Wind Effects on Overhead Tank under Different Soil Parameters

Aatish Kumar, R.K. Pandey, C.S. Mishra

Abstract- ***Large capacity elevated Intze tanks are used to store a variety of liquids, e.g. water for drinking and fire fighting, petroleum, chemicals, and liquefied natural gas. A water tank is used to store to tide over the daily requirements. Intze tank is a type of elevated water tank supported on staging. Intze tank is defined as bottom portion of circular tank is provided in flat shape, so in flat bottom, the thickness and reinforcement is found to be heavy. It is found in analysis that the bearing capacity increases for the same wind speed volume of concrete and quantity of steel both are decreased. Also, We have seen that in case of bearing capacity of soil 5 t/m*** ^{2} ***and 10 t/m*** ^{2} ***volume of concrete and quantity of steel are so high as compared to other.***

Key words: C++ programs, Intze tank, Over Head Tank, Soil Parameter, Wind Effect

I. INTRODUCTION

Water tanks are very important components of lifeline. They are critical elements in municipal water supply, fire fighting systems and in many industrial facilities for storage of water. A reinforcement concrete tank is a very useful structure which is meant for the storage of water, for swimming bath, sewage sedimentation and for such similar purposes. Reinforced concrete overhead water tanks are used to store and supply safe drinking water. With the rapid speed of urbanization, demand for drinking water has increased by many folds. Also, due to shortage of electricity, it is not possible to supply water through pumps at peak hours. In such situations overhead water tanks become an indispensable part of life. As demand for water tanks will continue to increase in coming years, quick cost prediction of tanks before its design will be helpful in selection of tanks for real design.

OBJECTIVES

1. To study the effects of wind load on the quantity of concrete and steel required to construct an Intze tank.
2. To study the effects of bearing capacity of soil on the quantity of concrete and steel required to construct an Intze tank.
3. To develop a software program for the design of Intze tank using C++.

Manuscript received on August, 2013.

Aatish Kumar, PG Student Department of Civil Engineering, Sam Higginbottom Institute of Agriculture Technology and Sciences, Allahabad - 211007. India

R.K. Pandey, Professor Department of Civil Engineering, Sam Higginbottom Institute of Agriculture Technology and Sciences, Allahabad - 211007. India

C.S. Mishra' Assistant Professor Department of Civil Engineering, Sam Higginbottom Institute of Agriculture Technology and Sciences, Allahabad - 211007. India

II. REVIEW OF LITRETURE

Sanjay P. Joshi (2000), conclude that:

Equivalent mechanical model for rigid type tanks for horizontal vibration is developed. Parameter of the model are evaluated for a wide range of shapes of the tank and compared with those of the equivalent cylindrical tanks. It is shows that the errors associated with the use of the equivalent cylindrical tanks model in place of the Intze tank model are small.

Luis A. Godoy, (2005), **conclude that**:

The damage due to buckling in thin-walled, short cylindrical aboveground tanks is discussed. Various sources of buckling are considered, including wind, earthquake, support settlement and vacuum during emptying of the tank. The results have been obtained using the computer packages ABAQUS and ALGOR.

Hasan Jasim Mohammed (2011), conclude that:

An application of optimization method to the structural design of concrete rectangular and circular water tanks, considering the total cost of the tank as an objective function with the properties of the tank that are tank capacity, width and length of tank in rectangular, water depth in circular, unit weight of water and tank floor slab thickness, as design variables.

METERIAL AND METHODOLOGY

Design Of Elevated Water Tanks (Intze Tank)

This study has emphases merely on elevated intze tank. design of liquid retaining structure has to be based on the avoidance of cracking in the concrete having regard to its tensile strength. It has to be ensured that no cracks in the concrete should be formed on the water face. The design of such tank in is done in two stages:-

(i) Membrane analysis
(ii) Analysis taking into account continuity effect at joints.
(iii) Membrane analysis: - In membrane analysis, the members are assumed to act independent of the others. The members are therefore subjected to only direct stresses and no bending moment is introduced.

(i) Analysis taking into account continuity effect at joints: - In membrane analysis, it was assumed that each members is independent of the other and therefore subjected to direct stresses only. However, due to continuity of joints between the members, joint reactions are introduced, due to which secondary stresses in the form of edge moment and hoop stresses are induced in members. Stresses due to continuity can be obtained by applying the principle of consistent deformations. At each joint, the horizontal deformation and angular displacement between the shells should be consistent.

GENERAL DESIGN REQUIREMENTS

(Indian standard code practice (IS: 3370-PART II-IV)

Plain concrete member of reinforced concrete liquid structure may be designed against structure failure by allowing tension in plain concrete as per the permissible limit for tension in bending specified in IS:456 (permissible stress in tension in bending may be taken to the same as permissible stress in shear). This will automatically take care of failure due to cracking.

PERMISSIBLE STRESS IN CONCRETE

a) For resistance to cracking: The permissible tensile stresses due to bending apply to the face of the member in contact with liquid. The member with thickness less than 225 mm and contact with the liquid on one side, these permissible stresses in bending apply also to the face remote from the liquid.

b) For strength calculation: In strength calculation the usual permissible stress, in accordance with IS: 456-2000, is used. Where the calculated shear stresses in concrete above exceed the permissible value, reinforcement acting in conjunction with diagonal compression in concrete shall be provided to take the whole of the shear.

PERMISSIBLE STRESS IN STEEL

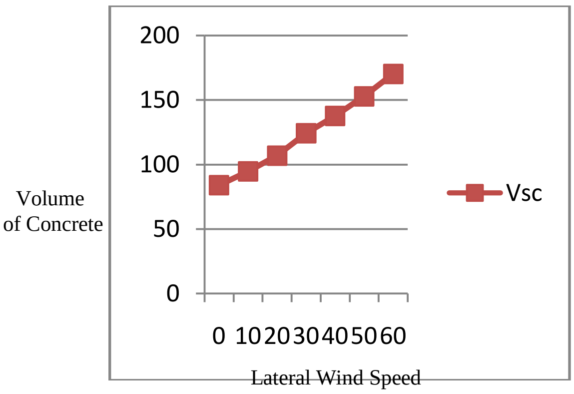
a) For resistance to cracking: When steel and concrete are assumed to act together for checking the tensile stress in concrete for avoidance of cracking the tensile stress in steel will be limited by the requirement that the permissible tensile stress in concrete is not exceeded so that tensile stress in steel shall be equal to the product of modular ratio of steel and concrete and the corresponding allowable tensile stress in concrete.

b) For strength calculation: In strength calculation the permissible stress in steel, in accordance IS: 3370 are used. When water is filled in tank container, the hydrostatic pressure will try to increase the diameter at any section of the tank. However, this increase in the diameter in all along the height of the tank will depend upon the nature of the joints. If the joint is flexible, it will be free to move outward and when the joint is fixed, no movement is possible, then a fixing moment will be induced.

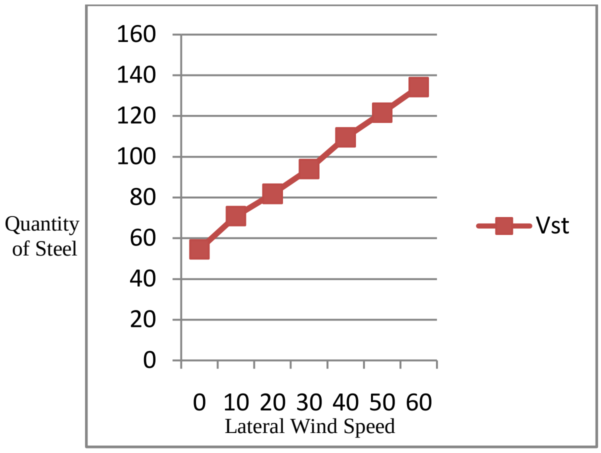
RESULTS ANALYSIS

The summary of design of Intze tank for the various wind speed and various soil parameter is given in graph below.

1. Results of intze tank: (bearing capacity 30 t/m²):- In this result for 30 t/m² bearing capacity of soil and different wind speed Volume of concrete (V_{sc}) and Volume of steel (V_{st}) are given below for super structure and sub structure

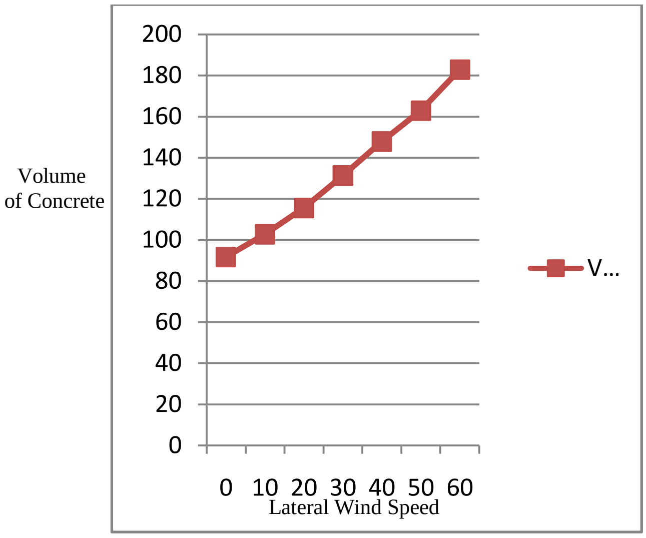


Graph-1.1 Between wind speed and volume of concrete

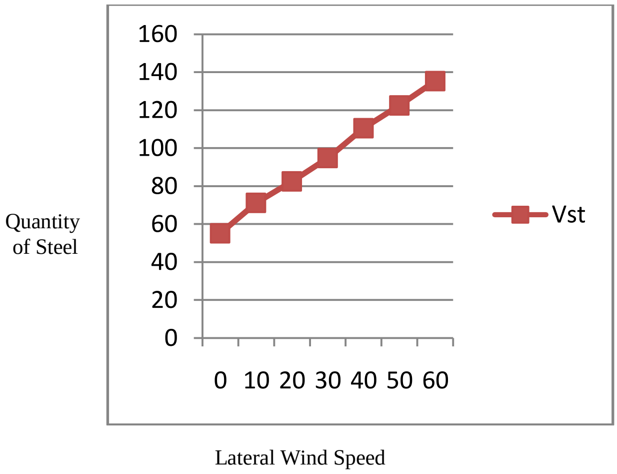


Graph 1.2 Between wind speed and volume of steel

2. Result of intze tank: (bearing capacity 25 t/m²):- this result for 25 t/m² bearing capacity of soil and different wind speed Volume of concrete (V_{sc}) and Volume of steel (V_{st}) are given below for super structure and sub structure

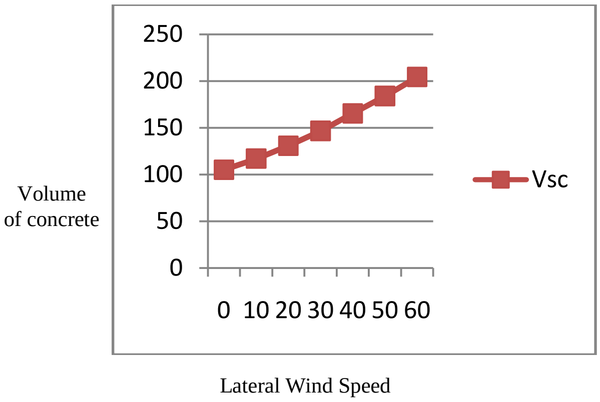


Graph 2.1 Between wind speed and volume of concrete

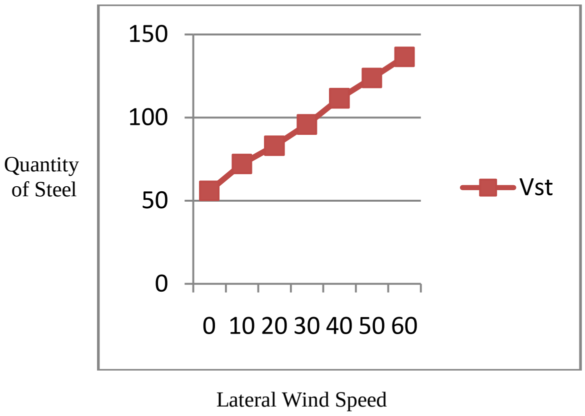


Graph2.2 Between wind speed and volume of steel

3. Result of intze tank: (bearing capacity 20 t/m²):- this result for 20 t/m² bearing capacity of soil and different wind speed Volume of concrete (V_{sc}) and Volume of steel (V_{st}) are given below for super structure and sub structure

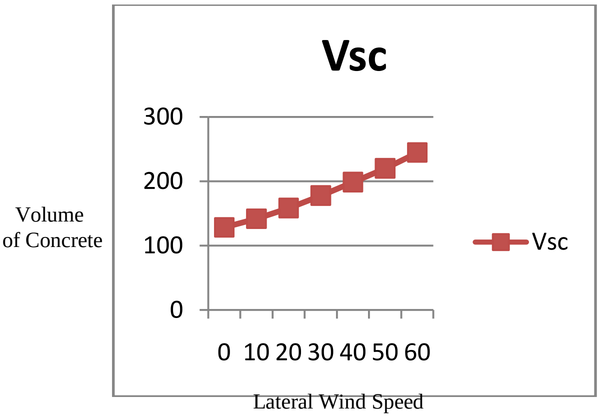


Graph 3.1 Between wind speed and volume of concrete

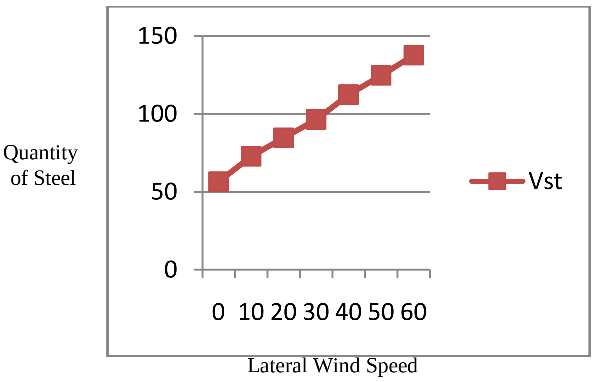


Graph 3.2 Between wind speed and volume of steel

4. Result of intze tank: (bearing capacity 15 t/m^2):- this result for 15 t/m^2 bearing capacity of soil and different wind speed Volume of concrete (V_{sc}) and Volume of steel (V_{st}) are given below for super structure and sub structure

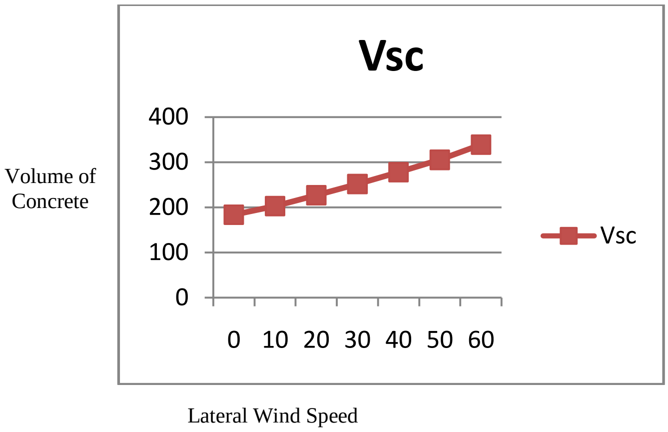


Graph 4.1 Between wind speed and volume of concrete

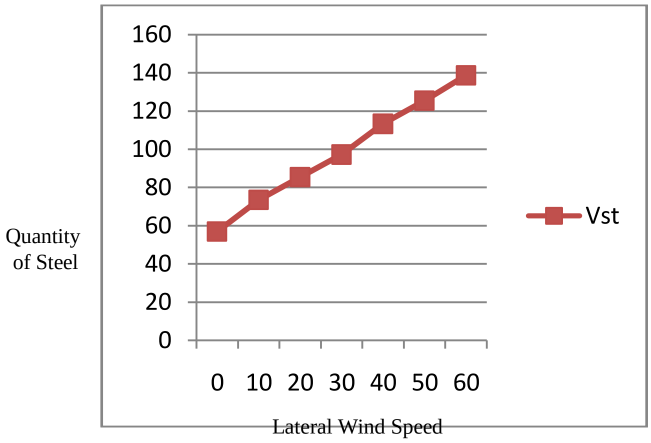


Graph 4.2 wind speed and volume of steel

5. Result of intze tank: (bearing capacity 10 t/m^2):- this result for 10 t/m^2 bearing capacity of soil and different wind speed Volume of concrete (V_{sc}) and Volume of steel (V_{st}) are given below for super structure and sub structure

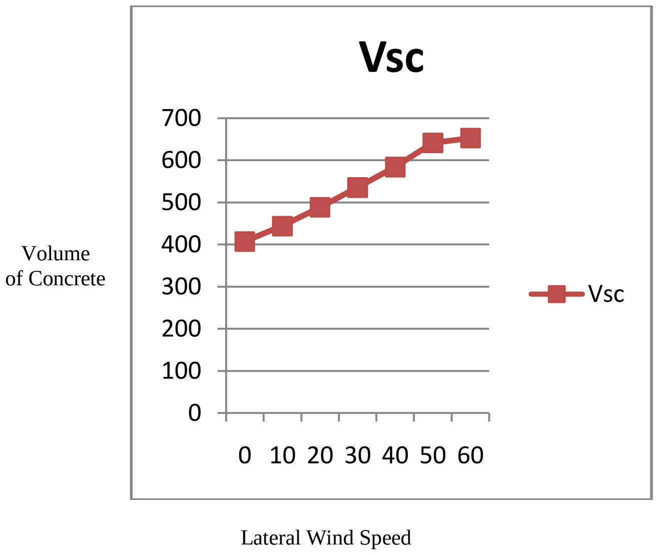


Graph 5.1 wind speed and volume of concrete

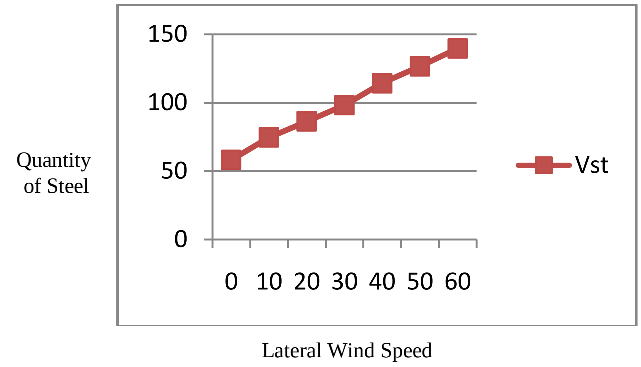


Graph 5.2 wind speed and volume of steel

6. Result of intze tank: (bearing capacity 5 t/m^2):- this result for 5 t/m^2 bearing capacity of soil and different wind speed Volume of concrete (V_{sc}) and Volume of steel (V_{st}) are given below for super structure sub structure

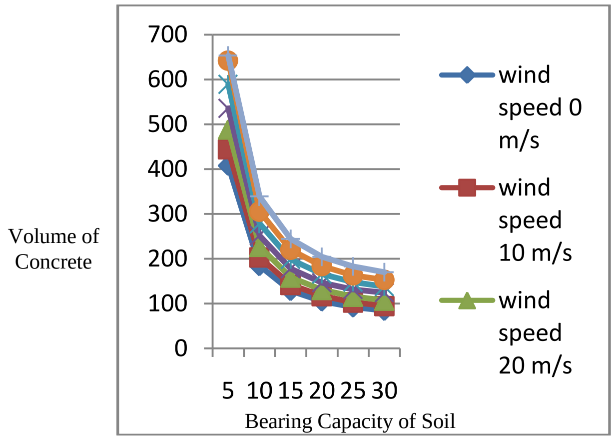


Graph 6.1 wind speed and volume of concrete

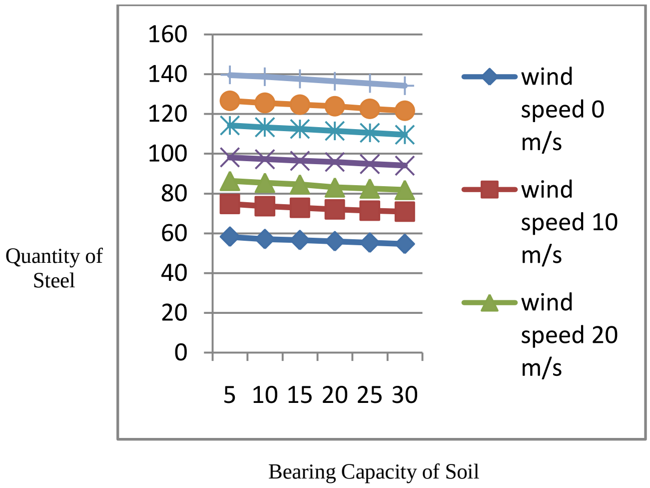


Graph 6.2 wind speed and volume of steel

Graph 7. Combined graph of bearing capacity of soil, volume of concrete and wind speed



Graph 8.Combined graph of bearing capacity of soil, quantity of steel and wind speed



CONCLUSION AND FUTURE WORK

We have seen that the result of Intze tank for the different wind speed and different bearing capacity in the form of graphs. From the above result as discussed as below:-

1. As the wind speed increases for the same bearing capacity volume of concrete and quantity of steel both are increased.
2. As the bearing capacity increases for the same wind speed volume of concrete and quantity of steel both are decreased.
3. We have seen that in case of bearing capacity of soil 5 t/m^2 and 10 t/m^2 volume of concrete and quantity of steel are so high as compared to other.
4. Depth of foundation in the soil of bearing capacity 5 t/m^2 and 10 t/m^2 is increased 2m and 1m respectively.
5. It's remarkably from the above given graph that the volume of concrete and quantity of steel in super structure are same while the volume of concrete and quantity of steel in sub structure are varying with variation in the value of wind load and soil bearing capacity.
6. From graph 7, we analyzed that for values of bearing capacity of soil, as wind speed increased by 10 m/s, the quantity of concrete is increased by @ 1%.
7. From graph 8, we analyzed that for values of bearing capacity of soil, as wind speed increased by 10 m/s, the quantity of steel is increased by @ 0.65%.
8. From graph 9, we analyzed that for values of wind speed , as bearing capacity increased by 50 N/m^2, the quantity of concrete is decreased by @ 8%.
9. From graph 10, we analyzed that for values of wind speed , as bearing capacity increased by 50 kN/m^2, the quantity of steel is decreased by @ 0.32 %

Further work: **-**

1. For further scope of study we analyzed and design of an Intze tank for different earthquake effects parameters.
2. In design of an Intze tank for varying height of staging and saw the results.
3. By using the language C/C++, any one can develop any other software.

REFERENCES

[1] IS: 875 (2002) "Code of Practice for Design Load" Bureau of Indian Standard, New Delhi.

[2] IS: 3370 (1965) (Part I) "Code of Practice for Concrete Structures for The Storage of Liquids" General Requirements, Bureau of Indian Standard, New Delhi.

[3] IS: 3370 (1965) (Part II) "Code of Practice for Concrete Structures for the Storage of Liquids" Reinforced Concrete Structures, Bureau of Indian Standard, New Delhi.

[4] IS: 3370 (1967) (Part IV) "Code of Practice for Concrete Structures for the Storage of Liquids" Design Tables, Bureau of Indian Standard, New Delhi.

[5] IS: 456 (2000) "Plain and Reinforced Concrete – Code for Practice" Bureau of Indian Standard, New Delhi.

[6] J. Krishna, and O. P. Jain (2000) "Plain and Reinforcement Concrete" Nem Chand and Bros, Vol.1and Vol.2.

[7] B. C. Punmia, A. K. Jain, and A.K. Jain, (2001) "R.C.C. Design", Laxmi Publications (P) LTD, New Delhi.

[8] J. Krishna, and Jain O. P. (2000) "Plain and Reinforcement Concrete" Nem Chand and Bros, Vol.1and Vol.2. 116

[9] N. Krishna Raju, "Advanced Reinforced Design" CBS Publishers and Distributers, New Delhi.

[10] S. Ramamrutham and R. Narayan "Design of reinforced Concrete Structure" Dhanpat Rai Publishing Company (P) LTD, New Delhi PVT. LTD.

[11] IS: 456 (2000) "Plain and Reinforced Concrete – Code for Practice" Bureau of Indian Standard, New Delhi.

[12] J. Krishna, and O. P. Jain (2000) "Plain and Reinforcement Concrete" Nem Chand and Bros, Vol.1and Vol.2.

[13] J. Krishna, and Jain O. P. (2000) "Plain and Reinforcement Concrete" Nem Chand and Bros, Vol.1and Vol.2. 116

[14] Luis A. Godoy, "Damage Due To Buckling In Above Ground Storage Tank", University of Puerto Rico, Mayaguez, PR 00681 – 9041, Puerto Rico.

[15] Meen-Wah Gui and Balasingam Muhuthan, (2006), "Bearing Capacity of Foundations on Sand Using The Method of Slip Line", Journal of Marine Science and Technology, Vol. 14, No. 1, pp. 1 - 14