Chapter 1

INTRODUCTION

1.1 General

Different capacity conical towers are used to store a water for water supply schemes. Middle range capacity tanks are designed as conical shape especially due to its esthetically appealing view. Satisfactory performance of tanks during strong ground shaking is crucial since these structures are more important as post recovery infrastructure.

The shaft support of elevated conical tanks should have adequate strength to resist axial loads, and moment and shear forces due to lateral loads. These forces depend on the total weight of the structure which varies with the amount of contents present in the tank container. Typically, the seismic load analysis is performed for tank-full and tank-empty conditions, while analysis at other contents levels may be desirable if convective fluid motions are of significance.

In Sri Lanka, use of Conical type water towers for storing in almost has been a practice in the country for a considerable period. All the structures, designed have been carried out for high winds. However, hardly any designs were carried with sufficiently serious attention given for earthquakes, since the location of the Sri Lanka was not considered as an earthquake prone area.

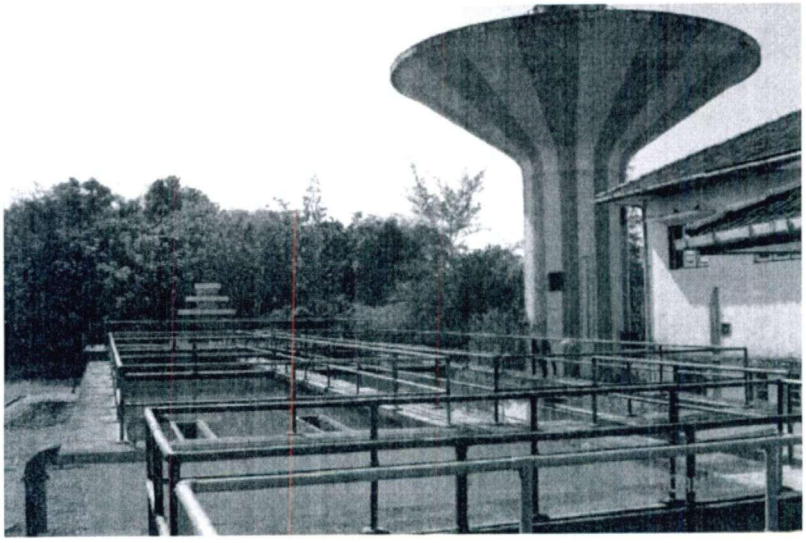

Figure 1 - Conical water tower in water supply scheme

When a tank containing liquid is subjected to lateral earthquake ground motion, the liquid exerts impulsive and convective hydrodynamic pressure on the tank wall in addition to the hydrostatic pressure. The impulsive component is the liquid mass in the lower region of the tank that moves in unison with the tank structure at a relatively short period. The convective component in the upper region undergoes a sloshing motion with a period that can exceed 10 seconds. In order to quantify these effects, tanks can be idealized as spring-mass models. The impulsive liquid mass (m_i) is rigidly connected to the structure while the convective liquid mass (m_c) is attached with springs.

1.2 Objectives

Main objectives of the research are listed below;

1. Investigate the structural adequacy of existing conical type water towers for earthquakes
2. Development of relationship with seismic analysis for the tanks which have designed for wind loads.

1.3 Methodology

In order to achieve the above objectives, the following methodology was adopted.

- Three different conical type water towers were selected which has capacities of 200m^3, 300m^3 and 750 m^3.
- These water towers were analyzed for 53.5m/s, 47m/s, 38m/s wind speeds which have been prescribed for post disaster structures for different zones in Sri Lanka.
- For earthquakes, dynamic analysis carried out for the same tanks using SAP 2000 – v14 for different soil types.
- For earthquake, base shear and moments calculated using spring mass model
- Base shear and moment induced on shafts due to wind and earthquakes were compared.

1.4 Main Findings

1. Existing structures which were designed for prescribed wind speeds were not adequate for resisting minor earthquakes.

2. Impulsive mode of most of the water towers would have a natural period of vibration (T) are in the range of 0.3s to 0.8s which will give the highest response (base shear and moments) in an Earthquake, irrespective of the height, thickness, diameter and grade of concrete of the supporting shaft.

3. Since the response corresponding to the Natural period of vibration (T) of the conical type water towers is very high, it is not practical to give general recommendations or guidelines. Therefore, it is advised to carry out a dynamic analysis for the design of conical type water towers, so that necessary changes to the shaft diameter and thickness can be selected to resist the expected loads.

1.5 Arrangement of Thesis

The second chapter of the thesis covers the literature study about modeling of water towers for earthquakes and response spectrum diagrams

The third chapter includes the detail description of existing water towers which were investigated during the research and mathematical modeling procedure of the towers.

The fourth chapter explains the analysis procedures and parameters which were used for analysis of structures.

In the fifth chapter, calculations related to the modeling and analysis work have been presented.

The sixth chapter includes comments and interpretations of results.

Chapter seventh gives the conclusions and recommendations for future studies.