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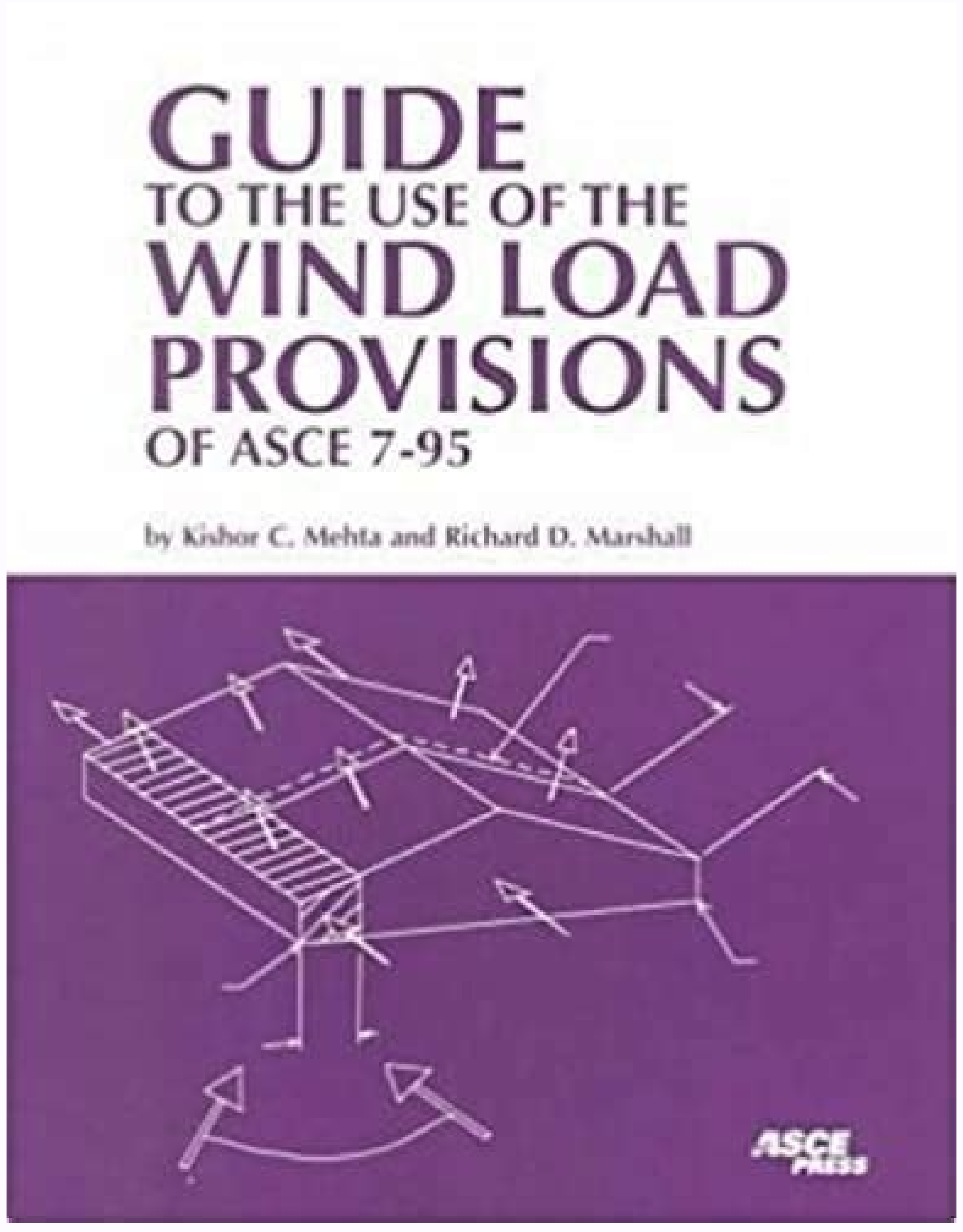

Investigations of Continuous Bed Load Saltating Process

By Hong-Yuan Lee,[1] Member, ASCE, Yen-Hsu Chen,[2] Jiing-Yun You,[3] and Ying-Tien Lin[4]

Abstract: Particle saltating motions during bed load transport are dominated by the forces acting upon particles and the random process of the particles impacting on and rebounding from the channel bed. A real-time flow visualization technique is developed in this study to measure particle saltating trajectories, corresponding velocities, and impacting and rebounding angles. Based on the experimental data, regression equations for the dimensionless saltating length, height, and velocity were obtained. A numerical model that is able to simulate the continuous saltating process of a single particle was developed. The model was calibrated and verified with the experimental data, and the results were satisfactory. The model was also used to generate a series of synthetic data. Based on these data and the flume data collected by previous investigators, a bed load equation was derived.

INTRODUCTION

Sediment transport in water can generally be classified into two major modes, namely, bed load and suspended load. The mode of transport depends on the size of the bed materials and the flow conditions. When the bed-shear stress exceeds the critical value for initiation of motion, a grain begins to move by sliding or rolling over the bed. If the bed-shear stress further increases, these particles will hop up from the bed and start to saltate. The transport of particles by rolling, sliding, and saltating is called bed load transport, and this is the subject investigated in this study. According to the previous investigations, the bulk of bed load transport occurs in the saltation mode (Einstein 1942; Sekine and Kikkawa 1992; Wiberg and Smith 1987, 1989), and the kinematic characteristics of saltation are dominated by the flow conditions, size of the saltating particles, and the random process of the particle impacting on and rebounding from the channel bed. Hence, investigations of the continuous saltation is crucial to the study of bed load transport.

Numerous researchers have investigated the saltating process. Based on his flume study, Einstein (1950) found the thickness of the bed load transport is about two times the particle size, and the saltation length is about 100 times the particle size. Gordon et al. (1972), Francis (1973), Abbott and Francis (1977), and Murphy and Hooshiari (1982) used a multiple-exposure technique to measure the saltating trajectories and the corresponding velocities of a saltating particle in water. However, due to the limitation of the technique used, the particles have to be larger than 3 mm. Van Rijn (1984) established a single-step saltating model. This model was calibrated and verified with the data collected by previously mentioned researchers and is applicable to low Reynolds number flows. Wiberg and Smith (1985) established a continuous saltation numerical model. In this model, a 2D impacting and rebounding scheme was proposed. The friction coefficient was assumed to be equal to the restitution coefficient, and this coefficient was used as the calibration factor. Hui and Hu (1991) used a high-speed photographic technique to measure the particle motions near the channel bed and proposed the dividing boundaries between rolling, saltating, sliding, and suspending motions. Sekine and Kikkawa (1992) assumed the position of the sediment particles in the channel bed followed a Gaussian distribution and adopted the stochastic theory and random number generation model to develop a 3D impacting and rebounding model. The friction and restitution coefficients were assumed equal in their model. Nino and Garcia (1994, 1998) also developed a high-speed photographic technique to measure the saltation trajectories and established a 2D continuous saltation model. Lee and Hsu (1994) developed a real-time photographic technique and a high-speed photographic technique to measure the saltation trajectories and the corresponding velocities. They also established a single-step saltation model, and the model was calibrated and verified with the laboratory data.

EXPERIMENTAL SETUP

The experiments were conducted in a 12-m-long × 0.3-m-wide slope-adjustable recirculating flume. Several combinations of water depth, channel slope, particle size, and specific gravity for the particles were tested. The water depth was fixed at 5 cm, and the range of the slope was from 0.003 to 0.008. Particles with a diameter of 0.6 cm and specific gravities of 1.38 and 1.08 were chosen. Particles of the same size as for the saltating particles were glued to the channel bed. Key hydraulic and sediment transport characteristics are given in Table 1, where u_* is the shear velocity, u_{*c} is the critical shear velocity, and θ is the dimensionless shear stress.

The real-time flow visualization system consists of a CV-M30 charged-coupled device (CCD) camera, a Nikon 35-mm lenz, an IBM PC 586, and a Coreco F64 professional image-processing card. The system can take 30 photos, 512 × 512 pixelsA and then transfers the photos into digitized formats through an Optimas V5.22 image processing software. The general configuration of the experimental setup is shown in Fig. 1. During the experimental process, the laboratory was kept in complete darkness, and the only light sources were installed at both sides of the CCD camera. Sediment particles were released at about 2-m upstream of the working section. As the saltating particles passed through the working section, the images were recorded by the CCD camera.

The analogical images were transferred into digitized images, with 256 different gray levels, through an analog-to-digital convertor and then stored in a video ram of an F64 pro image-processing card installed in an IBM PC 586. The digitized images were analyzed using an Optimas V5.22 software. The background noises were first eliminated through a logical subtract process to outshine the particle images. The area and the centroid of the images were then calculated to identify the locations of the particles and then transmitted into a worktable through a data dynamic exchange process. Be-

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Technical Note

Evaluation of Design-Builder Qualifications through the Analysis of Requests for Qualifications

Bo Xia[1]; Martin Skitmore[2]; and Jian Zuo[3]

Abstract: The two-phase best-value process has been widely used by public agencies for Design and Build (DB) procurement, with a key issue in the first phase of prequalification the determination of evaluation criteria. This study identified a set of general qualification criteria for design-builders and compares their relative importance by a thorough content analysis of 97 Requests for Qualification (RFQ) for public DB projects advertised between 2000 and 2011 in various regions of the United States. The thirty-nine qualification criteria found are summarized and classified into eight categories comprising: experience; project understanding, and approach; organizational structure and capacity; past performance record; professional qualifications; responsiveness to RFQs, office location, and familiarity with local environment; and legal status in descending order of their relative importance. A comparative analysis of different types of projects shows that the relative weighings of the qualification criteria vary according to different characteristics of the DB projects involved. **DOI: 10.1061/(ASCE)ME.1943-5479.000095.** © *2012 American Society of Civil Engineers.*

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Introduction

Design-build (DB) is an alternative delivery method where one entity or consortium is contractually responsible for both design and construction and has been gaining in popularity in public sectors in recent years (Hale et al. 2009; Park et al. 2009; Rosner et al. 2009). To find the right person for the right job, the best-value procurement process has been widely used by public agencies (Jackson 2010). Specifically, the preferred approach is a two-phase process where the first phase consist of an evaluation of bidders' qualifications, and the second phase involves the technical and price submission of a short-listed group of bidders. According to Molenaar et al. (1999), the two-phase best-value method outlined in the 1996 Federal Acquisition Reform Act delivers the best overall budget and schedule performance.

With the two-phase best-value procurement method, considerable attention is placed on the issue of DB Request for Qualification (RFQs). In particular, to solicit design-builders with necessary and desirable qualifications, owners need to establish clear, objective selection criteria to measure and determine the potential design-builders to be invited to prepare and submit a design-build proposal. According to Beard et al. (2001), the determination of prequalification selection criteria is a key issue that an owner must consider when evaluating prospective DB contractors. When the selection criteria and process is sufficiently transparent to all the interested DB contractors, it is more likely that the selected qualified design-builders will adequately address the owner's requirements and expectations. However, for many owners the formulation of selection criteria is not an easy task. Owners should carefully define and summarize the evaluation criteria for specific types and sizes of projects as every design-builder has unique qualifications. Otherwise, design-builders that are better qualified may not be selected because the selection criteria do not address their advantages.

To facilitate the determination of selection criteria in RFQ, this paper presents an examination of key qualification criteria in 97 design-build RFQs collected across the United States Unlike other opinion-based research studies, the analysis of different sets of selection criteria and their weightings in RFQs reflect the perceptions and real practices of owners in the selection of design-builders. Although the determination of qualification criteria is done separately for each project, it is clear that the analysis of a general set of criteria will not only demonstrate owners' understanding of qualified design-builders but also reflect their philosophies of DB practices in general.

Research Methodology

Content analysis was adopted to identify the qualification factors and their importance weighting adopted by public owners in DB RFQs. The content analysis is defined as the systematic, objective, quantitative analysis of message characteristics (Neuendorf 2002). It is an observational and power data reduction technique for dealing with large volumes of data (Stemler 2001) to summarize any form of content by counting the number of times an activity happens or a topic is depicted (Kolbe and Burnett 1991).

The first step in conducting a content analysis is to identify the materials to be analyzed (Guthrie et al. 2004). A sizable sample of actual DB RFQs was collected from those posted online by a

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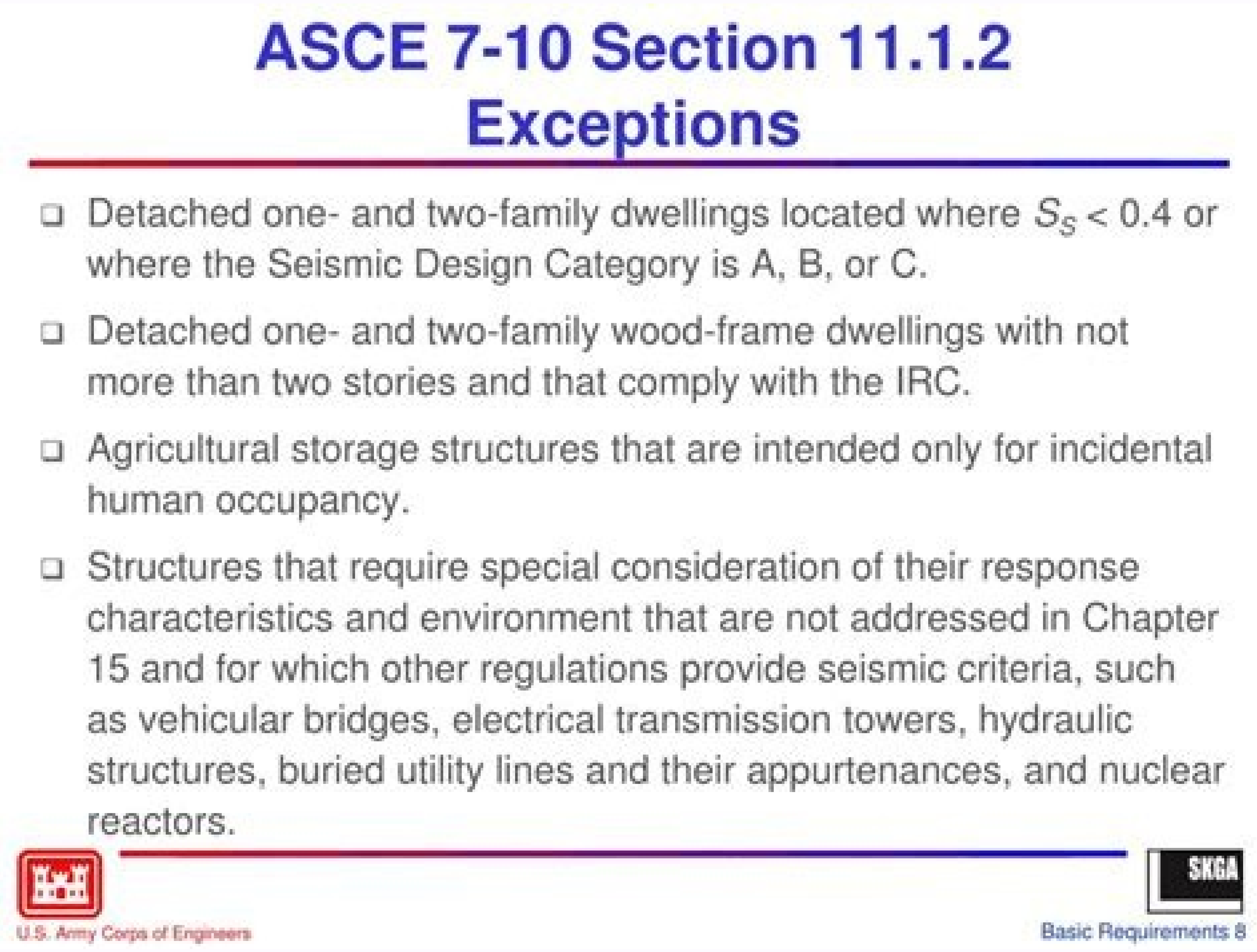

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