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A physical study of plumbing life cycle in apartment houses

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Abstract

We know that extending the life span of a building can reduce environmental impact, and also save money with the viewpoints of life-cycle cost. But due to the complex system construction of buildings, if we apply the concept of life-cycle cost to design, we must consider it in coordination with the life spans of subsystems in order to avoid unreasonable wastage and problems of utility function. Concerning corrosion of piping, past documents mostly direct investigation and analysis to the physical or chemical characteristics of materials. This paper focuses on the plumbing system of a building, by matching up the investigation of practical cases, we determined the life span of a plumbing system in a building and try to offer an assessment system for a life-cycle model. This could be of use in life-cycle architectural planning and design.

Keywords: Life span; Building equipment; Corrosion of piping; Plumbing system; Life cycle

1. Introduction

The environment is an issue of deep concern all over the world in the latter half of the 20th century. According to a government announcement, CO_2 emission from energy consumption related to construction is 33% of the total produced in Taiwan. It means that building has a large impact on the environment. Therefore, how to reduce the global environmental impact from building construction has become a continuing concern in the field of architecture. The construction of a building is very complex including structure, material, interior, equipment, furniture, etc. Every system unceasingly consumes energy and resources from the planning, design and construction processes, through usage and demolition, and impacts the environment. We know that to extend the life span of a building could reduce the environmental impact, and also save money with the viewpoints of life-cycle cost. But, due to the complex construction system mentioned above, if we apply the concept of life-cycle cost to planning and design, we must consider the operation in coordination with each subsystem life span to avoid unreasonable wastage and problems of utility function. Concerning corrosion, aging or durability of building materials or equipment and machines, there are many achievements in past research and documents [1–3]. American and Japanese ASHRAE Handbooks and journals have many clear and definite data on durability of air-conditioning machines and plumbing systems [4,5]. These documents provide reference data on durability ranges. On the other hand, past documents mostly direct investigation and analysis to the physical or chemical characteristics of material, laying particular stress on experiments and guidelines [6–8]. There are few discussions of practical cases and application systems, because the elements of buildings are so complex and it takes long observation and verification of data. This paper focuses on the plumbing systems of buildings. We start from the observation of aging phenomena in whole building systems and analyze the life span of plumbing systems from practical cases. By matching up the investigation of practical cases, we determined the life-span range of plumbing systems in buildings and a simple model of the whole life cycle. Finally, we try to offer an assessment of the life-cycle model, which could be of use in building life-cycle planning and design.

2. Issues and investigation of plumbing system in apartment houses

In order to grasp the application of practical cases and verify plumbing system data, first, we performed field investigations to see plumbing system-related issues in buildings. The first observation in the area of Taipei indicates that most apartment houses still cover up the plumbing system

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Table 1
Composition of water supply system in building

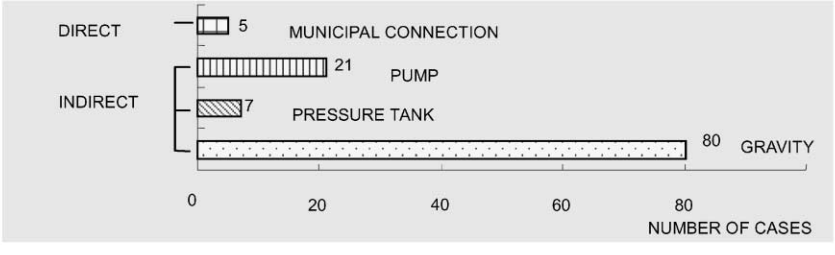
STORAGE	SERVICE PIPING	TERMINAL FIXTURE
BASEMENT TANK GROUND TANK ROOF TANK	SUPPLY PIPING CROSS CONNECTIONS VALVE PUMP	FAUCET SINK SHOWER WATER CLOSET
INLET POINT	DISTRIBUTION	OUTLET POINT

during construction. Therefore, as the building is finished, plumbing for maintenance or repair of will be troublesome and there will be no way to deal with failures or blocks of the piping and equipment. The only way to deal with a failure in the plumbing system is to tear down the construction for repair or discard the whole system. Meanwhile, it is impossible to modify or replace the system of its parts. The aging phenomenon of water supply piping will happen after a period of usage, especially the phenomenon is obvious in metal piping material. The covering up style is incapable of dealing with this trouble, except when water pollution is found or leaks happen, then we have to dismantle the construction and to build a new one. In the past, the concept of building life cycles was not paid much attention by designers, so existing buildings have no explicit renewal schedules. But in most renewal cases, plumbing system function are the major reason for the renewal decision.

The water supply system of a building would roughly include storage devices, piping systems and terminal faucets and implements, the composition as shown in Table 1. Concerning the field investigation of the present situation, we checked 113 cases of apartment houses in the Taipei area. The items of investigation included fundamental data on the building, elevated tanks, storage devices, piping systems and water quality. Owing to the covering up style of plumbing installation which was buried into concrete or hidden during construction or placed where it could not be easily observed, the paper's materials are mainly interviews with owners, managers, users or technical staffs of the buildings. According to the investigation results, the water supply systems can roughly be divided into four modes to supply water, that is a direct connect system, a pressure tank system, a gravity supply system or a pumping supply system. We found the gravity supply system is generally used in Taiwan. In this survey, as shown in Table 2, the direct connection system without a storage device only accounts for 4% of water supply systems, the others, which we could call indirect supply systems, account for 96%. Among storage devices, as shown in Table 3, concrete storage devices are most common, occurring in 66% of cases, the second is stainless at 16%, the others include fiber glass, plastic, etc. In this investigation, we also found that most people do not place importance on the hygienic condition of a storage device. Miscellaneous articles or objects always could be seen around storage devices. Cleaning frequencies, from interviews, are shown in Table 4. The most usual is the case of once for one year holding 34% of cases. The next is the case of 2 or 3 times per year which was 27%, less than once per year was 21%, never or have no idea was 11%. Therefore, it is necessary to enhance the general idea of hygiene management and maintenance for storage devices in water supply systems. The survey showed 71% of systems used PVC pipe combined with galvanized pipe. This is shown in Table 5. Besides, many plumbing systems are composed of mixed materials. Different materials have different connection methods, aging cycles, durability and corrosion endurance. The mixture of piping material leads to high risk of leaking. Among these problems, the issue of galvanized piping aging dominates life cycle and application functions of plumbing systems in buildings at present. Therefore, this paper is aimed at the issue of galvanized piping aging and corrosion. So we will discuss galvanized pipe and its implications further.

Table 2
Frequency of water supply system in building

WATER SUPPLY METHOD	NUMBER OF CASES	PERCENTAGE(%)
DIRECT FROM CITY MAIN	5	4
SUPPLY BY PUMP	21	19
SUPPLY BY PRESSURE TANK	7	6
GRAVITY WITH ROOF TANK	80	71
TOTAL	113	100



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