Project of subway station "Yuzhnaya" (south station) in Kharkiv

Mr. Oleksandr Galychyn
arekusandorosu6@gmail.com

Abstract — Many populous housing estates of Kharkov (Ukraine) outside of pedestrian accessibility of subway stations. For study it was decided to choose Rohan housing estate with population of 10 thousand people and usable area 16 m^2 per resident with poor pedestrian accessibility of trolleybus and bus stops. In order to resolve transportation and living problems was decided place Southern terminal station there along with renewal of resident area. During the project elaboration in first place was placed station, created subway station construction management plan, designed site construction plan and were proved their efficiency. Second, was design future site plan based on evaluated redevelopment and prohibited areas. Eventually, was proved its rationality, economically and safety based on feasibility indicators and limit state method. In result construction period of platform part of station was reduced to three month than traditional standard value and in a comprehensive way is possible to shorten the construction period of station five and a half months. Moreover, first time was proposed reasonable, economical and safe in operating future site plan of terminal station «Yuzhnaya», where maximum usable area per resident totaled after redevelopment of 21 m^2. Data derived in the present study and practical study of innovation at the time of construction and operation of proposed station will attract interest in the following cases: Firstly, at major cities around the world that has developed, subway construction and site plan projects in their suburbs. Secondly, at cities in various parts of the world where subway evolves to suggest their data and solutions of construction process management of station structure subway shallow single vault to include construction plan in the suburbs and site plan with mentioned above prohibited area. Implementation of this project only possible with direct investment of foreign capital, because of 70 million U.S. dollars debt and large costs in renovation and new construction according national standards.

Index Terms— site plan of station «Yuzhnaya», construction management, subway station construction management plan, site construction plan, urban renewal, prohibited area, precast reinforced concrete construction method, limit state method.

1. INTRODUCTION

In 2010 year the existing network of public transport lines not handle with the total passenger traffic, because the subway is only 30% of public transport network. As result, many populous housing estates of Kharkov outside of pedestrian accessibility of subway stations.

For study it was decided to choose Rohan housing estate with population of 10 thousand people and usable area 16 m^2 per resident. Entire housing estate, where is situated one trolleybus stop and bus stop in their area of pedestrian accessibility only 0, 96 km^2, which is not enough for the area of 3,26 km^2. Transportation and living problems can be resolved by building Southern terminal station and reconstruction of resident area.

Despite the poor pedestrian accessibility and as result regular complaints of residents who do not enough time to get to work on time, ways to solve these problems are not found. Scientific innovation consists of study based on investigated site construction plan in accordance with subway station construction management plan and feasibility indicators were analyzed site redevelopment area, first time proposed reasonable, economical and safe in operating future site plan of terminal station «Yuzhnaya». We made it possible to significantly reduce the total cost and duration of the single shallow vault station construction by defining new solutions of precast reinforced concrete construction process management.

2. RESEARCH PURPOSE

The ultimate goal of this research is to elaborate a future site plan of subway station «Yuzhnaya». Were determined following tasks in order to achieve it. First, were determined location of station and used area of construction site, were created subway station construction management plan, were designed site construction plan and prove its efficiency based on feasibility indicators and structure of single station shallow vault according precast reinforced concrete construction method. Second, was design future site plan according evaluated redevelopment and prohibited areas. Thence prove its rationality, economically and safety based on feasibility indicators and limit state method.

3. RESEARCH METHODS

This paper is divided into three chapters. In Chapter 1 were analyzed taken in project organization 1:1000 scale topographic survey map of Rohan, architectural drafts (plan of station and longitudinal section, cross-sectional view) and detailed cross-sectional view (structural members joints that connect station structure and segments) to determine location of station and used area of construction site, according open-cut method. Was created a subway station construction management plan [1] , [2], [3] [4], [5] tailored to the architectural drafts, open-cut method and was calculated the working hours until the completion subway station and was summarized final construction plan that combine other elements [3], [4], [5] (construction timetable details, construction

methods). And then more was detailed separate part (such as platform part) of detail drawing, construction timetable and moreover was summarized the construction method to be used and taking labor intensity [3]. Based on this plans and data we design site construction project and calculation its feasibility indicators [6], [7]. As a result was proved reasonable and economic of construction site plan and structure of single station shallow vault according precast reinforced concrete construction method [8], [9]. Were determined following solutions of precast reinforced concrete construction process management: 1) Cost savings for total process that performed due to gantry cranes [1] that have a maximum lifting capacity of 10 tons [2] as shown in Fig. 1. 2) Were made it possible to reduce by half the working hours in the primary station lining installation work [9]. 3) Was succeeded in reduction of construction period [4], [5] and flexibility of construction work by a combination of identical work and phased operation [3]. Summary of results is shown in Table 1.

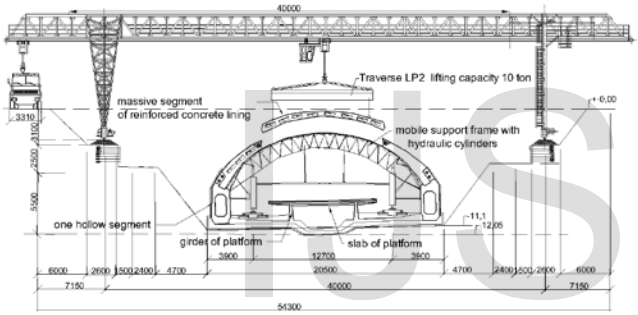

Fig. 1. Process that performed due to gantry cranes (installation of segments)

TABLE 1

MAJOR FEASIBILITY INDICATORS OF STATION

№	Name	Units of measurement	Amount
1.	Building volume	m^3	34295, 4
2.	Construction costs of 1 running meter	1000 $	277,147
3.	Construction period of platform part	days	368
4.	Estimated labor intensity	1000 man-hours	229,962
5.	Estimated costs of platform part construction	1000 $	28269, 02
6.	Estimated costs of station construction « Yuzhnaya »	1000 $	40000

In Chapter 2, where construction site plan has been designed [6], was decided to move to site plan after construction. According used area construction site plan from Chapter 1 and present Rohan plan infrastructure to evaluate area of redevelopment will be limited to improve the environment around the station to 30 hectares and was placed entrances of the subway station, infrastructure, and public welfare facilities, residential buildings[10], [11]. Were analyzed urban development, economic and comfort indicators and proved the rationality of site plan around the station [11]. In order to avoid the phenomenon of karst system was set prohibited area construction high burden[12] around 50m from the longitudinal center line of station) [13], to ensure the safety underground structure. Using this data were excluded buildings and non-building structures from prohibited area [13]. New dwelling houses were provided outside the danger zone for the people instead of low-value housing to be demolished. After the redevelopment usable area per resident [11] was 21 m^2 as shown in Table 2.

TABLE 2

BALANCE OF SITE PLAN TERRITORY

Indicators of redevelopment area	Units of measurement	Amount	
		Existing	Prospective
Area of site plan	hectares	30,00	30,00
Population of site plan	inhabitants	3689	3689
Housing stock	m^2	59285,2	78603,2
Usable area per resident	m^2	16	21
Area of roads, driveways	hectares	8,39	8.33
Area of alley sidewalks, grounds	hectares	3,98	8
Average number of floors	floors	2	3
Building area	hectares	3,18	4,22
Building area of residential zone	m^2\ heet.	0,09	0,12
Area of landscaping	hectares	10,69	13,45
Other territory	hectares	4,16	-
Cost of the total area of residential buildings	1000 $	29,643	40.152
Cost of 1 m^2 of housing	1000 $	0.5	0.5

In Chapter 3, after site plan has been proposed, were calculated by limit state method [14] in order to prove safety of station and improvements above the station. Was measuring the amount of road transport nearby and calculate the variable actions [15], [16] coming from there as shown in Fig. 2 and then calculate permanent actions (soil, station structures, etc.) [17] And, finally, calculated the accidental action [18]. Was established limit states from these data [14], [19], [20] to ensure the safety of underground structures.

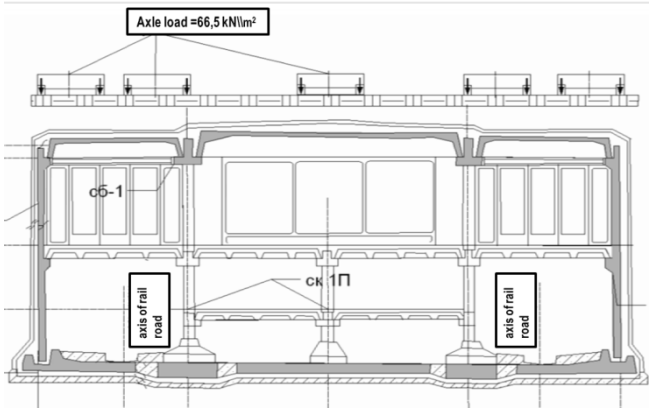

Fig. 2. Design scheme of entrance hall to determine normative load from wheel of vehicle

Then, in order to further improve its safety, was selected (such as rebar) for construction materials [14], [20]. Were provided the required level of reliability, by the way, it was appeared all together and to complete the final design of the subway station structural elements [20]. And finally were elaborated landscape plan [21] as shown in Fig. 3 and scheme of transport accessibility and pedestrian traffic according future site plan as shown in Fig. 4. Summarizes the results of these analyzes, was proved that future site plan of station «Yuzhnaya» is most acceptable land use that suited for residents.

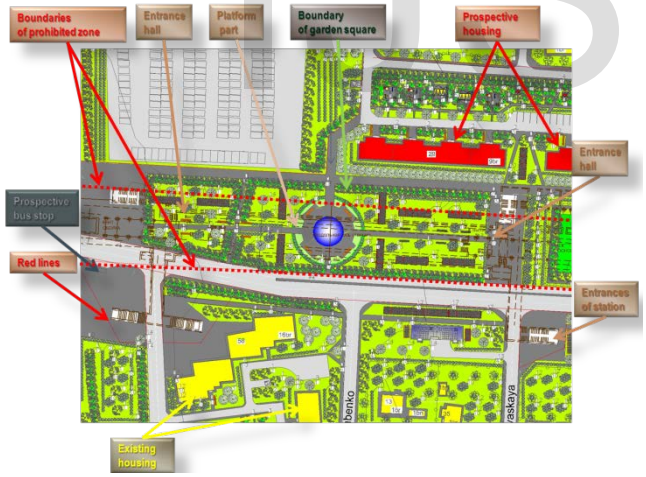

Fig. 3. Fragment of landscape plan

Fig. 4. Fragment of transport accessibility and pedestrian traffic scheme

4. Research Results

1) Construction period of platform part of station was reduced to three month than traditional standard value and in a comprehensive way is possible to shorten the construction period of station five and a half months. Moreover, fourteen million U.S. dollars was saved of total cost of station construction that was amounted a forty million U.S. dollars. 2) Was determined area of redevelopment, was calculated the maximum prospective usable area of housing stock outside the karst area and as result was received the maximum usable area per resident after redevelopment of 21 m². 3) Based on pedestrian traffic around station, present transport scheme of Rohan and a master plan for public transport lines until 2026, were added bus stops and was concluded that entirely 3,16 km² inside pedestrian accessibility. 4) In result of calculation for limit states in order to reduce the load on the station to ensure its reliability was accepted decision on placement garden square above the station (two entrance halls and platform part). 5) Summarizes previous results together with feasibility indicators were helpful to prove rationality, economically and safety of future site plan of station «Yuzhnaya».

5. Consideration

Data derived in the present study and practical study of innovation at the time of construction and operation of proposed station will attract interest in the following cases: Firstly, at major cities around the world that has developed , subway construction and site plan projects in their suburbs (was assumed to be able to ensure the required land and there is no highway nearby) in accordance with mentioned above proposed solutions of precast reinforced concrete construction process management and with setting the limits of prohibited area. Secondly, at cities in various parts of the world where subway evolves to suggest their data and solutions of construction process management of station structure subway shallow single vault to include construction plan in the suburbs and site plan with mentioned above prohibited area. Thirdly, principles of future site plan will be a basis of detailed design of pedestrian crossings, entrances of station and transport hub and minor objects, as well as development and harmonization a plan of rational underground and ground functional zoning in conjunction with the rest of the urban area.

Can be raised following three points as an important research issues in the future: First point that could not calculate a detailed construction cost in the case of the application of new standards during the construction of the new subway station of Kharkov city, due to

environmental conditions and hydrogeological engineering geological environment other than this studied subway station. Second point that comparison of construction costs if was calculated by world's most advanced technology of Japan. Third point that inability to provide people with a usable area of 25 m^2 per person due to prohibited area. And also was not made forecast of housing estate Rohan in accordance to population growth after station construction in order to ultimately offer a long-term development model of master plan for Rohan development.

At present, construction area Rogan is not included in a master plan for the city of Kharkov to 2026, not to mention the construction of terminal station «Yuzhnaya». City official's motive is the fact that the debt subway is 70 million U.S. dollars and the area will never be promising due to large investments in renovation and new construction. Direct investment of foreign capital initially at the moment is the only way to solve the problem. So while financial problem is not solved are compelling reasons to continue and develop this research topic to find a way to resolve this problem in analog situation using advanced technology abroad.

ACKNOWLEDGMENT

The author is wishing to thank supervisor professor Semenov V.T., associate professor Zavalny O.V., senior lecturer Gordienko S.N, Kharkiv National Academy of Minicipial Economy. Those researchers provided support and guidance to the article, such as controversial discussions and beneficial consultations.

REFERENCES

[1] GOST 24390-99 "Gantry cranes, electrical containerized. Basic parameters and dimensions.", pp. 2-3.
[2] Catalog of production PJSC "Zuevsky electromechanical plant" (official website),http://www.hardcrane.ru/kk25.php
[3] L.G.DIKMAN "Organization, planning and management of the construction industry", textbook for higher educational institutions. Publishing house Moscow "Higher School", pp. 112-132, 2006.
[4] "Standard technological scheme for the single shallow vault station construction according open-cut method", Moscow, 1976, http://nordoc.ru/doc/56-56501#i36408.
[5] Gaevoi A.F., Usik S.A. "Term paper and degree project of designing industrial and civil buildings", Leningrad, pp.91-127, 1987.
[6] Krasny Yu.M. "Designing of construction site plan and organization of the site", Yekaterinburg, pp.15-92 2000.
[7] Program complex AVK-5, version: 2.11.3, 2011, (official website), http://avk.creator.dp.ua/.
[8] Golitsyn D.M., Frolov Yu.S. , Ledyaev A.P "Metro systems: Textbook for higher educational institutions", pp.506-511, 2001.
[9] DBC 48-93 "Erection regulations of monolithic concrete and reinforced concrete linings for transport tunnels", Moscow, pp. 104-106, 1994.
[10] NBC 360-92** Urban planning. Planning and development of urban and rural settlements, Kiev, pp.11-16, 2002.
[11] Comprehensive methodical instructions for the course "Urban Geography", Kharkiv: KNAME, pp.8-35, 2008.
[12] NBC 32-02-2003 Subways, Moscow, pp. 24, 2004.
[13] Moscow Government "Regulations of utilization of technical and protection areas of underground in Moscow, Section 6. Regulations of utilization territories of technical and protection subway areas in Moscow", http://www.stroyplan.ru/docs.php?showitem=47351 Moscow, 2006.
[14] ISO 2394-2007: General principles on reliability for structures, pp.11-28, 2007.
[15] GOST R 52748-2007 "Vehicle roads of general utilization. Normative loads, design loading models tracks clearance", Moscow, pp. 2-3, 2008.
[16] V.N. Baikov, Sigalov E.Ye. "Reinforced concrete structures. General course. Textbook for higher educational institutions", edition, 5, revised - Moscow, pp. 615-617, 1991.
[17] NBC V.2.3-7-2010 "Buildings of transport. Subways ", pp.34-36, Kiev, 2010
[18] SNIP II-11-77 "Civil defense structures", pp.18-25, 1985.
[19] NBC 2.01.07-85* Loads and actions, pp. 3-22, 1985.
[20] N.O. Psurtseva, O.M. Pustovoytova Methodological guidelines for accomplishment the term paper, calculated and graphical work, practical exercises and self-study in accordance with courses on "Building structures" and "Building structures (reinforced concrete structures)", Kharkiv: KNAME, pp.5-29, 2011.
[21] NBC III-10-75 "Accomplishment of territories", pp.12-18, 2000.