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Holism vs. Sustainability in Construction

Tomasz Szkuta

Polish Association of Civil Engineers and Technicians (PZITB) Branch in Toruń, Szeroka 34, 87-100 Toruń, Poland, tomszkuta@gmail.com

Abstract. *Introduction, motivation: almost 40 years of observation, work and cooperation with investors, designers, contractors, manufacturers, distributors, authorities directly in the construction, rescue of monuments, problem solving, design, implementation, maintenance of facilities is a field of research. I have been there to see how and why construction facilities are implemented, used and protected. The title holism is a good method for analyzing problems but also a tool for predicting the necessary characteristics of what we want to create. Holism is a way of thinking about a problem. Where it is applied it gives good results, especially in the long term. It allows one to see the consequences of the flow of time more easily than reductionism. The study of the causes of a problem is broader which allows us to better diagnose and solve it. It makes you always analyze the effects on the whole object and its environment. It places each problem in the context of nearer, farther, sometimes very far and the passage of time. An important element is the analysis of human behavior during the creation and life of the object.*

Most of the ways to research and determine the condition of objects are obviously known and used. The problem is to determine them (almost) all and the details. Understanding Aristotle's "The more you know, the more you realize you don't know." is crucial here. The point is to explore and come to a conclusion without "closing the door" to more sometimes diametrically opposed knowledge as you go along. Holism in construction can be formulated, describing principles so as to facilitate broader analysis. Such an approach is desirable, which will give the opportunity to benefit from the results to people with different levels of competence, that is, the majority. The purpose of the paper is to try to systematize the approach and show, with examples, why it is worth using.

Method: shown in the table are the elements of the research method used in the appraiser's practice.

Some areas and elements should be analyzed for the recognition and determination of conditions, impacts and behaviors of construction objects are described. It was determined how to situate the problem in the broadest possible context, with particular attention to typical human behavior. As it turns out, this context is underestimated here. Due to the small volume of the text, examples were limited to the analysis of two relevant elements: lime mortar brick masonry and monolithic reinforced concrete. Objects from the appraiser's practice were selected. For masonry, a school building from the early 20th century and a farmhouse from the mid-19th century. For reinforced concrete, the school swimming pool erected in 1968 and the building of the printing house from 1972, both in emergency condition.

Results: The time caesura is important for the results of the conducted research. The indicated errors in the selection of repair methods and materials are due to simplistic methods of analyzing problems. Overlooking the longevity of existence under different conditions and the most important influence of human behavior at each stage of the establishment, use and existence of building structures prove to be crucial.

***Table 1**. Examples of items considered during the study.*

Title	*Level of research, analysis*
General Scope.	*Guardian of identity and integration of communities, culture, civilization*
	Physical-biological-chemical product consisting of interconnected elements with different functions and interactions forming a whole
	Part of the happening history forcing changes for cultural needs and social development
	a place intended for people with their handicaps, social and individual behavior
	The object of a prolonged attack of environmental impacts
	The object of physical, chemical and biological interactions associated with long-term (centuries) maintenance of a state of usefulness or non-usefulness and the introduction of changes
Physical, chemical and biological phenomena.	*atmospheric conditions*
	The physical properties of building materials
	The composition of construction materials used in the construction of the facility, precipitation and deposits and their interaction
	Resulting from the type of object and material solutions used
	Arising from existing geological substrates
The influence of the environment near and far.	*Local natural impacts (typical, incidental)*
	supra-local natural impacts (long-term, incidental)
	Human-induced impacts (long-term, incidental)
Stratigraphy of change over time..	*aging of materials*
	use of repair materials
	changes in technology
	changes in culture
	interruptions and changes of use
	environment
	long-term changes caused by incidental events
Abnormalities resulting from human activity.	*creation process*
	process of use and existence
	protection
	reconstruction
	conflicts, especially armed conflicts

Keywords: *Holism, Durability, Renovations, Competence.*

1. Introduction

The 17th century physician and philosopher John Locke wrote that *wanting to understand disease by microscopic observation of the body is like trying to check the time by looking inside a clock*. It's been a while since the clock got old. It lacks confidence in its gait or no longer walks. It turns out that you can't fix a clock or cure a disease without examining the inside either. You can't predict lifespan without determining the immunities needed, determining the environment, external conditions, etc.

Everything that acts on an object from the inside, from the outside, through the passage of time, that characterizes and creates its usefulness and value makes up its holistic understanding. Thinking holistically is natural but not entirely simple and requires systematization in all areas. The greatest value of the holistic approach, in analyzing the state, is that it draws attention to the need to study interactions. It shows that reductionist analysis (reductionism) sometimes fails to show a significant increase or decrease in interactions in place of their expected simple summation. Holism posits that the whole is more or less than the sum of its parts. The state of the whole is not always constituted by the states of its parts. Holism and inseparability are related concepts but their exact relationship requires clarification. Holism is a methodological thesis according to which the best way to study the behavior of a complex system is to treat it as a whole, not just to analyze the structure and behavior of its component parts .

2 Holism in the Diagnosis of Existing Facilities

Preservation and maintenance of objects requires analysis of at least six levels: As a guardian of identity and integration of community, culture, civilization. As a physical-biological-chemical creation consisting of interconnected elements with different functions and interactions forming a whole. As a part of the happening history forcing changes for cultural needs and social development. As a place intended for people with their disabilities, social and individual behavior. As an object of long-term attack of environmental impacts. As an object of physical, chemical and biological impacts associated with the long-term (centuries) maintenance of a state of usefulness or non-usefulness and the introduction of changes.

2.1 Define, Name Physical, Chemical and Biological Conditions and Phenomena

Atmospheric conditions: precipitation including speed and energy of precipitation, humidity, winds including pressure effects on partitions and abrasive properties of deposits, insolation, temperature changes with special attention to rapid phenomena and transitions through 0^{o}C, In addition, it is proposed to supplement this group with wet and dry deposition, by atmospheric phenomena, of compounds and substances: chemical, organic and inorganic.

Physical properties of building materials: linear expansion (thermal, moisture), adhesion and cohesion, moisture content, solubility, hygroscopicity, changes in the state of aggregation (crystallization, freezing, evaporation, liquefaction), density, melting and softening point, viscosity, stiffness, ductility, elasticity, thermal conductivity, brittleness, vapor permeability, tightness, PH, electrical conductivity, electromagnetism, magnetism, smoothness, radioactivity, reflectivity, radiation absorption.

Composition of building materials used in the construction of the object, precipitation and deposits and their interaction: content of organic components, content of reactive and soluble components, content of mineral components, positive and negative interactions, resistance to internal and external interactions.

Resulting from the type of object and material solutions used: unheated objects - without thermal requirements, heated objects - with thermal requirements, temporarily unused objects.

Resulting from existing geological substrates: surface formation, surface water, bearing capacity of substrates including local susceptibilities and heterogeneities, layering of the ground, susceptibility to crustal movements natural and man-made, ground water level, level fluctuations, infiltration rate, directions, velocities of rainwater and groundwater runoff, contents of chemical compounds (including gases), minerals, organic particles, temperature, residues from previous use and development.

2.2 Identify the Impacts of the Near and Far Environment

Influences: local natural impacts (typical, incidental), supra-local natural impacts (long-term, incidental), human-induced impacts (long-term, incidental).

2.3 Identify and Name Changes over Time

Aging of materials: external impacts, internal impacts, repairs that accelerate the degradation of materials.

Stratigraphy of the use of repair materials: faulty analysis and poorly selected properties, unanticipated impacts, interactions, lack of contemporary equivalents.

Changes in technology: solutions change as knowledge increases, forgotten technologies, lack of understanding of the purpose of the technologies originally used.

Changes in culture: with the development of societies, with the development of science and technology, with access to facilities resulting from the development of civilization.

Interruptions and changes in use: periods of no use or reduced use, changes in use with changes in internal and external conditions.

Environment: changes in climate, changes in development, changes in the spread of organisms, changes in air, water, soil, electromagnetic pollution, geological changes.

Long-term changes caused by incidental events: war, earthquakes, tsunamis, terrorism.

2.4 Identify and Name Abnormalities Resulting From Human Activity

The process of creation. Influence of shape: the price of the design, the skills of the designer. Influence of materials: level of quality of workmanship, skills of technology selection, skills of material selection, workmanship changes, quality of selected materials, price. Influence of manufacturing technology: technology and workmanship skills, "obsolescence" of technology, culture. Impact of location: initial climate, foundation, usage.

The process of use and existence. Impact of location and neighborhood: long-term impact of climate, foundation, neighborhood. Influence of way of maintenance: way and quality of use, management, price. Influence of mode of current repairs: speed of response to damage, selection and quality of repair materials, ability to carry out repairs, price. Influence of time: long-term degradation of materials, economic development and long-term degradation changes in air, precipitation and water, cultural changes, changes in use. Climate impact: incidental and extreme phenomena, climate change, space impact (impact of landforms and vegetation especially high vegetation).

Conservation process. The impact of the status of an object. Influence of status and need for existence. Influence of the amount of operating expenditures.

The process of reconstruction. Influence of the ability to analyze the condition of the object (analysis of all elements above) and: identification of materials and structures, identification of degradation changes, selection of repair materials, quality of repair materials, implementation of repairs.

Incidental processes. Conflicts, especially armed conflicts.

3 Facilities

3.1 the School Building of the Teacher Training Center

The building is listed in the register of municipal and provincial monuments. The function of the building in accordance with the provisions of the local zoning plan. The facility underwent renovation about 15 years ago.

The building was erected in the historicizing style, with a predominance of classicizing forms. The ground plan of the building has an "L" letter plan, with a prominent central risalit at the front. It is a one-story building with an attic and a basement, partly of the basement type. The entrance opening in the form of a biforium, in the ground floor is topped with a triangular pediment, and in the tympanum is placed a circular blend. The elevations are divided by cordon cornices and a wide frieze, interrupted in the risalite. The first floor is decorated with rustication. In the risalite, the windows are closed in a semicircle, and the others are surrounded by profiled bands, on the first floor with shared window cornices above.

The building is constructed in traditional technology of solid ceramic brick on lime mortar. Ceramic ceilings on steel beams over the basement, the remaining wooden beam ceilings with a blind ceiling characteristic of the construction period (ca. 1863 - 1872). Flat wooden envelope roof covered with tar paper on full boarding.

The building is equipped with water and sewage systems, central heating, electricity, lightning protection and telecommunications.

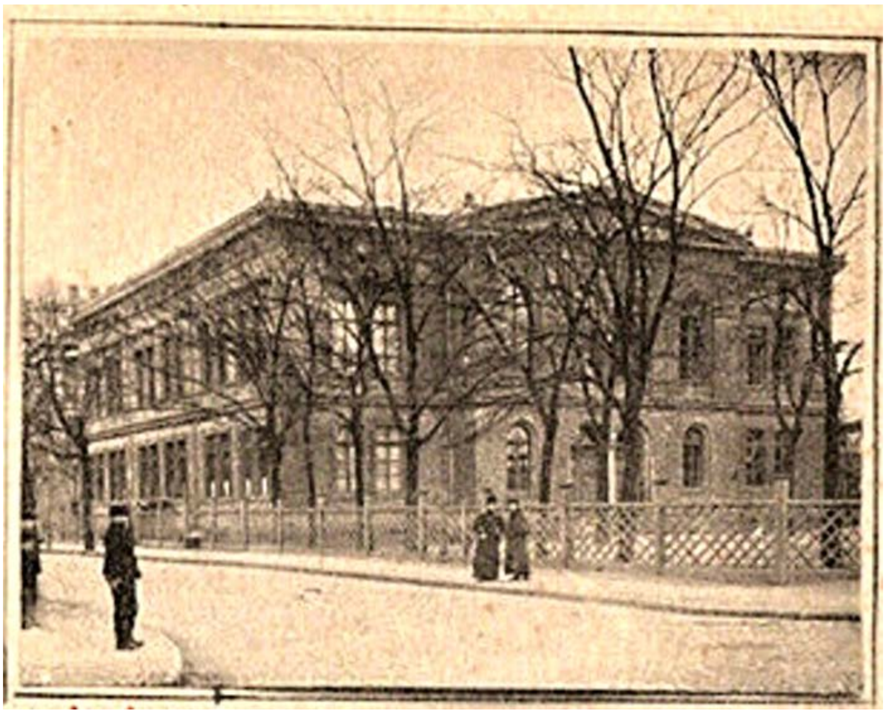

Fig. 1 Photo from around 1900

An extended survey of the solid brick masonry in lime mortar was performed. In places on the northern and eastern elevations with preserved original condition, well-preserved solid brick was found, with no significant cracks or damage to the facing layer. The lime mortar in this area has adequate strength. It is a typical mortar produced without the addition of calcium oxide (no lime clusters) which is symptomatic of the faster deterioration of the surface layer.

Fig. 2 Current state of the building 2023

As a result of the renovation 15 years ago, a surface repair layer of cement and cement-lime mortars with too much strength and tightness was applied. During the renovation, care was not taken to properly protect the underground part from the seepage of rainwater and groundwater. There was a disruption of moisture transport, drying and the impact of periodic temperature drops below 0^oC. The result was the complete destruction of plaster and limestone joints to a depth of about 2-3cm. After the repair layer was unraveled, shown in the photo, sand spilled out of the hole. The condition of the solid brick remains good despite the increased humidity.

Fig. 3 Plaster on an exterior wall 15 years after renovation. It shows the complete destruction of the lime mortar covered by a too-tight and too-strong repair system from one of the leading companies in the local market

In places on the south and west elevations, it was found, in an interview with the user, that there was significant deterioration of the original plaster and pointing, as well as the face layer of the bricks. This is an area with a significant impact of insolation, salt used to sprinkle the sidewalks during the snow and improper protection of the underground section from rainwater and groundwater.

Fig. 4 Plaster on exterior wall j/w. Shows lack of knowledge and skills at the stages of technical evaluation, design and execution. Unacceptable underlayment of cement render on brick wall in lime mortar

As a result of repairs 15 years ago, a repair layer was applied as on the north and east walls. In addition, a cementitious render was applied to level and "strengthen" the wall. The thickened roundup also restored the damaged rustication. There was deterioration of the repair layers with spalling. In this case, in addition to the previously described disturbances of moisture transport, drying, the impact of periodic temperature drops below 0^{o}C, there was strength and expansion incompatibility of the original wall material and improperly applied repair materials. The manner of distribution of moisture with significant salt content, crystallization, and the variation of humidity and temperature in different regions of the wall are also important elements of the damage here.

3.2 A Farm From the Mid-19th Century

A typical example of a farmhouse development with a two-room living area connected with the farm section (stables, barn, pigsty, poultry house). Attics designed for storing feed for the raised animals. The building is made of solid brick on lime mortar with a wooden roof and a ceiling in part wooden and in part, over the utility rooms, ceramic on wooden beams. It is interesting because of its layered wall with an air void and its location on a floodplain with shallow groundwater. Cut off from the influence of groundwater originally by the construction of a stone plinth masonry on lime mortar with the addition of a small amount of clay from local deposits. Layered wall without plaster of solid bricks on lime mortar in a 12-4-12 [cm] arrangement tied with bricks. Ceramic ceiling made of non-standard ceramic bore bricks joined by profiling the joints with lime mortar.

Fig. 5 The north wall of the outbuilding section with partial improper restoration with cement-lime mortar of the brick wall and cement of the stone plinth

Fig. 6 The southwest corner of the farm section showing the good condition of the brick improperly jointed with cement-lime mortar. Still without damage caused by improperly applied material

Poor technical condition. The building original to the level of the ceiling above the ground floor. Roof altered in non-historic layout. Walls over 150 years of use have been partially destroyed. The clay brick is preserved in relatively good condition which is probably due to the maintenance of tall greenery shading the building from the south and west sides. Lime mortar in very poor condition mostly almost without strength < 0.3 MPa. Improperly applied cement-lime mortar for piecemeal repairs has not yet managed to damage the brick. This is due to the prevailing hydrogeological drought, which has lowered the groundwater level, and the relatively low load on the walls. Improper grouting of the stone plinth with cement mortar has not yet had the destructive effects of uneven stiffening of the plinth and a potential increase in capillary rise in the mortar. The cement mortar is systematically cracking and falling off exposing the original lime mortar with clay.

3.3 School Swimming Pool of 1968

The pool building was constructed in 1966 - 1968. This time in the construction industry was characterized by significant difficulties in access to good quality construction materials and limited opportunities to obtain workmanship at a professional level. Construction work was carried out largely in community deeds and with the materials used (available) at the time. The visible effects of this condition in the area of the pool's location are the existing facilities in the neighborhood built at the same time and with the same technology. The main part of the pool was made as a reinforced concrete basin supported on poorly compacted soil. As the geological surveys carried out at the pool and in the immediate vicinity showed, not much attention was paid to proper compaction of the subsoil at the time. Not insignificant for this condition was the previous use of the land. Part of it was wild waste dumps and areas transformed to achieve land leveling - excavation, backfilling. The pool part of the facility was used intermittently until the last renovation (2017) without major repairs.

Fig. 7 Condition of the pool basin. Complete destruction of reinforcement, effect of carbonation of concrete

Important for the technical condition of the pool basin was the time of disuse of the pool which caused changes in humidity and temperature and increased air inflow (CO2) into the concrete of the basin, especially in areas of cracks. The swimming pool basin was constructed using monolithic reinforced concrete technology made at the construction site. The primary reinforcement was made of plain steel bars (St0S) with poor mechanical properties and significant susceptibility to corrosion and rheology. The primary shaping of the reinforcement at the point of contact between the walls and the bottom plate of the tank basin was done in an erroneous manner without ensuring the possibility of transferring the moments that open the contact. Such shaping of the reinforcement allows deformations that cause cracking of the non-tensile concrete. The concrete used for the primary reinforced concrete structure is characterized by significant porosity, heterogeneity and a strength class not exceeding C12/15. The condition shown in the above photo should be an indication directly to the scope of the repair. Unfortunately, the quality of the repair design, workmanship, supervision and excessive savings of the investor led to the failure, leaking after only 5 years of repair.

3.4 Printing Plant Building from 1972

A production building from the 1970s with no change of use throughout its existence. Prefabricated ceiling structure in part, made of 24cm thick reinforced hollow core slabs with a load capacity of 15 kN/m^2 supported by 30x50cm truss beams and 30x60cm stringers. concrete C16/20 steel 34GS. The remaining reinforced concrete monolithic ceilings on a grid of columns 6,0x6,0m with a section of 30x35cm, made of slabs 14cm thick reinforced with st0s steel, C12/15 heterogeneous concrete. The slabs cooperate with multi-span reinforced concrete stringers 25x55cm and 30x84cm (at expansion joints) of C12/15 heterogeneous concrete, St0S steel. columns supported on foundation footings. Foundations build on medium and fine sands layered with clay.

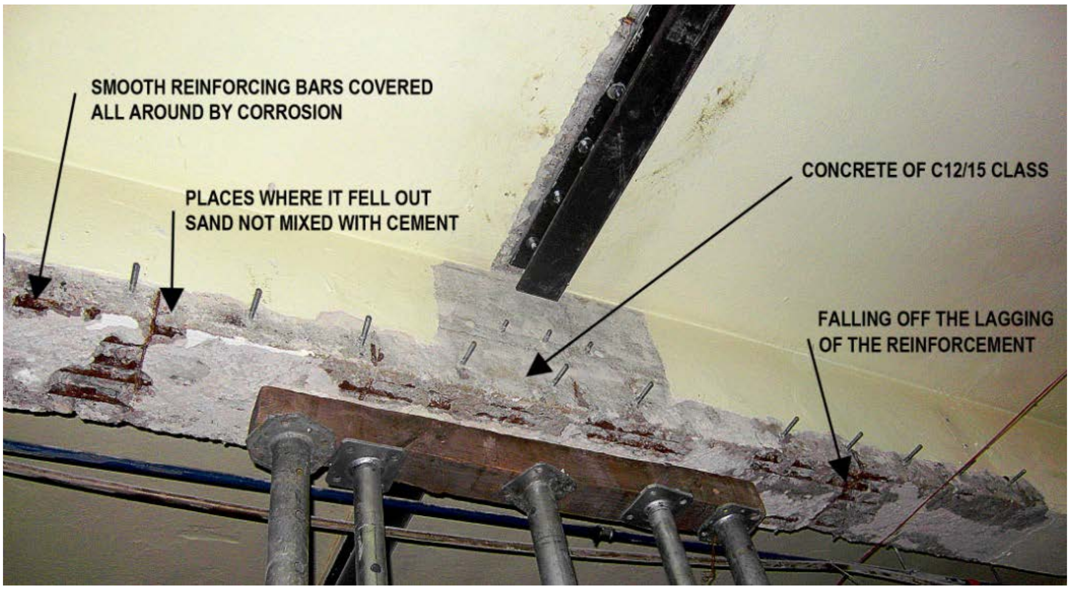

Fig. 8 Shown is an uncovered reinforced concrete beam in a structurally unsafe condition

The condition shown in the photo is an example of carbonation causing corrosion of reinforcement under conditions of increased air pollution (printing plant). Elements investigated that had a significant impact on the progression of deterioration were also: improper loading of the ceiling causing excessive deflection (8cm for a span of 600cm) and cracking of the ceiling, production interruptions with reduced internal temperatures, improper ventilation system, delaying repairs, improperly carried out repair work. Also of significance, unthinkable today, was the original design of the floor for high loads including dynamic loads with C12/15 concrete with St0S smooth reinforcement. (*St0S steel is a lower quality steel. It was used in the construction industry in the past for reinforcement of auxiliary elements and low load-bearing capacity*).

4. Conclusion

The analytical and research approach for determining the phenomena occurring in designed, operated, repaired, reconstructed facilities must be broad for determining all factors for making decisions on design, construction, repair, reconstruction, reconstruction of facilities. Treating facilities in a typical manner without considering detailed analysis at the location and time is unjustified. It cannot be as it is in most cases: "there is a hole and it leaks then it should be plugged". We holistically determine what the hole is, where it came from, what effect it had on the surrounding area, what effect of leaving it will be, what and how to repair it, and what the long-term effects of the repair will be on the hole and its surroundings. When listing and analyzing the elements of a site, it is important to remember that the whole is most important. A holistic view that collects overall and individual impacts makes it easier to see the non-obvious effects caused by them.

ORCID

Tomasz Szkuta: http://orcid.org/ 0000-0003-2089-1106

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