Deterioration and Protection Of concrete structures in industrial facilities

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Abstract: Industrial buildings are known as structures that house factories and manufacturing plants. Industrial buildings and structures include separate premises designed to carry out production processes.
It is known that oil products are used in industrial buildings to operate machines. Owing to the possibility that some petroleum products such as kerosene and oil might fall on the ground of concrete structures, required precautions must be taken to prevent the negative effect of oil penetration in concrete holes, which affects the durability of concrete.
An initial objective of this project is to identify the negative effects of oil products on the physical, mechanical, and dynamic properties of concrete. Furthermore, this study set out with the aim of assessing the importance of some solutions in protecting the concrete foundations exposed to oil products in order to maintain their life.
Keywords: Concrete, oil, industrial buildings, physical and mechanical properties, protection.

INTRODUCTION

IT IS GENERALLY ACKNOWLEDGED THAT CONCRETE IS NOT HOMOGENOUS COMPOSITION. IT CONSISTS OF CEMENT MATERIALS SUCH AS PORTLAND CEMENT, SAND OR STONES WITH SUFFICIENT AMOUNT OF WATER. CONCRETE IS ONE OF THE MOST IMPORTANT SOLID AND STRONG MATERIALS. IT IS USED IN ALL KINDS OF BUILDINGS SUCH AS INDUSTRIAL CONSTRUCTIONS. OIL PRODUCTS ARE ALWAYS USED TO OPERATE MACHINES AND ENGINES WITHIN SUCH BUILDINGS. THEY MIGHT FALL ON CONCRETE STRUCTURES AND LEAD TO GREAT DECREASING OF THEIR CHARACTERISTICS AS A RESULT OF THEIR NEGATIVE EFFECT. THUS , CAUSING DEFORMATIONS IN THE CONCRETE STRUCTURE, HAZARDOUS EFFECTS AND COLLAPSE TO BUILDINGS. THE CONCRETE STRUCTURE IS CHARACTERIZED BY THE EXISTENCE OF PORES. THE GREATER THE PORES, THE MUCH PENETRATION OF OIL PRODUCTS .THE MAIN OBJECTIVE OF THIS INVESTIGATION IS TO STUDY THE EFFECT OF OIL PRODUCTS (SUCH AS KEROSENE, GAS OIL AND CRUDE OIL) ON THE COMPRESSIVE AND TENSILE STRENGTHS OF HIGH PERFORMANCE CONCRETE AND TO COMPARE THE BEHAVIOR WITH THAT OF CONVENTIONAL CONCRETE [1].

THE IMPACT OF OIL PRODUCTS ON THE PHYSICAL PROPERTIES OF CONCRETE.

Several reports have shown that oil products are distinguished by many physical properties that greatly affect the concrete such as oil viscosity. Viscosity is defined as the resistance of a liquid to flow. It is one of the most important physical properties of oil products that differ according to their type.

Oil is a noncompressible liquid. It presses into two directions vertical and horizontal once penetrates the concrete mixture. The defects or weaknesses in the horizontal direction cause destruction to pores structure and lead to create cracks in the concrete while the defects in the longitudinal direction are few because oil is a non-compressible liquid in pores and with the support of the concrete structure they carry this load and prevent distortions in the longitudinal direction.

Many studies reported that the negative effects of oil products increase with decreasing their viscosity. Viscosity has excessive effects on the compressing resistance and splitting tensile strength as they normally decrease with decreasing the viscosity [2].

THE EFFECT OF PETROLEUM PRODUCTS ON THE MECHANICAL AND DYNAMIC PROPERTIES OF CONCRETE

It is important to study the effect of crude oil saturation on the mechanical and dynamic properties of concrete. Thus, the same properties can be compared with water saturated samples. The most important of these characteristics:

- Static modulus of elasticity

It is a constant modulus representing the ratio of axial stress to axial strain of concrete exposed to axial forces. The static modulus of elasticity is higher in dry concrete immersed in water than that of concrete immersed in oil.

Practical experiments have demonstrated the negative effects of oil on the static modulus of elasticity. The modulus of concrete immersed in oil for 600 days decreases by (15.5-14 %) comparing to the modulus of samples immersed in water. The static modulus of elasticity becomes lesser with increasing the period of exposing to oil products as the penetration of oil in pores increases leading to breaking the pores and reducing the compression strength [3].

- Compressive and tensile strength:

Normally, another risky problem that might be happening in industrial buildings exposed to petroleum products is deformation by the time due to the permeability of oil in the concrete leading to catastrophic results.

In general, oil penetrates the concrete in different directions, not only in the vertical direction. It spreads out in all directions, which leads to changes in the concrete structure [4]. Practical studies stated that the compressive strength of the concrete is reduced by 40% to 70%, in case of compression while it decreases more concerning the samples exposed to the petroleum oils for a long time. The tensile strength is also lower for the concrete samples. The main reason for that dropping is that the molecules of petroleum products can penetrate the existing pores of the concrete and then apply a hydraulic presser inside the pore, which negatively affects the bonding forces of the aggregate and cement in the concrete.

- Modulus of rupture

The modulus of rupture is the resistance of concrete to indirect tension as a result of bending. The resistance of bending is usually greater than tension strength since the tension is equal to 60% of the former one [5].

The test of modules of rupture is one of the significant tests used for evaluating the bending strength of concrete and study the concrete behavior against bending loads.

The modules of rupture concerning oil-soaked concrete samples for 24 hours increases by (6 – 3 %). This increasing is followed by continuous decreasing of the modulus value with increasing the amount of oil absorbed and period of immersion (soaking).

- The dynamic modulus of elasticity

Concrete dynamic modulus of elasticity (E) is a ratio of change in stress to the change in strain at a certain level of cement in the concrete according to the following equation:

The dynamic modulus of elasticity (E) = Stress σ/ Strain ϵ

This value should be known as it is used in buildings designing and concrete structures. It differs according to the concrete type. Many studies have shown that the dynamic modulus of elasticity increases by (8 – 10 %) in terms of the saturated concrete in oil and based on the immersion period.

Prior studies have clarified that if we take two cubic samples of the same concrete mixture and immerse one of them in water and the other in oil for 25 days, the cubic immersed in water will be fully saturated; while the cubic immersed in oil is saturated with a rate of 97.5 % for the same period of time. It means that the pores in the concrete cubic sample were still empty. The existing of these pores decreases the density of concrete and consequently, reduces the modulus of dynamic elasticity. Accordingly, decreasing the modulus of dynamic elasticity reduces the concrete resistance against stress, which results in increasing deformations taking place in concrete [1]. Furthermore, the modulus of dynamic elasticity concerning the samples soaked in oil is (60 – 65%) the modules of samples immersed in water using the same soaking time.

- The Damping Capacity

The damping capacity in concrete is the ability of concrete to absorb vibrations and dynamics forces. It is one of significant dynamic features that should be studied in buildings exposed to continuous vibrations as a result of using equipment and machines, particularly industrial buildings. The damping capacity must be in an acceptable limit as it indicates the safety of concrete structures. It relies on the number of oil particles that fill the pores and the immersion period [4]. Practical studies demonstrated that the damping capacity of dry samples after being immersed in oil significantly rises during early days of soaking. Afterwards, it gradually decreases due to oil evaporation from pores [6] .

PROTECTION METHODS AGAINST THE OIL PRODUCTS

As mentioned in the literature review, oil products negatively affect the physical, mechanical and dynamic features of concrete foundations [2] . There are several possible solutions for this hazardous issue as follows:

1. Collect the waste of petroleum products dropped from machines or engines in metal pots.
2. Clean floors and concrete surfaces from the oil products waste.
3. Improve the strength of concrete structures used in the industrial buildings by adding materials such as:
    - ADDICRETE BVD that improves the compression resistance of concrete and increase its strength and density [7].
    - Insoluble materials named as Pozzolans that interact with Ca (OH)2 (as a result of the interaction of cement with water). These materials decrease the porosity of concrete as they occupy the concrete structure holes and consequently, reducing the penetration of harmful liquids such as oil.
    - Paint the concrete foundations by epoxy for instance as they are tough, tolerate heavy weightsresist chemical substances, anti-slip and add aesthetic appearance to the floors.
    - Covering the concrete structures by ceramic.

CONCLUSION

In conclusion, this paper has dealt with the effects of oil waste on concrete structures. It focused on the impact of used machines oil on the physical, mechanical and dynamic features of concrete. Many comparisons have been clarified for cubes soaked in oil waste for a certain time with that of oil-free concrete cubes. The study proposed that concrete materials or foundations should be free from oil contamination as they deteriorate their performance. Furthermore, in the current study, comparing the properties of oil contaminated concrete with clean one showed that necessary precautions should be taken to avoid the problem of oiling of structural elements presented in industrial building and consequently, prevent the considerable damage, which often impairs a building's exploitation.

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