APS BLASTING

APS Blasting 1

NEW DEVELOPMENT ON ENGINEERING BLASTING

Editor in Chief

Prof. WANG Xuguang

METALLURGICAL INDUSTRY PRESS

APS BLASTING

APS Blasting 1

NEW DEVELOPMENT ON ENGINEERING BLASTING

Editor in Chief
Prof. WANG Xuguang

METALLURGICAL INDUSTRY PRESS

Published and distributed by
metallurgical Industry Press
39 Songzhuyuan North Alley, Beiheyan St
Beijing 100009, P.R. China

图书在版编目(CIP)数据

工程爆破新进展：英文/汪旭光主编. —北京：冶金工业出版社，2007.4
ISBN 978-7-5024-4278-1

Ⅰ.工… Ⅱ.汪… Ⅲ.爆破技术－文集－英文 Ⅳ.TB41-53

中国版本图书馆 CIP 数据核字(2007)第 053446 号

出 版 人 曹胜利 (北京沙滩嵩祝院北巷 39 号，邮编 100009)
责任编辑 刘 源 程志宏 美术编辑 李 心 版面设计 张 青
责任校对 侯 瑚 李文彦 责任印制 丁小晶
ISBN 978-7-5024-4278-1
北京百善印刷厂印刷；冶金工业出版社发行；各地新华书店经销
2007 年 4 月第 1 版，2007 年 4 月第 1 次印刷
210mm×297mm；38.5 印张；1330 千字；600 页；1－400 册
冶金工业出版社发行部 电话：(010)64044283 传真：(010)64027893
冶金书店 地址：北京东四西大街 46 号(100711) 电话：(010)65289081
(本社图书如有印装质量问题，本社发行部负责退换)

The Asian-Pacific Symposium on Blasting Techniques

(2007)

APS BLASTING 1

The Asian-Pacific Symposium on Blasting Techniques 2007 is abbreviated to "APS BLASTING 1". With the great effort and contribution from the experts, scholars, and engineers throughout the Asian-Pacific area in industrial explosives, engineering blasting and other related fields, we hope and believe the Asian-Pacific series Symposium on Blasting Techniques will go ahead smoothly and successfully.

ORGANIZED BY:

China Society of Engineering Blasting

CO-ORGANIZED BY:

Guangdong Handar Blasting Engineering Corporation
China Gezhouba (Group) Corporation
Guizhou Xinlian Blasting Engineering Corporation
Rock and Earth Engineering Corporation, China Railway Erju Co., Ltd.

HONORARY CHAIRMAN:

Prof. FENG Shuyu, Academician of Chinese Academy of Engineering (CHINA)
Prof. KANG Yi (CHINA)

CHAIRMAN:

Prof. WANG Xuguang, Academician of Chinese Academy of Engineering(CHINA)

VICE CHAIRMAN:

Dr. ZHENG Bingxu (CHINA)
Prof. WEN Dejun (CHINA)

THE ORGANIZING COMMITTEE MEMBERS (in alphabetical order):

Dr. BHANDARI Sushil (INDIA)
Prof. CAO Guangjing (CHINA)

Mr. CARLOS P. Orlandi (CHILE)
Dr. Chang-Ha Ryu (REPUBLIC OF KOREA)
Mr. CHIAPETTA Frank (USA)
Gen. Manager DU Fangxian (CHINA)
Mr. Francisco Mardones B. (CHILE)
Prof. GU Yicheng (CHINA)
Mr. HUSTRULID William (USA)
Prof. KANEKO Katsuhiko (JAPAN)
Prof. KUNIHISA Katsuyama (JAPAN)
Prof. LI Lin (CHINA)
Prof. LI Yongchi (CHINA)
Dept. Head LIN Jusheng (CHINA)
Dr. LIU Dianshu (CHINA)
Prof. LIU Honggang (CHINA)
Dr. LIU Yuntong (CHINA)
Mr. Mckenzie Keith Cameron (AUSTRALIA)
Prof. MIAO Yangang (CHINA)
Prof. MOHANTY Bibhu (CANADA)
Mr. Oon Hoe Sing (MALAYSIA)
Mr. RICHARDS Alan B. (AUSTRALIA)
Prof. Sergei D. Viktorov (RUSSIA)
Mr. SPATHIS Alex (AUSTRALIA)
Dr. SUMIYAA Ganjargal (MONGOLIA)
PhD. Terushige Ogawa(JAPAN)
Prof. WANG Hao (CHINA)
Prof. WANG Maoling (CHINA)
Prof. WANG Yaohua (CHINA)
Prof. WANG Yunmin (CHINA)
Prof. WANG Zhongqian (CHINA)
Mr. WU Chengqing (SINGAPORE)
Prof. XIAO Chun (CHINA)
Gen. Manager XIE Xianqi (CHINA)
Dr. XIONG Daiyu (CHINA)
Prof. XU Tianrui (CHINA)
Dr. XUE Peixing (CHINA)
Dept. Deputy Head YAN Zhengbin (CHINA)
Dept. Head YANG Fu (CHINA)
Prof. YANG Jun (CHINA)
Prof. YU Yalun (CHINA)
Prof. ZHANG Yongzhe (CHINA)
Prof. ZHANG Zhengyu (CHINA)
Prof. ZHOU Jiahan (CHINA)

SECRETARIES GENERAL:

Prof. ZHANG Shixun (CHINA)
Prof. QU Shijie (CHINA)

EDITORIAL BOARD

PREFACE

Asia-Pacific region is the most active region globally in the field of engineering blasting. As the biggest producer and the largest consumer of industrial explosive material, China has produced 2606900 tons of industrial explosives and 3159000000 shots of industrial detonator in 2006. Engineering blasting plays an important role in various fields critical to national economical development and construction, especially at the golden stage when China's economy keeps a strong momentum for growth in recent years, which greatly boosts the development and innovation of blasting technology. To further promote the development, China Society of Engineering Blasting has stipulated a blueprint for medium and long-term development as well as a standard system to steer over engineering blasting industry in China. USA, Australia and Canada are among the big producers of blasting equipment, meanwhile they boast of advanced blasting technology in mining industry. Japan and South Korea, attaching great importance to environmental protection and safety, have accumulated rich instructive experience. Countries like Russia, India and Chile have fostered a great number of outstanding blasting engineers active on international stage. In one word, it is no exaggeration to say the development of blasting technology in Asia-Pacific region is of far-reaching influence in the world.

In a bid to further promote the development, thanks to the advice and suggestion from discussion with experts in Japan, South Korea, India, USA, Canada, Chile and Russia etc, the first Asia-Pacific Symposium on Blasting Technology, after two years of well-arranged preparation, will be held from May 8,2007 to May 11,2007 in Kunming, China. The theme of the Symposium is to strengthen the academic exchange and technological cooperation among various nationalities in Asia-Pacific region, to enhance inter-disciplinary penetration, to brainstorm about the opportunities, challenges and counter-measures faced by blasting technology in the new century and to explore the application prospects in other fields. The Symposium offers a valuable opportunity for experts, professors and engineers engaged in industrial explosives, engineering blasting and relevant fields to enhance understanding and cooperation in a bid to boost the development of blasting technology in the world. I hope and believe this series Symposium will go ahead smoothly and successfully.

This Symposium has attracted intensive and extensive attention and support from both China and overseas. The organizing committee has received 198 papers. 122 have been approved and accepted by the experts from the organizing committee, among which 32 papers are from countries other than China. The Symposium proceedings has been published, covering a wide range of subjects and presenting the leading technological innovations and fruits in industrial explosives, detonating facilities, rock fragmentation theory, fragmentation results, blasting vibration effect, blasting numerical simulation, blasting excavation and blasting demolition etc. We, colleagues and friends from Asia-Pacific region engaged in relating fields, gather together, profoundly communicating new thoughts, theories, technologies, sharing new experience and extensively discussing the opportunities, challenges and countermeasures faced by blasting technology. We believe this Symposium will further the development of industrial explosives and blasting technology not only in Asia-Pacific region but also the whole world and finally make new contribution towards a brighter future for human beings.

The Symposium has been well prepared thanks to the great effort and contribution from the organizing committee composed of experts of various countries. They have done a lot of work in publicizing the Symposium theme and calling for more papers. My colleagues and friends in China also made tremendous effort and indispensable contribution. I would like to avail myself of this opportunity to express my sincere appreciation for all the effort and work.

Prof. Wang Xuguang
Chairman of Organizing Committee, Asia-Pacific
Symposium on Blasting Technology
President of China Society of Engineering Blasting
Academician of Chinese Açademy of Engineering

Contents

1 General Review

2 Blasting Theory Research

3 Rock Fragmentation by Blasting

4 Underground Blasting

5 Blasting Demolition

6 Explosives and Initiation Technology

7 Explosion Fabrication

8 Blasting Vibration and Measuring

9 Underwater Blasting and Soft Soil Treatment

10 Blasting Safety

1

General Review

Status Quo and Outlook for Engineering Blasting in China

WANG Xuguang, WANG Zhongqian, ZHANG Zhengyu, ZHOU Jiahan, GU Yicheng, XIONG Daiyu, LIU Dianshu, CHEN Jisong

(*China Society of Engineering Blasting, Beijing, China*)

The last century was a period of fast development for science and technology on the mankind history, it also was a period for great change of economic development in China and other countries of the world.

The Chinese nation had opened a new page of history after having the experience of 50-year wars. After the foundation of People's Republic of China, especially after the implementation of a policy on "reform and open to outside" the great achievements upon which all over the world focused, had been obtained. Engineering Blasting has played important role on mining, railway construction, communication construction, hydroelectric construction and urban construction. Blasting technique, commercial explosives, blasting supplies and accessories, blast testing, safety technique, the all have been improved tremendously along with economic development. Engineering blasting calling of China has increased its influence in the world. On September of 2006 Metallurgical Publishing House published a collection book"Chinese typical blasting engineering and its technique" in which 245 papers had been collected. These papers systematically summarized important and different blasting projects including the typical blasting projects, blasting design and technique, explosives and firing technique, blast testing and safety technique during last 50years. This book was a rare historic document.

1 NEW DEVELOPMENT OF BLASTING TECHNIQUE IN CHINA

After summarizing the 50-year achievements of engineering blasting the developing stratagem plan for engineering blasting had been constituted, the award of science and technology had been set up by China Society of Engineering Blasting (CSEB). These measures effectively motivated the progress and innovation of engineering blasting. The great fruits have been obtained in such areas as blasting research, design and construction. Some of them reached international level and others——leading level in China. The new development of blasting technique which has played an important role in economic development is listed as follows.

1.1 Underwater Blasting

The blasting demolition of upstream cofferdam for Ⅲ phase of Three Gorges Projects (TPG)Concluded successfully. It not only met the need of TGP construction and also had an innovation and development in the theory. It created a lot of first items in the construction. The technique of blasting demolition was on international level.

This project was carried by Changjiang Water Conservancy Research Institute and Changjiang Water Conservancy Design Institute. They were processing many years' experiments and testing at different proportional models, concerning selection of blasting supplies and accessories, permitted standard of the safety, blasting vibration, water shock wave, surges caused by blasting, safe guard and protective measure. China Association of Engineering Blasting and Three Gorges Engineering Corporation had organized domestic experts to review the design of blasting demolition several times, and they had proposed the suggestion and made some changes. The blasting demolition consisted of 1022 blasting holes /chambers, 2506 digital detonators and 191.3 tons mixed emulsion explosives. The length of cofferdam demolished by blasting was 480 meters, its total volume was 186 thousand cubic meters. The maximal depth of water where the blasting demolition was carried out was 38 meters. Blasting demolition started on June 6th of 2006 and it lasted 12.888 seconds. This blasting project was no precedent in term of its size, intensity and difficulty. It was a high-technique example on engineering blasting.

The 12th dock cofferdam of Zhoushan Zhongyuan Shipping Engineering Co. Ltd was demolished successfully by blasting at 14:00 of Feb 17th, 2007. The dock cofferdam was the biggest in the country. The time limit for this project was very short. Its demolished volume was big, and the demand for safety was very strict. Besides, there were some interfering factors for the implementation of blasting operation.

The design and construction of this blasting project were carried out by Gaoneng Blasting Company of Zhejiang Province. The 1600 holes were drilled including 557 deep holes and the total length of the holes was 8119 meters. They had used 1900 tires for protection, 8300 bamboo chicks, 2300 pieces of bamboo, 2300 cubic meters of stone powder and 4000 sandbags. The inclined drill holes inside cofferdam had been drilled. The blasting circuit was with initial firing at middle and ignition of one hole by one hole toward both side. This blasting project had consumed 51 tons of explosives and 4500 detonators including 3012 Orica detonators. The check after blasting had shown that this blasting demolition had met the requirement of design and the safety standard. The blast vibration, flying stones by blast and blast shock wave were not harmful to the surroundings.

1.2 Engineering blasting of railway construction

The engineering blasting for tunnel excavation in frozen earth of Qinghai-Tibet altiplano was a key project of 11th five-year plan constructions.