builders' work and fixing schedules (such as sanitary fittings, doors, windows, ironmongery, light fittings, louvres, roller shutters, diffusers, grilles, manholes and so on).

Schedules of work are typically prepared by designers rather than by a cost consultant or quantity surveyor. They may be prepared as part of the production information alongside drawings, specifications, bills of quantities and preliminaries and are likely to form part of the tender documentation and then contract documents.

They simply list the work required. Any information about quality should be provided by reference to specifications, and information about location and size should be provided on drawings (so as to avoid conflicting information). Where a schedule does include a description of the work required, this may be referred to as a 'specified schedule of work'.

Schedules of work should allow the contractor to identify significant work and materials that will be needed to complete the works and to calculate the quantities that will be required. As a consequence, it is important that schedules of work properly describe every significant item of work to which they relate. Failure to do so may result in a claim by the contractor.

Schedules of work can be arranged on an elemental basis (for example, groundwork, concrete, masonry, etc.), or on a room-by-room basis

8.6. A general plan of bulding

Site layout planning is an important activity that involves identifying, sizing, and placing of temporary facilities within the boundaries of a construction site. The basic consideration in an effective site layout planning is the smooth and low-cost flow of materials, labor, and equipment within the site, in addition to satisfying various work constraints and safety requirements. This book presents a methodology for site layout planning. This methodology aims at supporting the three decisions related to site layout planning: identifying necessary facilities and determining their sizes; determining the inter-relationships among the facilities and optimizing the placement of the facilities on the site. The three decisions are mainly experience-

based, however, each lends itself well to a different solution mechanism. Identifying the facilities and their sizes is knowledge dependent and as such a knowledge-based system is used in this process. Determining the desirability of having facilities close or apart from each other is also a problem that lends itself well to fuzzy-set applications. The optimization of facility placement on the site is done using genetic algorithms.

Most construction sites that run into trouble do so for reasons related to managerial factors rather than because of technical problems. The site-based management can make significant improvements in the cost and time savings during the construction process without involving a mass of additional work. The role of site managers is to control and maintain work performance and then taking actions to rectify situations where performance is unsatisfactory.

Concepts and Formulas

A well-planned site including all temporary facilities and utilities lead to: 1) increasing productivity and safety, 2) reducing area(s) needed for temporary construction, and 3) maximizing utilization. The following points should be considered in good site layout

Safety:

Fire prevention: Fire is a major cause of damage on construction sites. So that, fire extinguishers are basic requirements on a construction project.

Medical services: On construction project a first aid kit is a must. In remote projects a well-equipped medical room with a doctor and nurse is important.

Construction safety clothing: Basic safety supplies like safety shoes, hard hats, gloves, and goggles must be used by workers.

Site Accessibility:

Easy accessibility will keep the morale of the equipment and vehicle drivers high, minimize the chance of accidents, and save time in maneuvering to arrive at and leave the project. In case of large projects, proper planning is required to layout the roads leading from the nearest highway. Internal roads are necessary for easy

flow of work. Also, Parking Lots are provided for the owner, office, and craft personnel, but this facility must be planned where space does exist.

Information Signs:

Site map: It should locate details of the project, and displayed in the office of the site superintendent or project manager and posted at the entrance gate.

Traffic regulatory signs: For large projects, traffic regulatory signs help in guiding the traffic on the site and avoid accidents to a considerable extent.

Display of labor relations' policy and safety rules: This will help in eliminating disputes between labor and management.

Emergency routes and underground services: It is important to display the emergency escape routes on every floor as the building progresses. Locations of underground services should be marked to prevent its damage.

Security:

Entrance: It is necessary to have a proper guard entrance to the site provided by a booth. Also, it is necessary to keep track of all visitors to the project.

Lighting: It is necessary to have a standby generator to maintain site lighting.

Fencing: The boundary should be fenced off from a security point of view.

Accomodation:

On large construction projects, it is necessary to provide camp accommodation for all type of staff involved in the project.

Offices:

The offices should be close together, close to the site, and in a safe area. Also, provide the offices with proper office equipment. The offices at the site may include job office, general contractor office, and sub-contractors and consultants Offices.

Water Supply and Sanitation:

It is necessary to have water and toilet facilities in convenient locations to accommodate the work force.

Material Handling:

One third or more of all construction operations can be classified as material handling. The use of proper equipment for material handling and advance planning for minimizing multiple handling will result in direct cost and time savings.

Storage and site cleaning:

It is necessary to plan and reserve storage areas for materials so that multiple movement of material is avoided.

Laydown areas: Areas reserved for storage of large materials and equipment and it can be short-term or long-term.

Warehouses: They are sheltered storage facilities where materials are stored until they have disbursed to the job.

Material staging areas: They used when materials are stored near the work on a short-term basis. They are generally as close to work as possible.

Site cleaning: It is necessary at a work place and especially where the extent of debris produced is high. Regular disposal of debris is necessary.

Craft Change-Houses:

Craft change-houses provide sheltered space for craft personnel to change and store clothes, wash, and rest during waiting periods.

Batch plant and Fabrication Shops:

Batch plants are provided on projects where it is more economical to produce concrete on site than to buy a ready mix. Aggregate storage piles, cement silos, and admixture tanks will accompany an on-site batch plant. Shops are used where materials and equipment are fabricated on site. This includes electrical, mechanical, carpentry, and paint shops. Also, testing shops used to house the necessary testing equipment and personnel for the project.

7. Safety protection and labour precaution

8.1. Dangerous and harmful production factors during the construction of buildings and structures

According to the system of labor safety standards (SSB), which is the main regulatory and technical base of labor protection, working conditions are characterized by the absence or presence of dangerous and harmful production factors.

The factor of production which influence on the worker leads to an injury is considered dangerous. Harmful is the factor of production, the impact of which on the worker leads to disease.

According to dangerous and harmful production factors are divided into physical, chemical, biological and psycho-physiological.

The group of physical factors includes:

Elevated or decreased temperature, relative humidity and air velocity, causing heat or sunstroke, bronchitis, frostbite, etc. The levels of these factors are regulated in closed production facilities and unregulated - in open construction sites. Characteristic of construction and installation work performed in the cold and transitional periods of the year, processes with a significant release of thermal energy, work on cranes, excavators and more.

Increased or decreased barometric pressure in the working area, which causes caisson disease or external hemorrhage. Characteristic of work in mountain conditions or caissons.

Increased dust and gassiness of the air (prolonged inhalation of dust containing silicon dioxide in the free or bound state, coal, electric welding dust, chromium aerosol; gassing with carbon monoxide, manganese, nitrogen dioxide, etc.), causing damage to organs pneumoconiosis, acute and chronic poisoning, pneumosclerosis, lesions of the mucous membranes, skin tumors). Occur during crushing and transportation of bulk materials, blasting, the use of sandblasting units, mining, stone, asbestos, radioactive ores, electric welding.

The main requirement that determines the reliability of the object is its compliance with the purpose and the ability to maintain the required performance during the estimated service life.

Reconstruction

To ensure the comprehensive safety of construction measures to organize construction production should include:

a) compliance with the requirements for labor protection and all types of industrial safety during the preparation and execution of construction works in accordance with DBN A.3.2-2;

b) maintenance in the process of construction of indicators of strength and stability of structures and foundations of the construction object as a whole and objects of adjacent buildings;

c) observance of safe operating conditions of adjacent buildings in accordance with DBN B. 1.2-12;

d) compliance with the requirements for the performance of construction works in the conditions of the existing enterprise during the reconstruction, overhaul or technical re-equipment;

e) protection of the construction object, adjacent territory and buildings from the influence of adverse natural or man-made factors;

Prior to the dismantling of buildings and structures and their reconstruction or demolition, measures must be taken to prevent the impact on workers of the following dangerous and harmful production factors:

- collapse of structural elements of buildings and structures, falls

loose structures, equipment;

- moving machines and objects moving by them;
- sharp edges, corners, pins;
- increased content in the air of the working area of dust, harmful substances;
- increased noise, vibration in the workplace;
- location of the workplace near the difference in height of 1.3 m and more.

Before dismantling, reconstruction and overhaul, it is necessary to inspect the general condition of the building (structure), as well as the foundation, walls, columns, vaults and other structures, and for superstructures also the condition of the foundations. Based on the results of the inspections, an act is drawn up, on the basis of which a project of construction organization (POB) and a project of works execution (PVR) are developed.

All necessary approvals for the preparatory activities should be made at the stage of development of POB.

For the development of POB and PVR, the customer must provide additional

the project organization the following initial data:

- composition of separate technological sections of the enterprise, possible

the sequence and duration of their stop for reconstruction;

- sequence of disassembly and relocation of engineering networks, places

connection of temporary networks, the list of industrial and sanitary-household

premises provided to construction companies for the period of dismantling, reconstruction, information on areas with high temperatures, gassiness, explosives and flammable substances, with limited working conditions;

- restrictions on the performance of special types of work (driving piles,

gas welding, trenchless pipe laying, etc.);

- locations of structures damaged during execution

construction and installation work can lead to serious consequences and human casualties (fuel and lubricant depots, gas pipelines, power grids, etc.).

The following should be noted in the design and technological documentation

measures:

- choice of method of disassembly, dismantling and installation, superstructure of the building

(buildings);

- determining the sequence and safety of work;

- identification of dangerous areas, use of protective fences;

- temporary or permanent fixing or strengthening of building structures,

disassembled, in order to prevent accidental collapse of structures or parts of the building;

- dust settling;
- occupational safety during work at height;
- determination of the slinging scheme during dismantling of structures and technological equipment. In addition, safety requirements must be specified work provided during:
- performance of works without stopping the main production or with partial stop;
- performance of works during dismantling or reconstruction of internal engineering networks;
- performance of transport works in the conditions of limited production space;
- storage and disposal of materials and structures obtained during dismantling or reconstruction of buildings.

Responsibility for the preparation and implementation of measures to ensure the safety of all employees at the site (shop, building) in accordance with the requirements of NPAOP 45.2-2.01, are equally the heads of construction companies and the existing enterprise.

The developed measures should be coordinated with heads of shops and productions on the territory of which works will be carried out.

The general management of development of measures and the control over performance of construction and installation works should be carried out by the general contracting construction organization, and the measures providing safety of technological process in the shops - the management of the enterprise.

The whole set of measures is approved by the chief engineers of the general contractor construction organization and the enterprise under reconstruction.

8.2. Organizational and technical measures to eliminate harmful factors during the reconstruction and renovation

Construction or reconstruction of the facility must be provided with documentation on the organization of construction and works, without which any work is prohibited.

The project of construction organization (POB) develops labor protection issues related to sanitation of all workers, the organization of the construction site and its artificial lighting, safe location of construction machinery and equipment, the device of temporary and permanent communications, warehouses and construction roads, demarcation and designation of zones of permanently and potentially operating dangerous production factors, etc.

In the project of carrying out works (PPR) questions of labor protection are specified and worked out in detail on the concrete object under construction.

The most important issue of labor protection in construction master plans and technological maps is to determine the boundaries of areas that may be with permaAreas with permanent hazardous production factors (close to uninsulated live parts and unfenced differences in height of 1.3 m or more; in places where harmful substances are kept in concentrations above the maximum allowable) to prevent access by unauthorized persons should be protected fences.

During the production of construction and installation works in these areas, it is necessary to take organizational and technical measures to ensure the safety of workers.nent or potentially dangerous hazardous production factors.

Zones with potentially dangerous production factors (zones of movement of machines and equipment or their parts of working bodies; places over which there is a movement of cargo by cranes; sites of the territory near the constructed house, floors of buildings and constructions in one capture over which there is an installation or movement of cargo) are fenced off by a signal protection.

Boundaries of danger zones within which danger may arise due to falling objects.

8.3. Ensuring fire and explosion on construction site

At each site, the employer creates and is responsible for the operation of fire safety.

The person responsible for fire safety of facilities under construction, reconstruction, technical re-equipment and construction sites, timely implementation of fire safety measures, provision of fire extinguishing means, organization of fire protection and work of voluntary fire brigades is the supervisor from the general construction organization (or a person who replaces it).

Responsible for fire safety of individual construction sites, availability and proper maintenance of fire extinguishing means, timely implementation of fire-fighting measures provided by the project are (appointed by order) supervisors of works at these sites.

Fire safety measures

Persons of engineering and technical staff who have studied the designed device, instructions and passed the test on safety and fire safety are allowed to work with the designed object.

Fire safety of the object must be ensured:

- fire prevention system;
- fire protection system;
- organizational and technical measures.

Dangerous factors of fire that affect people are:

open fire and sparks; elevated temperature of the environment, objects, etc .; toxic combustion products; smoke; reduced oxygen concentration; falling parts of building structures, units, installations, etc .; dangerous factors of explosion.

Requirements for the fire prevention system

Fire prevention should be achieved in two ways:

- preventing the formation of a flammable environment;
- preventing the formation in the fuel environment (or introduction into it) of ignition sources.

Prevention of the formation of a fuel environment must be provided:

-the maximum possible use of non-combustible and non-combustible substances and materials;

-limiting the mass or volume of fuels, materials and the safest way to place them;

-maintaining the concentration of fuel gases, vapors, suspensions or oxidants in the mixture outside of their ignition;

-sufficient concentration of phlegmatizer in the air of the protected object (its component);

-maintaining its temperature and pressure, at which the spread of flame is excluded;

-maximum mechanization and automation of technological processes associated with the pumping of fuels;

-installation of fire-hazardous equipment if possible in isolated premises or in open areas;

-application of devices of protection of the production equipment with combustible substances against damages and accidents, installation disconnecting, cutting off and other devices;

-using insulated compartments, chambers, cabins, etc.

Prevention of ignition sources in the fuel environment must be achieved:

-application of machines, mechanisms, equipment, devices, during the operation of which ignition sources are not formed;

8. Environment protection.

8.1. Substantive provisions.

Pollution is an issue that the construction industry cannot ignore. The main types of pollution you need to be aware of are air, water and noise. If you don't put precautionary measures in place to manage harmful waste, it can directly affect site employees and people living nearby. This includes causing irreversible damage to their health, with a concerning link between pollutants and cancer.

Air Pollution

Air pollution refers to man-made emissions that are released into the atmosphere. Poor air quality is a global health hazard, responsible for approximately 4.2 million premature deaths in 2016. Further, air pollution contributes significantly to the warming of the planet, and therefore to climate change.

As construction activities are a large contributor to air pollution, organisations within the sector have a shared responsibility to limit the amount they produce. Therefore, you'll need to have an awareness of the emissions your work activities create and take precautions to limit the harmful impact.

Common construction activities that contribute to air pollution include:

Use of plant and vehicles on site. This depends on the site activities but can include machinery such as breakers, bulldozers, dumpers and excavators. Plant and machinery that is used at construction sites is not regulated by the government to the degree that other vehicles are. Due to the scale of many construction projects, equipment is often running and polluting for a long time. As a lot of this heavy machinery, and other vehicles on site, operate on diesel engines, they release pollutants into the air. This includes the gases carbon monoxide, carbon dioxide, nitrogen oxides and hydrocarbons.

Land clearing and demolition. As land often has to be cleared and made suitable for construction to take place, this process must be done in a way that ensures the impact on the environment is as minimal as possible. As well as with the

construction of buildings, high levels of dust are generated when land is disrupted and existing buildings demolished.

Chemicals. It is likely that you will use hazardous chemicals on construction sites. This may include paints, glues, oils, thinners and plastics, which all produce noxious vapours.

Here, we explain the different types of pollution that may be produced as a result of construction activities and suggest ways you can manage and reduce your contribution.

Water protection

Water pollution happens when toxic substances end up in water bodies such as rivers, lakes and oceans. This pollution may be visible, either on the surface or deposited on the bed, or invisible to the human eye, such as chemicals that dissolve in water. Construction activities often involve the use of toxic chemicals and pollutants that can end up in the water table if not managed well.

Common construction sources that contribute to air pollution include:

- Diesel and oil.
- Cement.
- Glues.
- Paints.
- Other toxic chemicals.

All of these contaminants have the potential to end up in water as a result of runoff from construction work. Pollutants can enter the water system in a number of ways, such as through drains, seeping into soil, or runoff directly into rivers or lakes.

Water abstraction from the surface of water bodies within the city is usually carried out for technical water supply, irrigation of urban areas and firefighting.

For centralized water supply use water bodies that meet the standards and requirements for sources of drinking water supply and are located in environmentally friendly areas. The water intake of the Kyiv water supply system is located on the Desna River, 12 km from Kyiv.

Within the city, water intake for drinking purposes from surface water bodies is carried out in exceptional cases. These can be artificial water bodies - canals or reservoirs, specially designed for drinking water supply, in which other types of water use are prohibited.

8.2 General water treatment facilities

The water entering the city drainage system is a mixture of domestic and industrial wastewater. According to the drainage system, these waters are fed to citywide treatment facilities. The full complex of citywide treatment facilities includes units: mechanical and biological treatment, post-treatment, disinfection, sludge treatment.

Mechanical treatment removes large inclusions, suspended and floating impurities from wastewater. The mechanical cleaning unit includes gratings, sometimes with crushers, sand traps, pre-aerators and primary settling tanks.

Lattices are intended for catching of the big inclusions which if necessary are crushed in crushers. On the lattice is achieved almost complete extraction from wastewater of large inclusions that are treated. Extracted large inclusions are taken to the landfill.

In sand traps, which are containers of a certain size, due to a sharp decrease in the flow rate of the liquid to be cleaned, there is a deposition of suspended solids. Approximately 40-60% of small mechanical impurities are removed from wastewater in sand traps. From sandstones sludge is fed to sand sites. After drying, it can be used for planning work.

In the pre-aerators there is a primary saturation of wastewater with oxygen by supplying compressed air, which significantly improves the process of biological treatment. Dissolved oxygen is practically absent in wastewater coming from drainage systems. The mixing of treated water with air bubbles promotes the separation of various floating impurities, which occurs in the primary settling tanks. The degree of removal of floating impurities is 60-80%.

Emerging impurities are collected in barrels with special scrapers and sent for regeneration or incineration. Of the biological treatment facilities, aeration tanks were the most widespread. They are reinforced concrete elongated tanks, where the contact of treated wastewater with activated sludge while saturating them with oxygen.

Active is a specially cultivated community of microorganisms, which are fed by organic matter contained in wastewater. The degree of destruction in the aeration tanks of organic substances subjected to biochemical oxidation is about 90%.

The treated wastewater in the aeration tanks enters the secondary settling tanks, where the activated sludge that got here from the aeration tanks together with the water settles. Microorganisms of activated sludge during sedimentation adsorb with their scaly surface small suspensions remaining in the treated wastewater after passing sand traps and primary settling tanks, as well as heavy metal ions. The degree of extraction of metals due to adsorption by microorganisms ranges from 10 to 60%.

After the settling tanks, wastewater is considered to have undergone biological treatment and can be discharged into surface water bodies. Before discharging, they must be disinfected by treatment with chlorinated water. After chlorination, the water must be degassed, because the impact of active chlorine in the water body can lead to the death of fish. Degassing of water occurs in canals and rapids by passing from the place of chlorination to the place of release into the water body.

9. Scientific-Research part

9.1. Introduction.

Methods of strengthening building structures and facilities.

Reconstruction of a building or structure is accompanied, as a rule, by a change in loads on building structures, a change in their primary structural schemes. All this leads to the need to determine the technical condition of building structures, to determine the residual life of their performance, to decide on their future fate, to strengthen, restore or replace.

The need to strengthen or restore building structures arises not only during reconstruction or technical re-equipment, but also due to premature corrosion or mechanical wear, various damages and defects, and so on. All this arouses increased interest in the problem of strengthening and reconstruction of existing building structures.

The long life of buildings leads to their aging: the loss of buildings and their elements of initial performance (strength, stability, etc.), which is characterized by the concept of physical wear of buildings and their structures.

During the operation of buildings, repair works to some extent prevent the increase of wear of structures and elements of the building, but the process of wear is continuous and there comes a time when the cost of repairs becomes impractical. To ensure further normal operation of the building, it is necessary to perform its reconstruction with replacement or reinforcement of non-seeded structures.

In addition to the physical also define the concept of moral deterioration of the house or building.

The moral deterioration of a building is characterized by the loss of its technological, sanitary and hygienic qualities in accordance with current building codes and the needs of society.

Compared to new construction, reconstruction is characterized by the presence of some specific factors that affect the performance of construction work. They are caused by:

• the existing territory of the reconstruction site and its development;

• spatial planning decisions of the reconstruction object;

• new types of reconstruction works;

• specific environment;

• requirements for the norms of operation of buildings that are being reconstructed.

The construction site of the reconstruction is defined as limited conditions for storage of structures and placement of construction machines and mechanisms; the presence near the buildings and structures of roads, passages, underground and terrestrial engineering networks in operation. Limited conditions for storage of materials and placement of machines complicate the supply and use of building structures and machines with large dimensions.

Buildings, structures, roads, passages and utilities located near the reconstruction site must be eliminated from the destructive and dangerous effects of reconstruction works by taking special protection measures or using appropriate safe technologies.

Reconstruction of buildings requires work that is not usually used in new construction: it is work on the demolition and dismantling of buildings and structures by methods of destruction, breakage, cutting, work on temporary or permanent reinforcement of structures.

Reconstruction of industrial enterprises is mostly carried out in a specific environment due to their technological process.

Elevated air temperature, its gassiness, dust, increased noise level of the main production significantly affect the timing of reconstruction and quality of work, as these factors cause increased fatigue of builders and their need for personal protective equipment, and sometimes the impossibility of application. certain construction technologies.

During the reconstruction works in the houses, Ido are operated, requirements are set to ensure safe and comfortable operation of the buildings and the conditions of unimpeded carrying out of the main technological process in them. At the same time,

the execution of construction works should cause an increased level of noise, gassiness, dust, and vibration. Reconstruction must be performed as soon as possible.

Specific factors of reconstruction limit the use of modern technologies of construction works, reduce production and increase the cost of reconstruction. A significant number of specific conditions of reconstruction determines: its difference from new construction and the need to take them into account when choosing constructive solutions for reconstruction and technological methods of work.

Improving the efficiency of reconstruction is achieved by agreeing on design solutions and technological methods of reconstruction work at the stage of project development, for which design and construction organizations are created.

Metal constructions of constructions of industrial, civil, transport purposes during operation are exposed various operational factors - load, temperature, aggressive environment, resulting in reduced load-bearing capacity of structures, durability is reduced.

One way to recover and, if necessary, increase the load-bearing capacity of building structures is their strengthening. It is possible to say that the strengthening of building, including metal, structures is an integral part of the processes of construction and operation of buildings and structures for various purposes.

To the most common reasons for the strengthening of metal structures can include:

• damage to metal structures, which led to their reduction bearing capacity, rigidity, crack resistance;

• change in operating conditions of metal structures;

• change of the settlement scheme of metal designs;

• the need to increase the reliability and durability of metal structures;

• errors in the design, installation and operation of metal structures.

Issues of predicting the bearing capacity and durability of metal structures subject to corrosion destruction are considered in works.

To strengthen metal structures, traditional methods including increasing and increasing the cross-sections of elements, installation additional elements in existing structures, the device of additional supports and struts in order to change the structural diagram of elements, the device of additional ties, ribs, diaphragms and struts to increase local and overall stability metal structures, concrete coating of metal structures and other methods.

Recently, to strengthen metal structures, more and more steel apply modern methods of strengthening based on the use of reinforced fibers of polymer materials (composite or composite materials or, in short, composites).

In the literature, composite materials reinforced with glass fabric, aramid or carbon fibers, called composite materials with fiber - CMF, or fiber-reinforced plastics - FAP. The most widespread are CFRPs, i.e. composites reinforced with carbon fiber.

External fiber-reinforced plastic reinforcement is used to reinforce rod stretching and bending elements to create reinforcing reinforcing shells on columns and supports, to strengthen elements of trusses, overpasses, plates, shells and other designs.

When designing the reinforcement of metal structures using for fiber-reinforced plastics, the residual load-bearing capacity and the rigidity of the elements being reinforced. To estimate the efforts in the elements reinforced structures and in the elements of the reinforcement itself, it is necessary to use data obtained during the examination, which must necessarily precedegain.

When calculating reinforced structures, the method of limiting states, developed in Ukraine and later received wide distribution in the world under the name of the method of partial coefficients.

The calculation for the first group of limiting states is performed for all structures, reinforced with fiber-reinforced plastics. For the second group of limiting states, the calculation is performed if, after amplification, the calculated load increases. When calculating reinforced fiber-reinforced plastics metal structures are usually considered

several possible schemes of destruction and occurrence of limiting states of enhanced element.

Since the calculation can be carried out for several combinations of loads, then usually an iterative approach is used - that is, it is initially tentatively assigned, or the cross-sectional area of the reinforced plastic is determined for one of the loading options, and then this cross-sectional area is adjusted according to the results of the checks corresponding limiting states.

The deformation diagram of fiber-reinforced plastics is linear relationship between stresses and strains almost to failure, therefore, Hooke's law is used to model the behavior of reinforced plastics.

When it should be borne in mind that the properties of fiber-reinforced plastics depend on the type, the number and orientation of the reinforcing fiber fibers. In this case, you also need to take into account
that fiber-reinforced plastics are usually orthotropic materials, and their
the coefficient of linear expansion differs from that for reinforced metaldesigns.

A very important condition for the reliable operation of metal structures, reinforced with fiber-reinforced plastics, is the observance of structural requirements that are integral to the design.

Quite a common cause of the appearance and development of damage metal structures is also lack of monitoring of their condition, as well as almost complete absence of operating systems.

Due to many reasons, steel structure may be repaired. So, there are many methods to repair steel structures. So, there are many methods to repair steel structures. This may depend on location of the crack, type of crack, type of repairing work etc. So, in this portion of this article, causes of repairing, methods of repairing work, some practical examples and recommendations are included. So, some reasons which are liable to such type of repairing work are discussed below:

Fatigue. The main cause of fatigue is the creation of cracks in members or connections of steel structures. It can be caused due to cyclic service loading. Figure

1 shows the development of fatigue situation in I-beam. This picture (Figure 1) also shows the fracture surface of an I-beam flange created by fatigue-cycling.

Fracture. Fracture is a common phenomenon of steel structures. It is occurred when the rapid extension of the crack is happened. Fatigue and fracture are different. The large extension of World Scientific fatigue may cause fracture. The fracture of the members of steel structures may cause total collapsion of this structure. When the loads are applied at the first time of the steel structures then the fracture can be caused. The following picture shows the fracture surface of a bridge in Cherokee country, Iowa.

The top part shows the actual fracture surface where the horizontal element is the bottom girder flange, and a vertical element is the girder web. It is possible that fractures can occur directly without previous fatigue crack growth after years of service as was the case in the Hoan Bridge.

Brittle fracture can occur at high constraint details with little or no warning impending fracture. For example, in 1967, the Point Pleasant Bridge over the Ohio River in West Virginia, commonly referred to as the Silver Bridge, collapsed due to brittle fracture of one of the non-redundant eye bars supporting the main span suspension system. Figure 2 shows the girder flange fracture from Cherokee County, Iowa Bridge.

Rough holes. These are observed in truss members during ultrasonic testing and inspection. This is clear indication of the starting of fatigue cracks. When at a specific point, the connection is required in steel structures, then a hole is drilled. This is called open holes. 2. 4.

Hole Drilling. Hole Drilling is another famous method for repairing work. The main objective of this method is to remove the sharp notch at the crack tip. Several methods are used for repairing of steel structures. The choice of method depends on the location of fatigue cracking and may depend on the availability of certain skills and tools from local contractors who would perform the repairs. 2. 5.

Surface treatment. The effective and commonly used surface treatment for repairing of steel structures is hammer peening. This treatment is also easiest and

least expensive. repair of shallow surface cracks up to 1/8 inch (3mm) deep. And this treatment can also be applied on the welds.

Grinding. Grinding is another popular method for repairing of steel structures. This is also used to create a nice finish of the joints or welds of steel structures. It is mainly used to remove portions of a detail containing small cracks at any location of steel structures. Under cyclic loading, these cracks may turn into fatigue cracks. So, there grinding is needed to repair this. Especially in the field of offshore engineering, structures with tubular joints, where the welds are very large, grinding is effective in shaping the weld and by reducing the associated stress concentration factor, it is enhancing the fatigue strength. There are two types of grinding. They are:

Disc grinding and Burr grinding. Disc grinding is a circular type of instrument which is an effective means to remove metal. However, if the grinder operation is not careful, too much material may be removed. The goal of the grinding is to remove a small amount of material.

9.2 Methods for Strengthening Metal Constructions

Nowadays a great concerning issue is to retrofit buildings, bridges and other structures seismically as to increase the plastic deformation capacity in the conneTo distribute the vertical force which is generated for the buckling of braces a frame was proposed by is known as zipper frame. Later, Leon and Yang (2003) proposed a suspension zipper frame in which top story frames were designed elastic and all others considered to buckle, such frames were made with inverted v-brace with zipper columns. As a substitute of moment resisting frame a new system was introduced by Christopoulos et al] which is known as Self-centering system.

This system is a way of limiting the seismic effect economically, also reduces the damage and helps to regain its original shape after the earthquake. Steel plate shear walls are used in the beam to column connection to prevent the premature failure of columns.

The connection of SPSWs is done with bolt or weld in the beam and column joint, the role of this connection is to transfer tension and shear. Steel truss structures are popular day by and the weakest point in this system is the joint of the member, though this joint is made by bolt, it acts as a weak section. To overcome from this kind of problem energy dissipation devices has been added which can control the wave And the vibration effect which can increase the strength of load path. actions of the structures.

Strengthening is such a kind of method where this is helped to increase the load bearing capacity and update the steel structures. So, in this portion of article, different methods of strengthening are discussed. By welding additional angle shape profiles, The K type braced frames were strengthened to the diagonal members of this K bracing frame.

This strengthening method is increased the cross-section area and reduced the bulking probability of pre-existing K bracing members. Another method of strengthening and updating of the steel structure is to create beam-column joint between existing beam and existing column. It helps to increase the loading capacity of steel structure.

Welding additional plates on both sides of existing columns is used for strengthening. This technique has helped to increase the load bearing capacity of steel column. A mat foundation is considered as a large concrete slab is to carry many columns in several lines with base soil. At the type of low bearing capacity of base soil and higher column loads, then the mat foundation is suggested. It may go excessive settlement because of this reason. So, strengthening is required for this.

On the other hand, an increase in the acting loads on metal structures, in in particular, an increase in the load from the rolling stock and the intensity of its movement on bridges may require reinforcement of existing metal bridge structures.

In this case, it may turn out that the costs associated with the strengthening of the exploited metal structures will be less than the costs required for dismantling, reconstruction or replacement of an operated structure.

To strengthen metal structures in order to increase their load-bearing

abilities are usually applied to metal plates, plates, for attaching which are bolted or welded. However, this method has a number of disadvantages. Metal lining leads to an increase in the dead weight of the structure, they are subject to deterioration from corrosion and fatigue. Can often be difficult welding them to the reinforced elements.

In addition, the strengthening of the metal structures of transport structures, in operation, may lead to the need to limit or even stop traffic for the period of repair work.

It is most effective to carry out small reconstruction in general without replacement or strengthening of designs, using only reserves of bearing capacity of a framework and its elements. The bearing capacity of the stored structures is assessed both from the standpoint of the presence of reserves and from the standpoint of the actual bearing capacity, taking into account the defects and damages noted during the inspection.

Identification of its reserves can be carried out by: - clarification of the forces acting in the overstressed elements, by taking into account the spatial work of the frame; the actual conditions of connection and fastening, taking into account the actual values of loads, actions and their combinations; - specification of strength characteristics of the material of structures and joints, the actual dimensions of sections and elements; - inclusion in the work of fencing structures or other auxiliary elements of buildings and structures.

To this end, it is recommended to take measures to improve the working conditions of load-bearing structures, such as: - study of the possibility of reducing the loads acting on the whole building or its individual elements (crane tracks, changing the configuration of the roof to reduce "snow bags", measures to combat the deposition of industrial dust, etc.);

Reducing the load from the weight of the fence structures by replacing them with lighter ones, especially in cases when the replacement of the fence structures is associated with their unsatisfactory condition. Measures to reduce crane and other technological loads should not worsen the conditions of the main production and

should be agreed with the service department, including methods and techniques for controlling the level of loads.

The identified reserves allow to reduce the volume of reinforcement work, and in some cases even to abandon it.

At inspection establish the actual sizes of sections which can differ from design due to tolerances of hire and replacement of calibers of profiles and grades of steels at production, specify properties of steel and loading.

In the transition from the structural scheme of the frame to the design is not fully or not taken into account a number of factors that affect the operation of structures. Such factors include the redistribution of efforts by taking into account the spatial work of the frame; the actual operation of the connection of the crossbar with the column; flexibility of the base; inclusion in the work of rafter trusses roofing.

The account of spatial work of a skeleton allows to allow in some cases increase of loadings of cranes on a frame without its strengthening. In the transverse frames, incorrect accounting of the nature of the connection of the crossbar with the column can give both underestimated and overestimated the value of the calculated moments for the cross sections of the crossbar and the column. Taking into account the rotation of the foundations can reduce the bending moments at the base of the column up to 60%, but the horizontal displacements at the level of the crossbar will increase 1.15 times against the theoretical values calculated under the assumption of rigid clamping of the column. The unloading effect from the inclusion of the roof truss roofing can reach 15%.

Reinforcement of structures and their elements can be performed in one of the following ways.

1. After dismantling of structures or their separate elements which are subject to strengthening. This method is used either when restoring structures after an accident, or to reinforce individual structural elements, the dismantling of which can be performed relatively easily and without damage to the main load-bearing structure (for example, when reinforcing crane girders).

2. Without dismantling of designs after their unloading from all temporary and constant loadings (except for own weight of a design). An example is the reinforcement of rafter trusses in the design position after dismantling the roof and roofing.

3. Without dismantling of structures in a tense state. A special case of this method is the partial unloading or loading of structures at the time of reinforcement by means of jacks, mounting loads, tensioning devices or other devices in order to regulate the forces in them. Reinforcement of structures in a tense state is usually economically more profitable and technically feasible, as pre-unloading necessitates partial or complete cessation of production processes in the building, additional costs for dismantling structures and extending the production period.

Often reinforcement is required not by the structure as a whole, but only by the most tense or defective parts, elements or components, which confirms the feasibility of reinforcement under load. To increase the load-bearing capacity of structures and ensure their reliable operation, the following methods of reinforcement can be used: - increasing the cross-sectional area of individual structural elements; - change of the constructive scheme of all framework or its separate elements. as a result, the calculation scheme changes; - voltage regulation.

Each of these methods can be used alone or in combination with another. When choosing a method of reinforcement and design of reinforcement must take into account the requirements of installation technology.

At constructive registration of strengthening by increase in sections it is necessary:

- to ensure reliable joint operation of reinforcement elements and reinforced structures, in particular requirements for local stability (dimensions of overhangs, bends) and non-curvature of sections (installation, if necessary, of ribs, diaphragms, etc.);

- not to make decisions that make it difficult to carry out measures for corrosion protection, especially those that lead to crevice corrosion or the formation of closed cavities, using, if necessary, sealing cracks;

- to appoint places of breakage of elements of strengthening from a condition of work of not reinforced sections at action of settlement loadings in an elastic stage, without allowing sharp concentrators of tension in the specified places;

- take into account the presence of structural design of assemblies, stiffeners, gaskets, etc., as well as the admissibility of increasing the dimensions of building structures;

- to ensure the manufacturability of reinforcement works, in particular the availability of welding, the possibility of drilling holes, tightening bolts, etc. When reinforcing structures by changing the structural scheme must: - take into account the redistribution of forces in structures, elements, components and supports, including additional inspections of foundations;

- take into account the temperature difference, if the existing and new structures can be operated in different temperature regimes, as well as the temperature regime when closing statically indeterminate systems; - to provide in constructive decisions of elements and knots a possibility of compensation of a mismatch of the sizes of existing and new designs.

The method of strengthening the structures, which provides for the regulation of stresses, allows to reduce the forces acting in the structure. Its advantage is also that the reinforcement can be carried out without unloading the structure and stopping the process.

Reinforcement elements must be designed, usually focusing on their complete manufacture in the factory. In special cases, the manufacture of reinforcement parts with allowance and subsequent processing at the installation site is allowed. The connection of reinforcement parts to the structures is performed by welding, on bolts of accuracy class A and B or high-strength bolts.

The steel used for reinforcing elements, as a rule, should not concede on quality of metal of the strengthened designs (on mechanical properties, viscosity and weldability). When reinforcing structures operated in aggressive environments, the

corrosion resistance of the metal of the reinforcement elements must not be lower than the resistance of the metal of the reinforced structure.

At insufficient bearing capacity of separate elements, designs or houses and constructions their strengthening is carried out, thus, as well as at designs from other materials, it is necessary to provide the minimum losses because of stops of a technological cycle.

Elements of welded structures that experience tension, compression or bending can be reinforced by increasing the cross sections by welding new additional parts. The bearing capacity of the element increases with increasing cross section or stiffness. However, heating the element during welding can reduce its load-bearing capacity. The degree of reduction depends on the welding mode, the thickness and width of the element, the direction of welding. For longitudinal seams, the decrease in strength does not exceed 15%. for transverse can reach 40%. Therefore, the imposition of seams across the element when it is strengthened under load is strictly prohibited.

Due to some loss of strength of the elements during welding, as well as the redistribution of stresses in the cross section of the element and between the elements of the reinforcement under load produce at a voltage not exceeding 0.8Ry, where Ry - Estimated resistance for the steel from which it is made element.

Strengthening of compressed racks

An effective means of strengthening compressed steel rods is the use of pre-stressed telescopic tubes and elements made of other rigid profiles.

The essence of the method is that the unloading pre-stressed rack consists of two pipes of the required diameter, with the inner pipe compressed and the outer stretched.

This is achieved as follows: the outer pipe is installed in a horizontal position, from one end of the pipe welded flange with a central hole with a diameter of 30 ... 40 mm, from the other end at a distance of 2 ... 3 m strictly along the axis of the outer pipe set the inner pipe slightly smaller diameter so that it can enter the outside with a small gap.

Then the gas burners heat the outer tube to the calculated elongation, enter the inner tube and scald around the perimeter of the free end. Reducing during cooling, the outer tube compresses the inner. In this form, the pre-stressed element is installed next to the reinforced rack and tightly wedged under the unloading structure. Then, with two gas burners, the outer tube is cut in a circle in the lower part, thus releasing the prestressing force in the inner tube.

Extending, it unloads a nearby rack. After that, the outer pipe in the cross section of the cut is welded and able to absorb part of the additional load on the column (rack) after reinforcement. This method can also be used when reinforcing centrifugally compressed elements.

An effective way to increase the rigidity of the frames of industrial buildings is the device of pre-stressed rods and braces. However, distractions require massive anchor devices, increase the building area, and they increase the compressive force in the columns. More efficient strands that attach to adjacent stable buildings. Tension of such puffs is carried out by mechanical, electrothermal or combined way, and control of efficiency of strengthening - on reduction of shifts of the top knots of a skeleton at horizontal loadings.

Increasing the rigidity of the longitudinal and transverse frames can be achieved by installing cross diagonal rigid ties, and when this is not possible - rigid struts (crossbars) in combination with diagonal braces.

An effective way to increase the strength and rigidity of metal crossbars - bringing under them rolled or welded beams with welding under load in the heated state.

With the limited dimensions of the premises reinforcing beam is installed on top, open the floor and weld it to the top shelf of the reinforced crossbar in a pre-stressed state. Reinforcing beams in the first and in the second cases start and rigidly fix in frame knots.

Increasing the load-bearing capacity of the rafter beams and crossbars of the floor can be achieved by a device of solid reinforced concrete flooring, rigidly connected to the upper belt of the beam. In this case, the rigidity of the crossbar is

significantly increased, and it can be considered as a T-shaped reinforced concrete beam with rigid reinforcement.

Most often, compressed steel elements require reinforcement. The traditional way to strengthen them is to increase the cross section by welding strips, corners and other elements without prior stress.

However, this method of reinforcement has a significant disadvantage: the reinforcement elements are included in the work late, welding of these elements causes additional deformation in the compressed racks, which reduces the gain efficiency.

Therefore, traditional methods of reinforcement are used if the temporary load on the racks is at least 40% of the constant and during the reinforcement work it is absent.

Reinforcement of steel struts by unstressed elements is carried out by increasing their cross section and reducing their free length, while striving to maximize the radii of inertia of the cross section. When performing load reinforcement on the rack should not exceed 60 ... 60% of the estimated.

With low flexibility of the reinforcing element, it is necessary to reduce the eccentricity from shear, and with flexibility $\lambda > 80$ - to increase its stability.

The connection of the reinforcement elements is carried out mainly by welding. The welding deflection for elements that are amplified under load is a loading factor, so first the reinforced element is welded by spot welding, and then impose the main seam. At the same time preference should be given to keyway (intermittent) seams, which reduce the deformation of the elements, reduce the time of welding and reduce the weight of the weld metal.

Reinforcement of beams

Reinforcement of metal beams is carried out by increasing the cross section, it is necessary to unload them by at least 60% or install temporary additional supports. When designing reinforcement, the following technological rules must be observed: the amount of welding should be minimal, welds should be located in convenient accessible places, ceiling welding should be avoided, first the lower belt should be

reinforced, and then the upper, which eliminates beam deflection at the time of reinforcement.

The simplest way of strengthening - symmetrical overlays, however thus there is a need for a large volume of ceiling welding. With a large width of the lower cover, you can avoid ceiling seams, but its width should not exceed 506, otherwise there is a significant concentration of stresses at the edges of the beam.

Check the strength and stability of the reinforced beam is made as a solid section, as the critical force does not depend on the magnitude of the stress that existed before the reinforcement.

To increase the local stability of local areas of the beam wall set on these sections short stiffeners, bordered by their longitudinal ribs.

An effective way to strengthen the solid beams are tensioning devices that provide a stable value of the prestress, which does not depend on the pliability of the anchors and puffs. Such methods allow you to adjust the prestressing force in the lower belt of the beam. One of the gain options is presented.

The spacer elements are made in the form of sectors with sockets that form with the axis of the split hinges located between the beveled ends of the expanding beams, the tensioner of the required mass is placed inside the column. This method is most effective in strengthening the crane girders, as it requires minimal labor and material costs.

Reinforcement of truss elements

Reinforcement of steel trusses is carried out by lining new structures, introduction of additional elements of a lattice, change of the scheme of a design and increase in sections of separate elements. The choice of one or another method of reinforcement depends on the reasons that caused the strengthening of the rafters.

Supply of new structures is carried out in the event that other methods of reinforcement do not give the desired effect and if the conditions of production allow the installation of additional intermediate racks.

Additional lattice elements are introduced to reduce the flexibility of the rods in the plane of the truss, to strengthen the upper belt of the truss to local bending, as well as to increase the rigidity and load-bearing capacity of the truss as a whole.

Reinforcement of the lower belt is carried out, as a rule, by increasing its cross section. The upper belt is reinforced with a sprung lattice.

An additional cross lattice is installed to increase the load-bearing capacity and rigidity of the truss as a whole. In this case, the truss becomes a statically indeterminate system and there is a danger of redistribution of forces in the elements of the lattice (stretched elements feel the compressive force, and vice versa).

Therefore, sometimes there is a need for additional reinforcement of individual elements of the lattice.

The most common nature of damage to trusses - the curvature of the bars of the lattice, which reaches 50 ... 70 mm. In this case, increase the cross section of the lattice or install pre-stressed elements that reduce the curvature of the lattice elements.

A significant increase in the load-bearing capacity of the truss can be achieved by installing a third belt (sprung system) within the height of the truss or (if the height of the room allows) by fixing it in the lower support nodes. This reinforcement does not require additional supports and can be made of high-strength ropes (bundles), providing a minimum material consumption of reinforcement. The racks of the sprung system are made of rigid profiles. The unloading of the existing truss is carried out by prestressing the third belt, so its cross section must be sufficient to absorb the maximum stresses at full load of the truss.

The forces in the various structural elements are summed from the forces arising from the pre-tension of the third belt, as well as the forces in the statically indeterminate reinforced structure from all loads applied after reinforcement.

One of the ways to strengthen the trusses is the superstructure of hanging (cable) systems, which are suspended reinforced structure. This method is especially effective if the cables can be hung next to taller and more stable structures.

Strengthening of trusses can be achieved by including in their work light-aeration lamps. This method is most effective when placing the lights not in the middle of the span, but above the columns in two- and multi-run shops.

The main methods of strengthening truss trusses are largely similar to the considered methods of strengthening beam structures. Reinforcement of trusses by changing the structural scheme can be done: - supply of additional supports (Fig. 9, a), which greatly reduces the effort in all rods, except for the two middle braces (the use of the scheme is very limited);

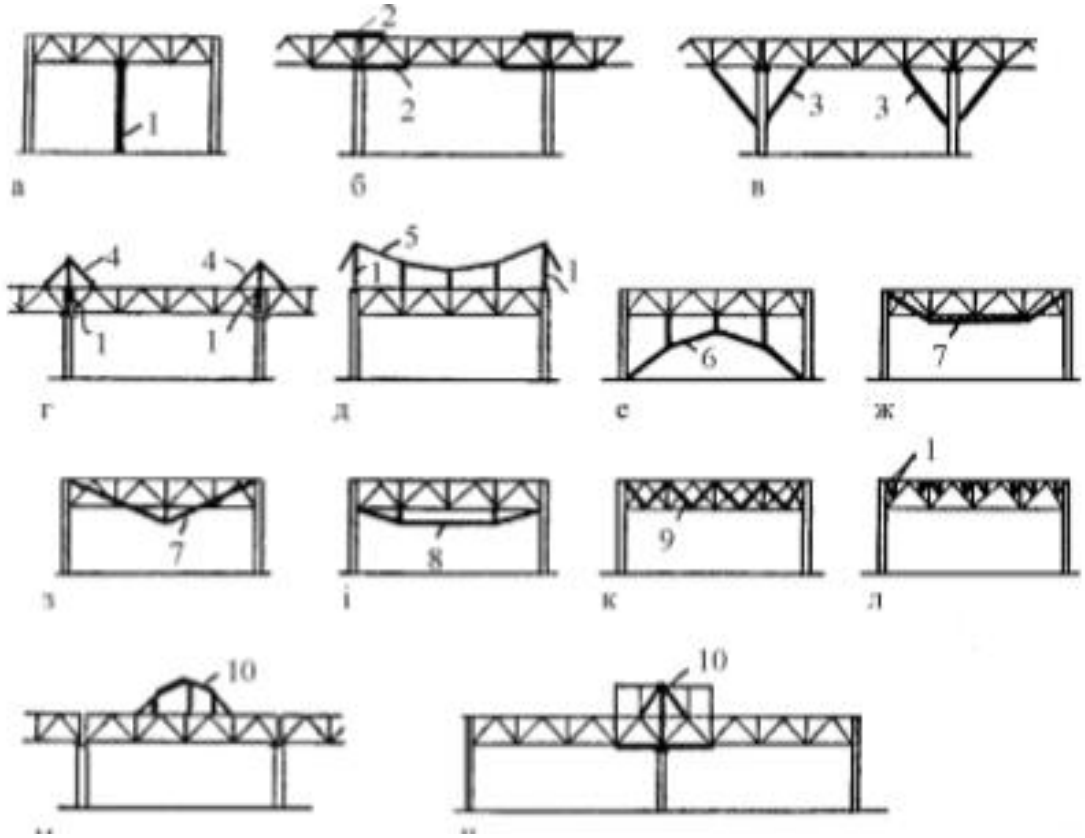


Fig. 9 - Reinforcement of rafter trusses by changing the structural scheme: a-n - reinforcement scheme; 1 - additional support; 2 - details of strengthening of basic knots; 3 - brace; 4 - suspension brackets; 5 - bearing thread; 6 - flexible arch; 7 - sprung; 8 - tightening; 9 - additional elements of the farm; 10 – lantern

- "self-counting" of hinged units of support of trusses on columns (fig. 9, b) and their transformation into long-span (application of the scheme demands dismantling of a roof); - introduction of struts (Fig. 9, c) or suspensions (Fig. 9, d);

- installation of supporting cable systems (Fig. 9, d) or arched structures (Fig. 9, e); - supply of sprung elements (Fig. 9, w, c) or setting puffs (Fig. 9, i) on the lower belt (the scheme is rational when used for puffs of high-strength elements); - the introduction of additional (Fig. 9, k) and sprung (Fig. 9, l) elements in the lattice of the trusses (the use of the scheme reduces the calculated length of the belts, but does not affect their stability from the plane); - inclusion in work of lantern designs (fig. 9, m, n).

The scheme is used when it is difficult to work inside the building, requires strengthening the risers and struts of the lantern. Reinforcement of trusses can be performed by installing additional vertical ties along the entire length of the pavement or horizontal ties and struts that reduce the calculated lengths of the belts. When strengthening rafter trusses by increasing the cross section of the rods should strive to maintain centering in the nodes of the trusses.

When reinforcing compressed rods, it is advisable to arrange the reinforcement elements so as to maximize the radius of inertia of the section, and they can not be wound on the shapes, if the strength of the unreinforced section. The reinforcing elements of the stretched rods are wound on the shapes to a length sufficient to transmit the perceived part of the force. When reinforcing rectilinear rods by increasing the cross sections (Fig. 10) for compressed rods most rational schemes "a", "c", "d".

Convenient scheme "b", because the seams are performed in the lower position, but significantly shifts the center of gravity of the section and, in addition, if necessary, to start the angle of reinforcement on the shape (for example, when reinforcing braces) it is necessary to arrange a slot. The use of schemes "b" and "e" to strengthen the upper belt may not be possible due to the resistance of the beams or paneling.

When reinforcing curved rods can be used schemes "l" and "m", which do not require adjustment of the reinforcement elements. Reinforcement of welds in the fastening units of the rafter truss rods can be performed in necessary cases with the use of additional shapes (Fig. 11, a, b).

Reinforcement of riveted trusses should be carried out by welding (if the quality of the metal allows and the seams will absorb all the effort) or by transmitting the force to the corner short and then to the shape through the bolts of accuracy class A (Fig. 11, c).

9.3 Features of the calculation of metal structures during reinforcement

When calculating structures that are reinforced under load, it is necessary to take into account the stress levels in the existing elements and the sequential inclusion of additional parts, as well as initial and additional deformations of the main structures that occur during the reinforcement stage.

The accepted calculation scheme of reinforced structures should reflect their actual condition and the actual working conditions found during the inspection. Theoretical analysis of the work of the bending element, reinforced under load, is based on the consideration of the work of an ideal elastic-plastic material corresponding to the Prandtl diagram.

There are several stages of the reinforced element. 1st stage - before the application of additional load, but after the reinforcement.

The stresses in the main section are distributed in height in proportion to the distance from the center of gravity of the main section, and the stresses in the elements used for amplification are zero; Stage 2 - an additional load is applied to the reinforced beam.

Stresses in the main section and reinforcement elements increase, reaching the yield strength in the boundary fibers of the main section (section of the existing beam); Stage 3 - with increasing load, plastic deformations penetrate into the middle of the main section, and the stresses in the boundary fibers of the reinforcing elements reach the yield strength; Stage 4 - the limit state of the reinforced bending element occurs with the formation of a plastic hinge.

To the margin of safety, to increase the reliability of the reinforced structural element, for the calculation of conditionally accepted stress plots shown in Fig. 17, b.

Below we consider the calculation of the reinforcement of the beams caused by the increase in loads.

The loads acting on the beam before and after reinforcement are taken evenly distributed along the length. The increase in load, which necessitates the strengthening of the beams, is due to the increase in the temporary load. Reinforcement of beams is carried out in the absence of temporary loading.

The calculation of beams reinforced under load by increasing the cross-sectional area can be performed both in the elastic stage and taking into account the development of plastic deformations. The calculation in the elastic stage should be performed for beams made of boiling steel or steel without a yield point, as well as for beams operated at temperatures below -300C or those operating under the influence of dynamic and vibration loads.

The criterion of strength of the beam, reinforced under load and calculated in the elastic stage, take the equality of stresses in the belt of the beam to the calculated resistance of steel y R.

Therefore, to strengthen the beams in this case, it is impractical to use steels with a design resistance that exceeds the design resistance of the reinforced beam

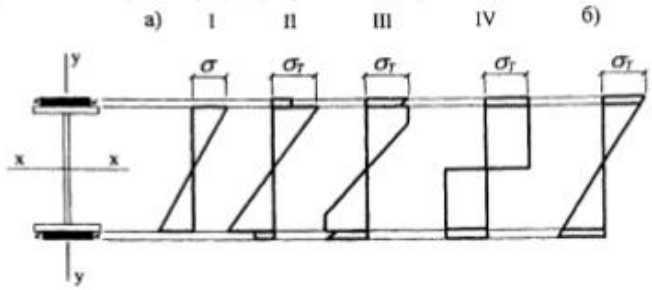


Fig. 17 - 1-4 stages of stress: a - reinforced under load; b - stress plot, accepted for calculations

According to the criterion of strength of the beam, which is reinforced under load and calculated in the elastic-plastic stage, can be taken to achieve the stress in the element of strengthening the value of the calculated resistance of steel. At the same time, plastic deformations appear in the belts and part of the beam wall.

If the calculated resistance of reinforcing steel is not more than 15% higher than the calculated resistance of the material of the existing beam, the norms assume to calculate the cross section as a whole for the total bending moment. Depending on the operating conditions, the reinforcing structural elements are divided into four classes, which differ in the norm of allowable ultimate plastic deformations: I. Welded structures operating in particularly severe operating conditions (crane girders for cranes 7K, 8K perceiving loads from rolling stock).

Calculations of the strength of the elements are conditionally performed in anticipation of the elastic work of steel. II. Elements of a structure directly perceiving mobile, dynamic or vibrating loadings which were not included in group I. Norm of limiting plastic deformations 001 0,, lim = p ε. III. Elements of structures operating under static loads, except for elements belonging to class IV, 002 0,, lim = p ε. IV. Elements of structures operating under static loads and satisfying the conditions of SNiP II-23-81 * to ensure general and local stability with developed plastic deformations, 0040,, lim = p ε.

Checking the strength of elements depending on their class is performed for elements of the first-third classes by the criterion of marginal yield strength (CT), and for elements of the fourth class - by the criterion of developed plastic deformations (RPD). When assessing the strength, the development of plasticity in the cross section of the reinforced element is assumed, but limited to the introduction of special reducing factors N γ and M γ, which guarantee the level of plastic deformation 004 0,0 = ε.

The values of these coefficients are taken depending on the reinforcement scheme, the ratio of steel characteristics, level and load conditions. The maximum level of the initial load of the elements for structures reinforced by welding, depending on the class of structures is limited, as a rule, by the conditions:0,2 0 ≤ β для I класу;

0,4 0 ≤ β for II class;

0,8 0 ≤ β for III and IV class,

where $\beta_0 = \frac{\sigma_{0,\max}}{R_y}$.

If these conditions are not met, it is necessary or pre-unloading of structures, or the use of special technological measures during reinforcement, which limit the deformation of structures (in particular, welded).

Checking the strength of the elements by the criterion of marginal fluidity (CT) is performed according to the formulas: - Centrally stretched or compressed symmetrically reinforced elements

$$N / A_n \le R_{yo} \gamma_c \gamma_N ,$$

where − N γ

a factor that takes into account the level and sign of the initial axial force; for stretched and compressed elements reinforced without the use of welding, 0.95 = N γ; for compressed elements reinforced by welding, 0 0,250,95 βγ - = N; - bending elements

$$M / W_n \le R_{yo} \gamma_c \gamma_M ;$$

$$\frac{N}{A_n} \pm \frac{M_x}{I_{xn}} y \pm \frac{M_y}{I_{yn}} x \le R_{yo} \gamma_c \gamma_M .$$

In formulas (2) and (3) for elements of class I take 0.95 = M γ; for elements of II and III classes - 1 = M γ. At 0.6) / (≥ yon RAN, the values of M γ are equated to N γ. Checking the strength of the elements by the criterion of developed plastic deformations (RPD) is performed according to the formulas: - Centrally stretched or compressed symmetrically reinforced elements

$$N \le [N] \gamma_c ;$$

- for bending elements

$$M \le [M] c_\tau \gamma_c ,$$

Checking the strength of bent and compressed or stretched-bent elements by tangential, local and reduced stresses is carried out in the usual way according to the instructions of Sec. 5 DBN B.2.6-163: 2010 taking into account the changed geometrical characteristics of the cross section

9.4 Analysis and design of steel beam strengthening bu means of modern Sofrware Ansys.

ANSYS is a professional finite element computational complex that allows solving problems of strength, heat transfer, electromagnetism, fluid dynamics, both separately and jointly, in a coupled setting (the so-called 'multiphysics' or 'coupled field'). The number of ANSYS jobs in the world exceeded 90,000 commercial and 130,000 university jobs in 2003.

The main vocation of the Workbench is to speed up, simplify, increase efficiency and unify the formulation of problems as much as possible, regardless of their belonging to a particular physical discipline and the solver used.

The DS (Design Simulation) shell and module are included with all ANSYS base licenses (Multiphysics, Mechanical, Structural, Professional) and do not require separate payment.

In the event that, in addition to the basic software product, a K.L. other / s (for example ICEM, CFX, AutoDYN), they are integrated into the Workbench environment and, in addition to being able to run independently, receive interactions within this environment, taking the form of modules in it.

All types of calculations performed by ANSYS program,are based on classic engineering concepts and concepts. With helpтreliable numerical methods, these concepts can be formulated in the form of matrix equations that are most suitable for finite element applications.

ANSYS uses two optimization methods: the approximation method and
first order method. In the first case, approximating functions are used, with the help of which an approximate description of the analysis results obtained for the previous design option. Minimum of the approximate objective function is found by the minimizing sequence method, then the next variant of the project. The target function is considered in the program as a function without constraints - by introducing penalty terms responsible for the constraints of project variables and state variables.

First-order optimization refers to a technology thatuses information about the derivatives of the objective function - about the gradients of the dependent

variables from project variables. The program determines the gradient and shape of the target function using the adaptive descent method. At each iteration, the direction is determined descent, and the magnitude of the displacement vector is chosen in such a way as to minimize target function.

Comparison of these two optimization methods shows that the first is more effective, but the first order method is more reliable. In ANSYS implemented consistent use of both methods. The usual situation is application of the approximation method to narrow the search area and the subsequent using the first order method to refine the solution.

In addition to the traditional procedures for obtaining an optimal project, the program ANSYS offers a number of other optimization tools and techniques.

The use of fibre reinforced polymer (FRP) composites in strengthening, reinforced concrete structures has risen considerably in recent years. Combining the strength of the fibers with the stability of the polymer resin, FRP offer ease of application lowered labour cost and extra durability.

Researches originally and practicing engineers with about 10 years lag, have used FRP to strengthen different reinforced concrete members such as beams, columns and slabs.

Extensive experimental studies have shown that externally bonded FRP can significantly increase the stiffness and load carrying capacity of the retrofitted structures. However, there have been reports of reduction in ductility associated with brittle behaviour due to bond failure and FRP rupture.

In my diploma works I used ANSYS software in the three dimensional (3D) modeling case and nonlinear static analysis. And he also showed the results that different types and thickness of CFRP plates influenced the load capacities and strain distribution properties of this.

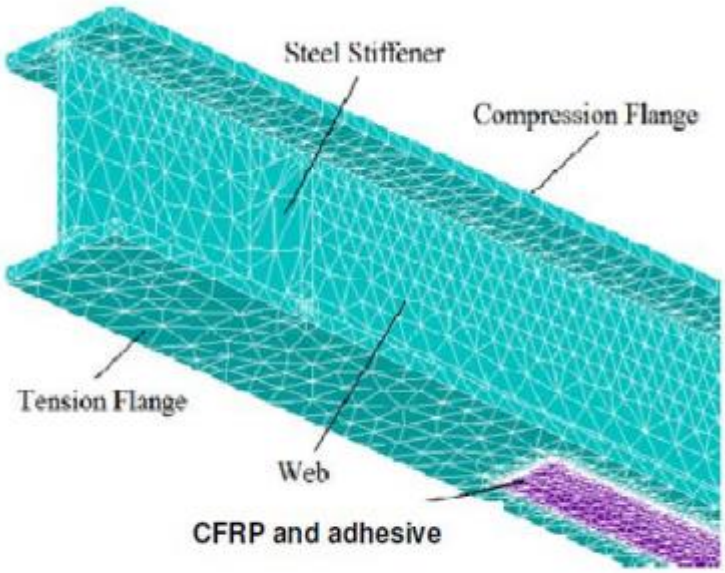
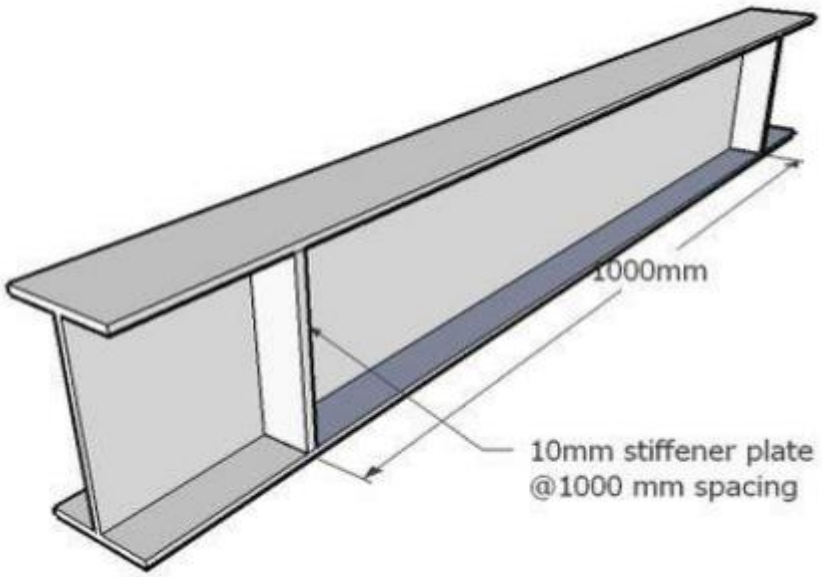


Figure 1 3D simulated specimen



RESEARCH GAPS AND FUTURE RECOMMENDATION

1) More investigations are required to execute the grinding operation in the field of offshore engineering.

2) Specific differentiation should be done between the disc grinding and burr grinding. And their suitability should be specified.

3) More researches should be needed in the dry welding process of offshore engineering.

4) Additional investigations are needed on the basis of foundation strengthening.

5) Further investigation should be needed on the basis of some specific improving materials to improve the bearing capacity of I-beam such as carbon fiber reinforced polymer.

CONCLUSIONS

1) Burr grinding is to work in more confined regions than disc grinding and burr grinding and burr grinding is easier to handle and having an excellent grinding operation.

2) The air hammer peening method is simple and effective for weld improvement.

3) Using stainless steel in pipe piles is the solution of protecting corrosion in the field of offshore engineering.

4) Strengthening of steel I-beams can be improved by using fiber reinforced polymer (CFRP).

5) Using stiffener is also a popular and most effective method to improve the strengthening and bearing capacity of steel beams or columns.

6) Higher research must be needed in this field to overcome the high intensity of seismic activity. This past records will help to find out a newer one which would be more economical and stable.

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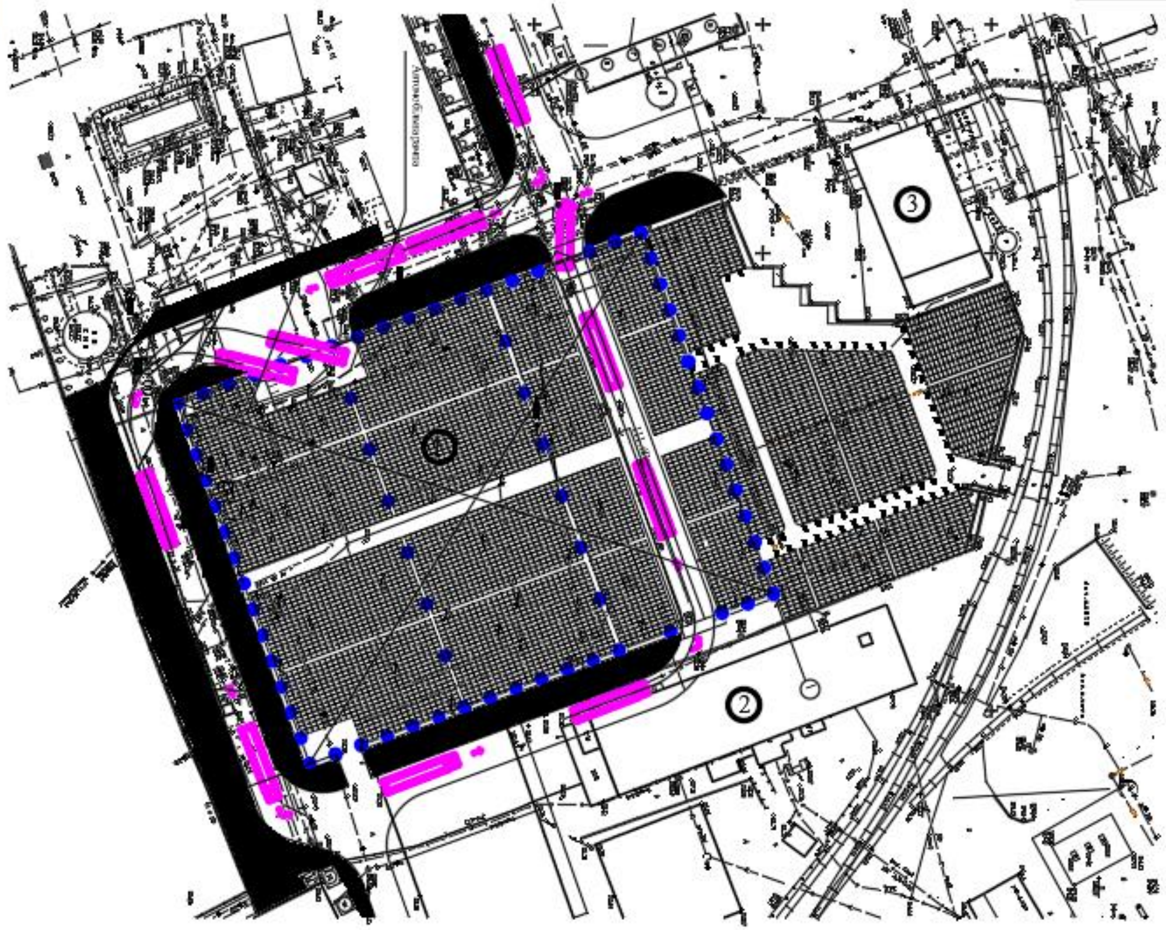
General Layout

Legend

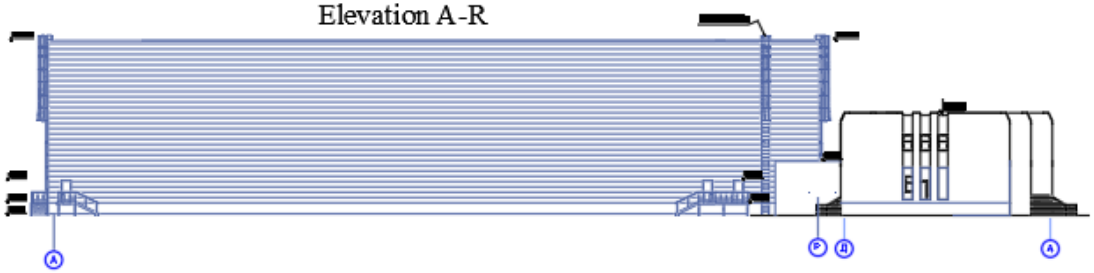
№	Name	Coordination
1	Logistic building	
2	Administrative building	
3	Boiler house	



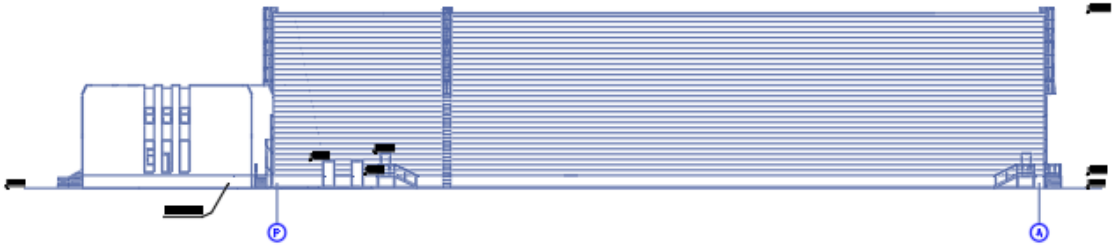
Chair of Computer technology in construction	National Aviation University	
	Reconstruction of production building of existing enterprise under the premises of logistic complex	
[redacted]	Architectural part	DW 1
	General layout	

Elevation 1-37

Elevation A-R

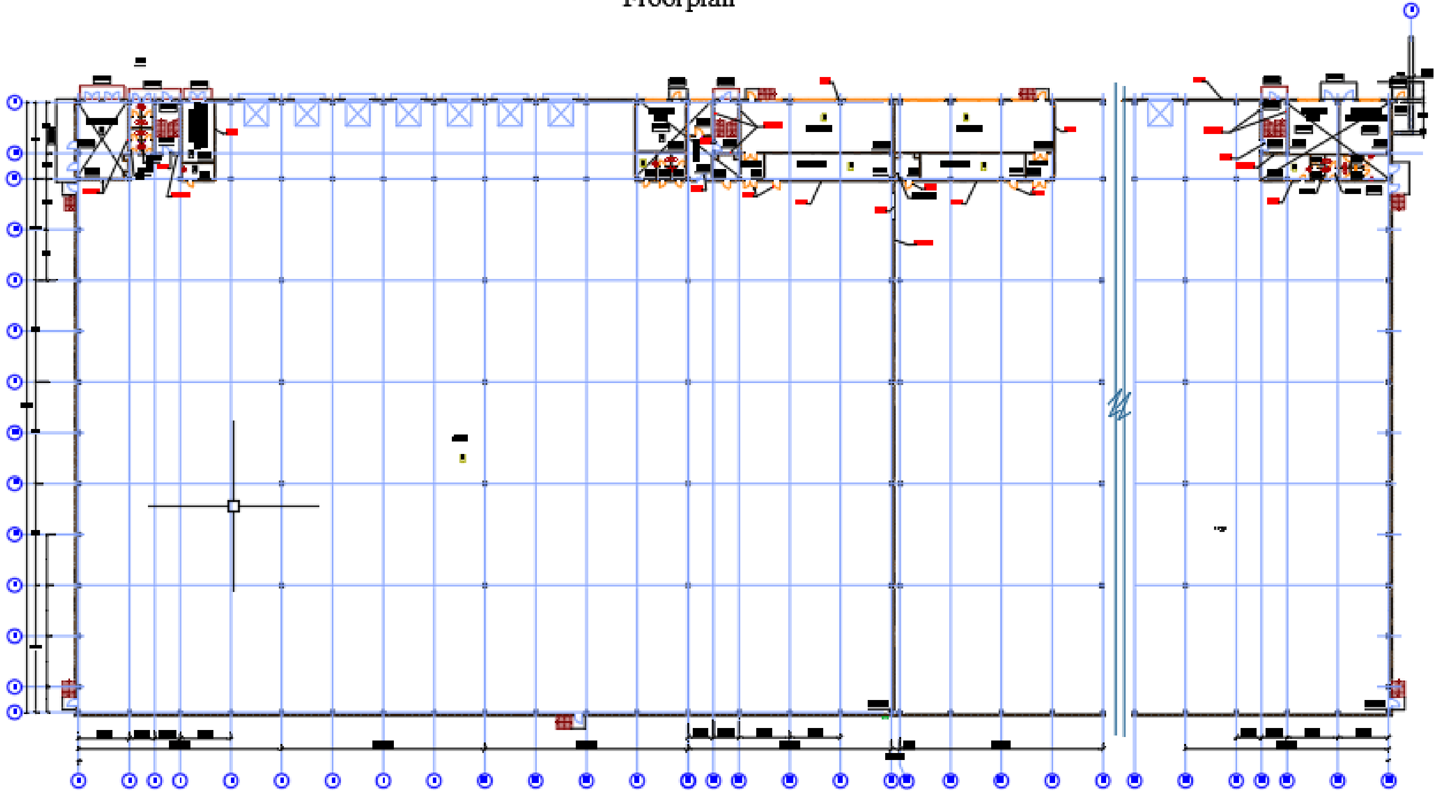


Elevation R-A



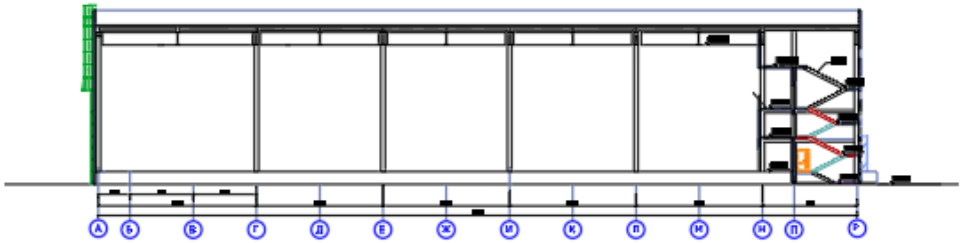
Chair of Computer technology in construction	National Aviation University
	Reconstruction of residential building of existing enterprise under the premises of logistic complex
	Architectural part
	Elevations

Floorplan

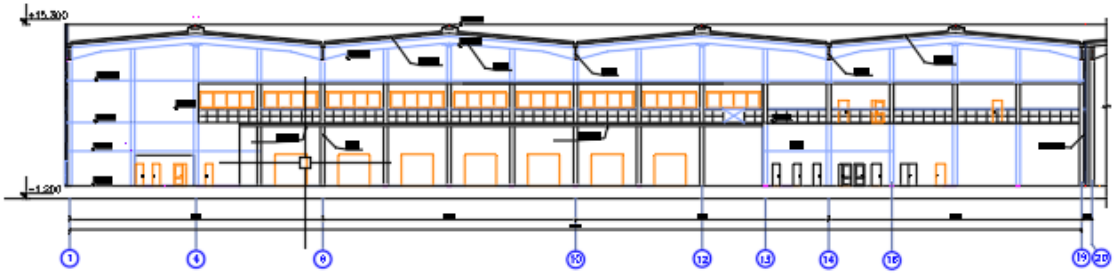


Chair of Computer technology in construction	National Aviation University	
	Reconstruction of production building of existing enterprise under the premises of logistic complex	
[redacted]	Architectural part	DW	3
	General layout	

Cross-section 1-1

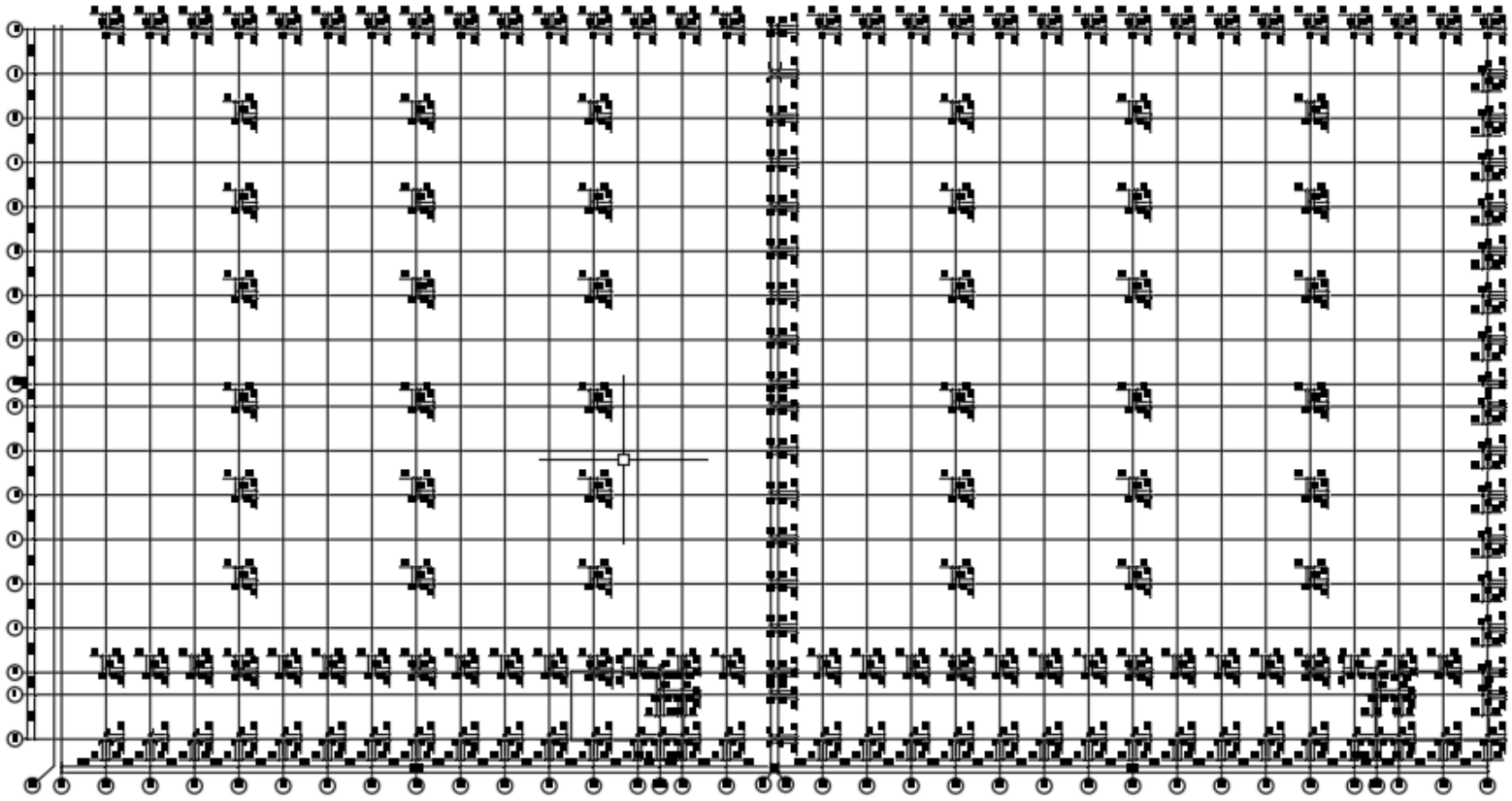


Cross-section 2-2

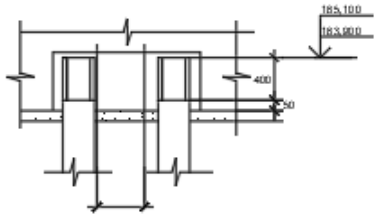


Chair of Computer technology in construction	National Aviation University	
	Reconstruction of production building of existing enterprise with the premises of logistic complex	
	Architectural part	DW 1
	General layout	

Fondation Plan (piles)



Joint of connection of pile and pile cab



Chair of Computer Technology in construction	National Aviation University
	Reconstruction of production building of existing enterprise under the premises of logistic complex
	Structural part — DW — 1
	Foundation Plan

Roof elements plan

Chair of Computer technology in construction		National Aviation University	
		Structural part	DWG / 5
		Roof elements plan	