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MAINTENANCE PROBLEMS OF UNDERGROUND GARAGES IN RESIDENTIAL AND PUBLIC UTILITY BUILDINGS

PROBLEMY EKSPLOATACYJNE GARAŻY PODZIEMNYCH W OBIEKTACH MIESZKALNYCH I UŻYTECZNOŚCI PUBLICZNEJ

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Abstract

The article presents selected maintenance problems of underground garages in residential and public buildings. Numerous examples from the authors' engineering practice are presented. The characteristics of the most common failures and problems related to the repair of objects are discussed. The aim of the article is to emphasize the importance of proper diagnostics preceding an effective repair of damage.

Keywords: durability, underground garages, damages, maintenance, repairs

Streszczenie

W artykule przedstawiono wybrane problemy eksploatacyjne garaży podziemnych w obiektach mieszkalnych i użyteczności publicznej. Przedstawiono liczne przykłady z praktyki inżynierskiej autorów. Omówiono charakterystykę najpowszechniej występujących uszkodzeń oraz problemy związane z wykonywaniem napraw obiektów. Celem artykułu jest podkreślenie znaczenia właściwej diagnostyki poprzedzającej skuteczną naprawę uszkodzeń.

Słowa kluczowe: trwałość, garaże podziemne, uszkodzenia, utrzymanie, naprawy

1. INTRODUCTION

Due to the high costs of investment areas and more and more intensive development in urban agglomerations, contemporary collective residence facilities and public utility facilities usually have one or more underground floors. There may be located technical facilities for the service, storage rooms or parking spaces and communication routes for parking vehicles, which are occupying the largest surfaces. Underground garages are often treated by residents or property managers as a specific showcase of the facility, hence any shortcomings, especially the visible ones, of these spaces are the subject of frequent warranty claims and repairs. The issues described in the article largely result from errors and omissions in design, materials and workmanship that were present much earlier, and appeared only during the operation of the commissioned facilities.

2. TYPICAL OPERATIONAL PROBLEMS OF UNDERGROUND GARAGES

The underground storeys of structures are exposed to a quite specific system of impacts, usually significantly different from those located above the ground level.

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In particular, it may be related to the presence of groundwater, obstructed ventilation, accumulation of loads on the structure, high intensity of use and, very often, neglect in the area of maintenance and proper operation of the facility. Due to the above conditions, the degradation of the building's elements is accelerated. Particular nuisances include water leaks, deterioration of plasters, damage and wear of floors, corrosion of system components and drains. Structural damage indicates more serious technical problems and is an alarm signal for the facility manager that the safety of use may be endangered.

2.1. Moisture

Moisture is a particularly troublesome operational problem in underground garages. It may be more or less intense, depending on the source of the penetrating water and the characteristics of the structure. The most common leaks occur at the contact of the floor/concrete slab with the walls of the building (Fig. 1) or through the external walls at cracks (Fig. 2a) or improperly made structural expansion joints (Fig. 2b, 2c). If, for economic reasons, the structure was founded on continuous footings instead of the foundation slab, a much higher intensity of leakage and much higher repair costs can be expected. Also common are leaks through the places where the installation passes between floors (Fig. 2d) and leaks through floors (Figs. 3a, 3b, 3c) and ceilings, especially in the areas of the storey beyond the outline of the above-ground part of the structure. Leaks within the lift shafts (Fig. 3d) pose a serious threat. Moisture in the underground parts of the building may also be related to improperly functioning ventilation – in the period of high temperatures, water vapor may condense on the inner surfaces of the walls.

Fig. 1. Water rising at the joint between the floor and walls (a, b) and corrosion of steel elements (c) exposed to permanent moisture

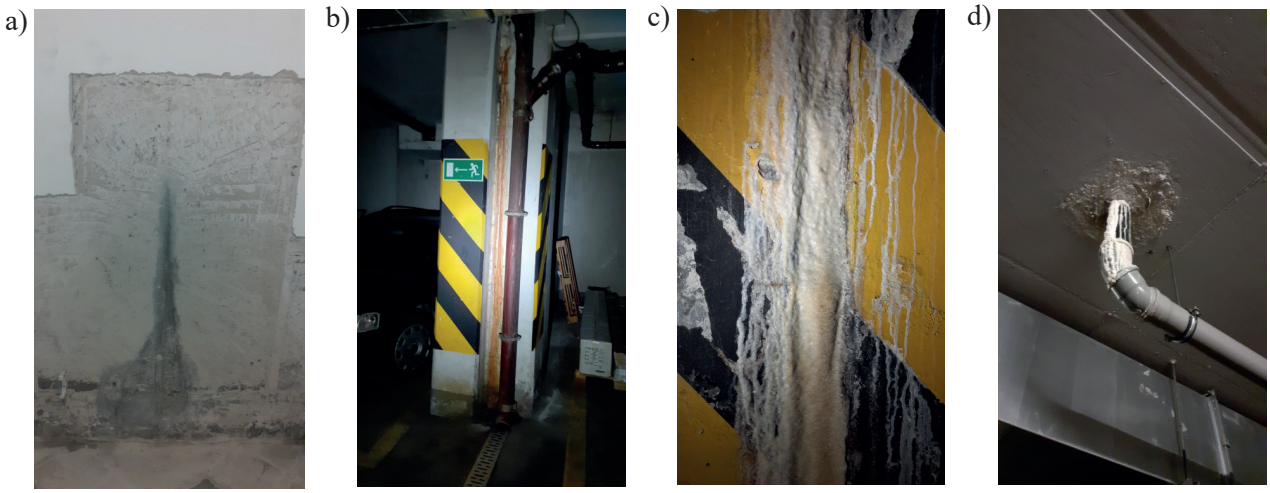

Fig. 2. Leaks through external walls (a), expansion joints (b, c) or installation penetration points (d)

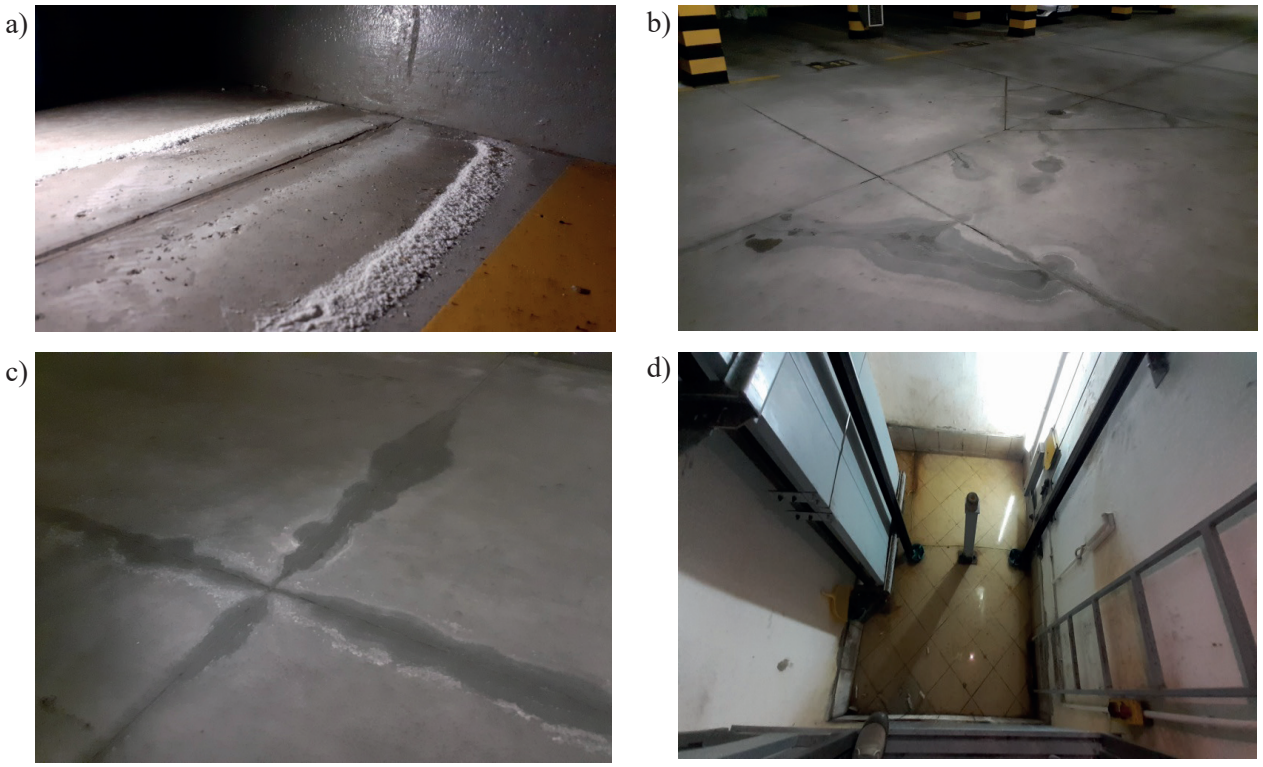

Fig. 3. Leaks through (a, b, c) floor / foundation slab, (b) lift shaft

2.2. Wear of the floor

The wear layer of garage floors is the area most exposed to damage related to mechanical, physical and chemical impacts. Water ingress, the presence of slush deposited by vehicles with de-icing agents (risk of chloride corrosion), intense abrasion (especially on ramps and curves) in the presence of sand and debris cause surface degradation. Surfaces in underground garages are usually finished in the DST (Dry Shake Topping) surface hardening technology or in the coating technology, less often as an additional unfinished surface, but only obliterated during concrete laying.

Floor wear is usually manifested as loosening (Fig. 4a), abrasions, extensive flaking or craters (Fig. 4b). Execution errors intensify the image of destruction, often manifested in the form of a regular grid of cracks (e.g. consistent with the location of the reinforcement mesh, Fig. 4c), surface heterogeneity or extensive cracks, e.g. in the vicinity of expansion joints.

Fig. 4. Damage to the usable floor layer: detachment of the resin coating (a), extensive concrete chipping (b), surface scratches (c)

Drainage is an important element of the floors in underground garages. Usually they are made in the form of linear or point drainage. Practice shows that this element of the garage surface is particularly sensitive. The maintenance of this system is often underestimated and neglected (Fig. 5a), and subsequent repairs are, unfortunately, extremely expensive and constitute a significant inconvenience for users. Common types of damage are channel cracks (Fig. 5b), corrosion (Fig. 5c, 5d) or deformations (Fig. 5e).

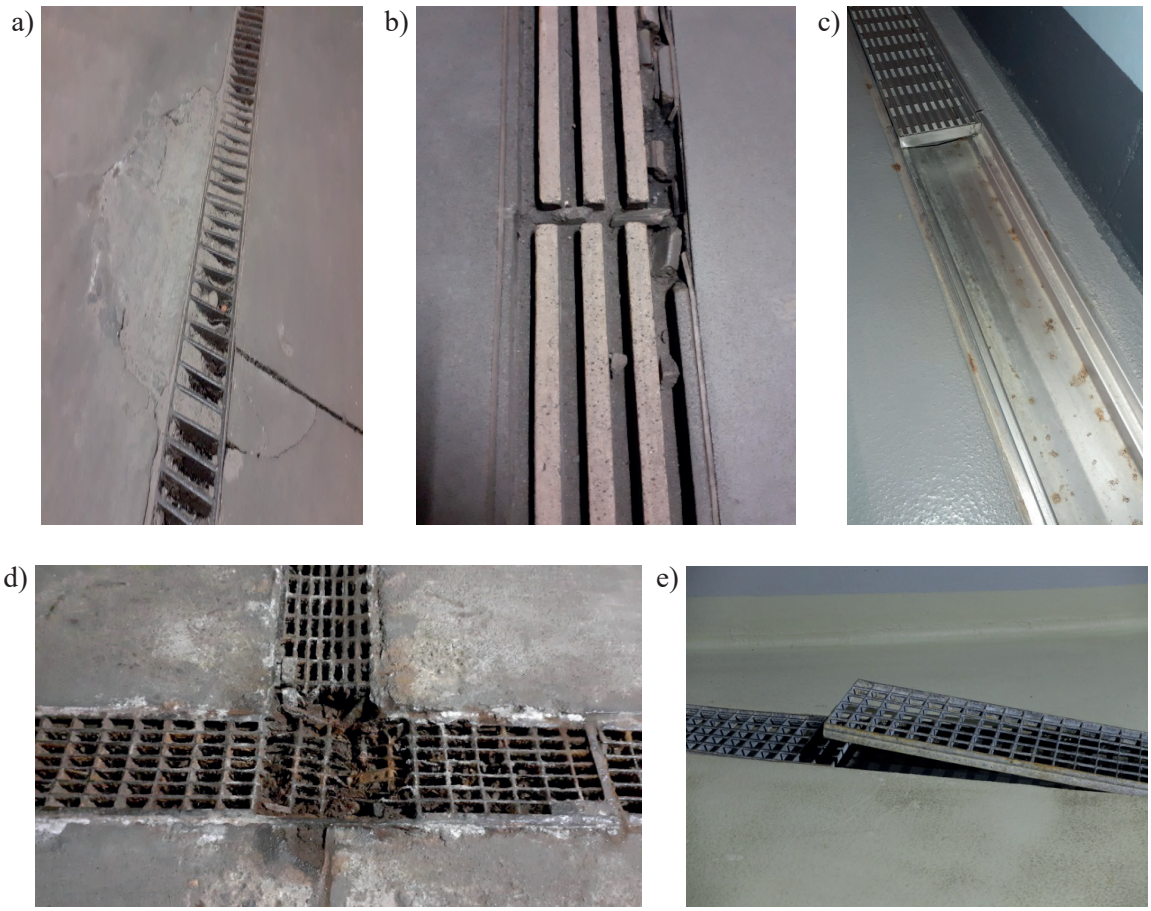

Fig. 5. Operational problems of linear drainage troughs: deformation (a), advanced corrosion of grates (b), negligence in maintenance (c), mechanical damage (d), corrosion of troughs (e)

2.3. Structural damage

Damage to the load-bearing system of garages, i.e. ceilings and binders, as well as walls and columns, usually appear in the form of scratches (Fig. 6a, 6b) and cracks (Fig. 6c). More serious symptoms appear as deformations or detachments of material. Such a state of the structure may indicate that the limit states of use or load capacity have been exceeded and should prompt the manager to take preventive measures. Contrary to the previously discussed damage, structural damage is usually identified only during the inspection of the object carried out by specialists in the course of periodic or ad hoc diagnostics of the object.

Fig. 6. Scratches in the ceilings (a), binders and columns (b) and cracks in the floor slabs (c)

3. REMEDIAL PROCEEDINGS

Remedial proceedings is a complex issue and each time requires a separate analysis covering a number of material, construction and functional issues [1, 5, 8, 9]. Practice shows that remedial proceedings are often carried out in the reverse order than it would follow from the rules of construction practice and technical knowledge. It happens that repairs are performed without prior analysis of the causes of damage or analysis of the actual impacts. Such action results in incorrect selection of materials and technical solutions and, consequently, ineffective repair (Fig. 7). The repair itself is sometimes performed only locally and not comprehensively, so the actual problem is not solved but only hidden. This generates even greater subsequent repair costs and organizational nuisance for the users of the facility. Correctly carried out corrective actions [2-6] should be preceded by an assessment of the condition of the object or its elements, which will allow to identify the scope and course of necessary remedial actions, and the principles and methods of repair should follow the concept of the PN-EN 1504 standard series. The scope of the analysis should include the assessment of design, material and construction reasons [10, 11]. The initial, indispensable stage of repair is, however, the diagnostics of the object [1, 5, 8, 9], which should be selected each time depending on the technical condition of the object and the expected scope of repairs and maintenance [12, 13].

Fig. 7. Examples of unsuccessful repairs performed only partially (a) or not in accordance with the construction practice (b-f)

4. SUMMARY

Problems at the operation stage of underground garages usually result from a combination of design, material, construction and functional reasons.

Correctly conducted remedial actions should be preceded by an in-depth analysis of the condition of the object or its elements, which will allow to identify the scope and course of necessary remedial actions, and the principles and methods of repair should follow the concept of the PN-EN 1504 standard series (Fig. 8). The initial, indispensable stage of repair, however, is the facility diagnostics, which should be selected each time depending on the technical condition of the facility and the expected scope of repairs and maintenance.

STAGE OF REPAIR	ELEMENTS IMPORTANT AT A GIVEN STAGE OF REPAIR
Use	Conditions and course of use, maintenance and upkeep
Condition diagnostics	Damage - classification and causes
Initial repair planning	Possibilities, principles, methods
Repair project	Defining the use of materials. Requirements for the substrate, repair materials and work
Performing repair work	Materials and equipment, quality control, health and safety issues
Receipt of repair work	Acceptance tests, preventive works, preparation of documentation

Fig. 8. Stages of repair according to PN-EN 1004-9 with the assignment of particularly important elements [6, 7]

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