# Mechanical Engineering, Materials Science and Civil Engineering

Edited by
Jeremy (Zheng) Li

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# Mechanical Engineering, Materials Science and Civil Engineering

Selected, peer reviewed papers from the
2014 3rd International Conference on
Mechanical Engineering, Materials Science and Civil Engineering
(ICMEMSCE 2014),
October 25-26, 2014, Phuket, Thailand

*Edited by*

**Jeremy (Zheng) Li**

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# Preface

Dear Distinguished Authors and Guests,

The Organizing Committee warmly welcomes you to 2014 the 3rd International Conference on Mechanical Engineering, Materials Science and Civil Engineering (ICMEMSCE2014) (http://www.scientific.net/conference-1161.), held on 25-26 Oct., 2014 in Phuket, Thailand.

The aim of the ICMEMSCE2014 is to present the latest research and results of scientists (professors, students, PhD Students, engineers, and post-doc scientist) related to Mechanical Engineering, Materials Science and Civil Engineering topics. This conference provides opportunities for the different areas delegates to exchange new ideas and application experiences face to face, to establish business or research relations and to find global partners for future collaboration.

After the peer-review process, the submitted papers were selected on the basis of originality, significance, and clarity for the purpose of the conference. The selected papers and additional late-breaking contributions to be presented as lectures will make an exciting technical program. The conference program is extremely rich, featuring high-impact presentation. We hope that the conference results constituted significant contribution to the knowledge in these up to date scientific field.

The proceeding records the fully refereed papers presented at the conference. The main conference themes and tracks are Mechanical Engineering, Mechatronics, Electrical System, Material Engineering and Processing Technologies, Machines, Equipment and Manufacturing Engineering, Information Science, Control and Automation, Biomedical Engineering, Methods, Systems of Modeling and Simulation, Design Technology and Industrial Engineering, Theory and Application of Civil Engineering. Hopefully, all participants and other interested readers benefit scientifically from the proceedings and also find it stimulating in the process.

On behalf of the organizing committee, I would like to especially thank Nguyen, Yvonne and all the editors from Trans Tech Publications for their great support to ICMEMSCE2014. Without their excellent editorial work, ICMEMSCE2014 will not be published so timely and successfully.

Finally we wish all the authors and attendees of ICMEMSCE2014 a unique, rewarding and enjoyable memory at ICMEMSCE2014 in Phuket, Thailand. We look forward to your participation in the 4th ICMEMSCE2015 in HongKong.

With our warmest regards,

Jeremy (Zheng) Li

The ICMEMSCE2014 Conference Guest editor

Oct. 31, 2014

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# CATIA-BASED STRENGTH ANALYSIS ON KEY COMPONENTS OF LARGE BULB TURBINE

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**Keywords:** Tubular turbine; CATIA software; Strength analysis

**Abstract.**Tubular hydropower station is a better way in the development of low-head hydraulic power resources. More and more people begin to study the tubular turbine in depth with the development of hydraulic power recourses in the direction of low head and large capacity. With the unique structural features and adaptive head range of tubular turbine, its development is very fast in recent years. The strength analysis of a tubular turbine is an important research aspect with the increasing of its capacity. Bulb turbine is one of the main types of tubular turbines. This paper uses CATIA software and finite element analysis to analyze and calculate the strength and deformation of key components of a bulb turbine, so as to ensure the bulb turbine's safe and reliable operation.

## Introduction

The development of hydraulic resources in China is mainly concentrated in low head and high head zones. And tubular turbines are mainly used for low head situations. Bulb turbine is the main type of turbine used in the development of low head hydraulic resources. Its structural dimension is increasing with the increasing of unit output. Bulb turbine is frequently used in the development of low head hydraulic resources in domestic and foreign countries, so it is really important.

The unique structure of bulb turbine leads to a low strength. The strength of various components of the unit during the operating process directly determines the safety operation of the power station and the power grid. Therefore, the strengths of various components of the unit play an important role in the safety operation.

Meanwhile, the rationality of strength is also one of the standards in measuring the design effect. Traditional strength analysis verifies the strengths of components by theoretical calculation. This method can only be used to analyze the strength of components with regular shape and the material must be distributed uniformly. However, hydraulic machinery is mainly composed of curved surface and other irregular geometries, so its strength analysis has certain difficulties [2]. In this paper, CATIA software is used to establish the geometric model and analyze the stress of key components of bulb turbine. This software is also used to discuss the strength calculation methods of bulb turbine. This can provide references for the design and optimization of large bulb turbines and the safety operation of hydropower stations.

## CATIA-Based Strength Calculation Method

The unsteady 3D incompressible continuous equation and Reynolds average Navier-Stokes equation (RANS) are used to simulate the flow in the draft tube. Meanwhile, RNG turbulence model closed equations are used. The unstructured tetrahedral meshes are used. The finite volume method is used to disperse the control equations in the unstructured meshes. Finally, reasonable boundary conditions and initial conditions are applied. The simulation calculation is conducted in given geometric parameters and different flow conditions.

The most powerful method in strength analysis is the finite element method. With the rapid development of computer technology, the finite element method is developing rapidly, and it is also widely used in the structural design and analysis of hydraulic machinery [3]. At present, CATIA software can be used to establish a working environment for the entire development process of a product. Especially in the research and development of hydraulic machinery, it can simulate all aspects of the development process [4].