

## STRUCTURE RELOCATION

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### Abstract

Civil engineering is constantly changing and introducing new technologies of building, demolishing, restructuring, modernisation, etc. The article presents the innovative subject of relocation of structures, i.e. moving them to a different place. The difficulty of relocation is influenced by the technical condition of the structure, its weight, and intended time duration of the relocation. The article shows how complex the discussed issue is. The subject was selected due to its infinitesimal presence in the literature.

Keywords: structures, relocation

## 1. INTRODUCTION

*"Logic will get you from A to B. Imagination will take you everywhere"*

Albert Einstein

### 1.1. Definition of relocation

Relocation is a process of lifting an entire building and moving it into a different location. Building law does not use this term, it is treated as building. Therefore, structure relocation requires a construction permit.

In the case of a structure placed inside another structure, it can be treated as an element of the interior/a part of the equipment. In this case, there is no need to obtain a construction permit or to file pre-construction notification.

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Relocation has become popular especially for historically significant buildings. However, structures are relocated also for the purpose of enabling new investments or moving them into safer locations.

### **1.2. Decision of relocation**

Making decision on structure relocation is a complicated process, since the decision is connected to high expenditures and presents a huge engineering challenge. There are many possible causes of relocation. Most frequently, the decision to relocate a structure is connected to its history. If the structure is historically significant, the decision becomes easier. Historical structures are most frequently relocated in order to protect them from the destructive force of nature or from demolishing when they interfere with development plans of the place. Occasionally historical structures are relocated to a museum, where they become an exhibit. The second frequent cause of relocation is sentimental, when the relocated structure is important to its owner. The third cause is connected to cleaning the area and preparing it for a new owner. Recently offers of sales for the purpose of cleaning the area are gaining more and more popularity. Investors looking for savings sell structure for a very low price, but in exchange for moving it from its current location. Sometimes, structure relocation is enforced by the risk that the structure presents to the local community, or the relocation of a whole community/town is necessary. AN example may be activity of a mine which causes so great mining damage and degradation of the environment that life in its present location becomes endangered. New trends and progress may also cause decision of relocating structure which architectonically does not fit the surrounding buildings [1].

Numerous aspects should be taken into consideration before making a decision of relocation. The first is relocation cost, which should be compared to the cost of building a new structure at the target location. Sometimes a good solution is exchange of structures. Unfortunately, it requires finding a party interested in purchasing the structure. The size of the structure also influences the decision – the bigger the building, the more complex (and therefore expensive) its relocation. Another aspect is the distance between the locations. The further away the target location is, the higher relocation cost and its difficulty level will be. Relocation costs need to include costs of all permits, insurance, fuel, transport, assists of providers of specific services (particularly electricity). Estimated average cost of house relocation in the United States equals about one hundred and fifty dollars per one square meter of the structure [1].

### **1.3. Relocation route selection**

A very important element of relocation is planning its route to be as short and wide as possible, with the lowest possible amount of obstacles. As a result of cost analysis and technical options analysis it may turn out that the relocation is possible if the interfering objects are relocated as well.

### **1.4. Foundations**

Relocation of foundations is economically unfounded and is not taken into consideration. The only exception are historical structures [2].

### **1.5. Relocation costs**

Relocation costs include not only hiring a specialist company, but also numerous other costs connected to various collisions. Very frequently parts of various installations need to be disassembled on the relocation route. In majority of cases, a permit needs to be obtained and costs need to be agreed upon with the correct service provider.

### **1.6. Relocation causes**

Structure relocation is often prompted by a new future function of space in which the buildings are located. In the United States relocation for the purpose of increasing structure worth at the new location are more and more frequent [3].

### **1.7. Damage**

Relocation may cause damage of the relocated structure. Façade cracks may appear, as well as other transport damages. Every relocation must be insured. Structures located at the relocation route may get damaged as well.

### **1.8. Paperwork and permits**

In the majority of cases, structure relocation does not require a permit, but the investor must obtain applicable permits for all new systems and foundations in the new location.

## **2. HISTORY OF RELOCATION**

The first relocations in the course of history were connected to transport of stone blocks with mules (Fig. 1). However, these were unrecorded.

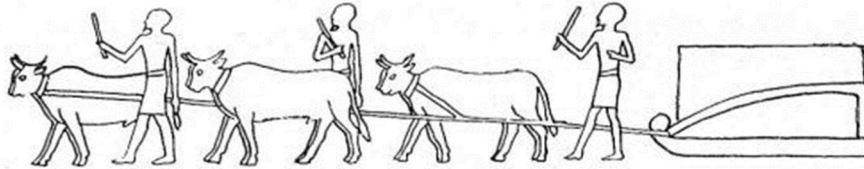


Fig. 1. Transport of stone blocks with mules [4]

Table 1 presents relocations conducted in various parts of the world in chronological order.

Table 1. History of relocation of structure. Based on [1] and author's own research

No	City	Structure	Relocation cause	Relocation date	Structure weight [t]
1.	London /England	House	First recorded house relocation	1598	No data
2.	Philadelphia /USA	Local prison	Reorganisation, relocating closer to sheriff's house	1799	No data
3.	Boston/USA	Pelham Hotel	Street reconstruction	1869	No data
4.	Winfield, Kansas/USA	Post office	Change of location of business	1870	No data
5.	Moscow /Russia	Dom	Railway reconstruction	end of 19th century	2000
6.	Yoshihama/ Japan	Fishing village	Destruction by a tsunami and threat of another one	1896	No data
7.	From Lancashire to Richmond/ From England to USA	Agecroft Hall	Sale with delivery to another continent	1925	180
8.	Calgary/ Canada	Church	Relocation to a more populated area	1926	No data
9.	Moscow /Russia	Residential building at Twierska Street	Political decision	1939	No data

10.	Warsaw/ Poland	Rogatki Grochowskie	Street reconstruction	1961 and 2001	600
11.	Warsaw/ Poland	Holy Virgin Mary Church	Political decision	1962	6000
12.	Abu Simbel/ Egypt	Ancient temples	Construction of a dam	1964 - 1968	31000
13.	Warsaw/ Poland	Lubomirski Palace	New investments – construction of a residential neighbourhood	1970	8000
14.	San Antonio/ USA	Fairmount Hotel	Instead of deconstruction	1985	1600
15.	USA coast	Cape Cod Lighthouse	Protection from nature	1995	No data
16.	Detroit/USA	The Gem Theatre	Saving a historical building	1997	2700
17.	Outher Banks, North California/USA	Cape Hatteras Lighthouse	Protection from nature	1999	4830
18.	East Sussex/ Anglia	Belle Tout Lighthouse	Protection from nature	1999	850
19.	Minneapolis/ USA	Schubert Theatre	Space for a new museum	1999	2908
20.	San Jose California/USA	Montgomery Hotel	Space for a new hotel	2000	4816
21.	Newark/USA	Airport no. 51	Airport modernisation	2000 - 2001	7400
22.	Gunangxi/ China	Fu Gang building	New investments	2004	15140
23.	Kiruna/ Sweden	Mining town	Destruction with iron ore exploitation, subsidence	2007 - 2033	No data
24.	Zurich/ Switzerland	Oerlikon factory	New investments	2011 - 2012	6800

The first record of a relocation appears in description of London from 1598, while the first technical description of relocation applies to North America in 1799. It consisted of moving a small wooden structure which fulfilled the role of a local jailhouse (Fig. 2). A wooden frame with wooden wheels was constructed. Then the structure was moved to its target location using large numbers of mules and horses. The relocation was planned by William Birch and his son [1].

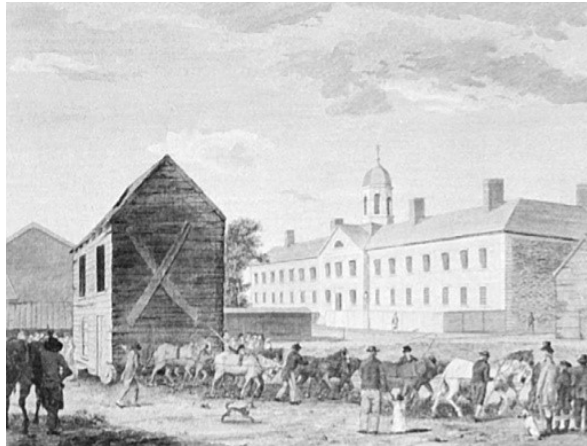


Fig. 2. Transport of a local jailhouse in Philadelphia (USA) in 1799 [1]

The most well-known relocation in Poland was moving of Lubomirski Palace in Warsaw (Fig. 3). The decision of relocation was made in 1970 due to construction of a new residential neighbourhood. The relocated structure weighted about 8000 tonnes. The relocation was performed using steel rollers, double-tee bars, and strand jacks of 500 kN load each, and ended with placing the palace on new reinforced concrete strip foundations. The whole operation lasted 49 days and changed the palace angle by 74 degrees [2].



Fig. 3. Relocation of Lubomirski Palace in Warsaw in 1970 [2]

### **3. RELOCATION PROCESS**

#### **3.1. Relocation types**

Structure relocation can be conducted in a few ways: as a whole, through complete disassembly, and through partial disassembly. Technical condition of the structure, possible transport routes, and target location should be analysed during the selection of relocation type, since the choice influences the entire process [1]. Relocation of a structure as a whole is the most interesting, but also the most difficult option. In this case, the relocation itself does not last long, as opposed to its design and preparation. Relocation by complete disassembly consists of deconstructing the structure to as small as possible parts, so that as many elements as possible could be used for reconstruction. This option consists of dividing the structure into segments. Each of the segments is relocated separately and combined into the whole at the relocation place. It is crucial to divide the structure into segments that will be in permissible size for transport. In some cases, additional bracing should be conducted to secure the structure. Relocation through partial disassembly additionally enforces securing the structure from weather conditions, mainly moisture. The simplest way to secure the segments is using foil or trailers to prevent water from reaching the transported elements. Moreover, this option requires securing the structure during its disassembly. After cutting off first segments, the undivided part of the structure also requires protection.

#### **3.2. Associations of companies performing relocations**

##### **AMSA - American Moving & Storage Association [5]**

It's an association of companies relocating structures and equipment. Every member of the association is verified and certified by it and has to uphold its standards and ethical code. The main purpose of the organisation is uniting transport companies.

##### **IASM – International Association of Structural Movers [6]**

The largest association of companies performing relocations in the world. It was set up in 1983. A group of companies performing relocations decided to organise themselves and unite to represent structure relocation industry. As of 2016, the organisation unites nearly 400 companies from all over the world. Joining the organisation equals being added to a database of companies performing relocation of the highest quality. The organisation awards the best companies and the most interesting relocations every year.

##### **IAM – International Association of Movers [7]**

The organisation was set up over 50 years ago by 18 USA-based companies. Its members declare to follow the organisation's ethical code.

**FEDEMAC – Federation of European Movers Associations [8]**

FEDEMAC was set up in 1959. In 1995 it was registered as independent association. The association unites over 3000 transport companies performing transport and relocation in 26 European countries.

**Relocation Insurance [9]**

It is an example of American company specialising in insuring relocations.

**3.3. Relocation stages**

Selection of a company that will perform the relocation is the most important stage which will define all consecutive steps. Factors which should be taken into consideration when choosing a company are presented below [1, 3].

**Insurance**

The company should have insurance in the case of damage or destruction of the relocated structure and other structures along its route. High insurance policy and well-known brand of the insurance company should be a strong point in favour of a specific company.

**Experience**

For relocation of historical structures it is necessary for the company to provide supervisors with proper qualifications. Documentation with pictures of previous relocations and letters of recommendations help verify company's experience.

**Opinions**

Opinions on the company should be verified. The best solution is finding information on the Internet and contacting previous customers of the company.

**Price**

When choosing a company to conduct relocation, one should not automatically select the company with the lowest prices. The safety of the relocation is the most important factor, therefore the price should not be the decisive factor.

Structure relocation requires signing a relocation contract and obtaining various permits. The contract must precisely describe the duties and scope of liability of both the company and the structure owner. Relocation schedule and its possible delays should be agreed upon. If there are other companies participating in the relocation process, their duties, scope of work, and influence on the schedule should be included as well.

Obtaining relocation permits is crucial. The main contractor must present a plan of the relocation and apply for the construction permit in the new place. Relocation and its route should be consulted and obtained necessary permits for at local police station, fire department, roads, water and sewage, gas, electricity, and ICT network authorities. Relocation of historical structures requires permission and supervision of a monument curator. Structure relocation requires opinion of a geologist, who may decide that foundations in the new place must have a different



design or rule out relocation of old foundations. An oversize load transport permission should also be obtained. Structure relocation must be conducted in compliance with environmental protection rules and it mustn't have negative impact on the environment [1].

#### 4. CONCLUSION

Structure relocation is a very demanding task. Designing and performing relocation requires knowledge, experience, and coordination of representatives of numerous industries. In Europe there aren't many companies relocating structures, since relocation costs are very high, while United States are the place with the highest number of performed relocations. The most frequently relocated structures in the US have skeletal wooden structure, which is very light. That enabled relocations to become nearly an everyday occurrence in the United States.

Every year dozens of small and large structures are relocated all over the world. However, it should be remembered that every relocation is a huge technical, logistic, and economical challenge that requires a lot of experience and skills. It seems there are no borders that human race can't move, therefore in the future there might be no limits of size of relocated structures. This industry should be developed in Poland not only in regards to the structures rescued from destruction, but also as investments increasing structure value through its relocation.

The future of the construction industry should include issues connected to relocations. Architects and designers should take into account the possibility and ways of relocating the designed structures.

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