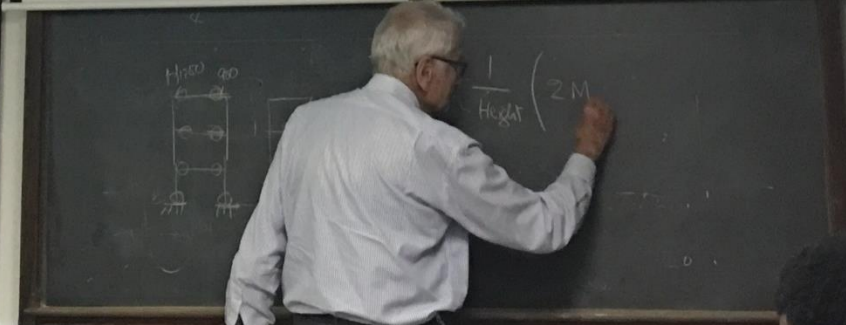
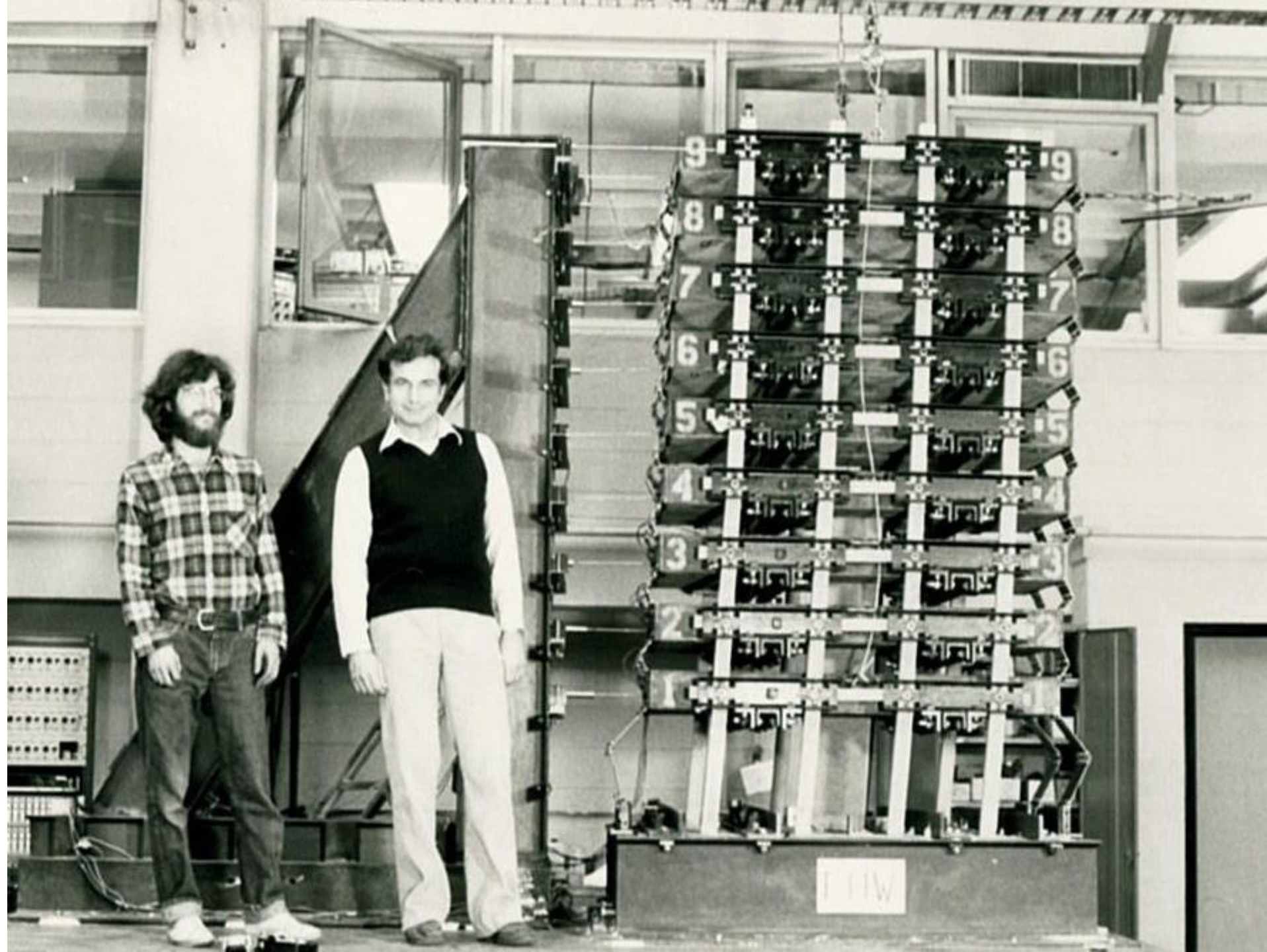


September 11

















With appreciation

*Lawrence J. [unclear]
Administrator*



C-SPAN Thursday



WHY SHOULD DRIFT DRIVE DESIGN FOR EARTHQUAKE RESISTANCE?

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ABSTRACT

It was the disastrous Messina Earthquake of 1908 that led the structural engineers in Italy to develop a procedure for earthquake-resistant design based on lateral forces. Considering the physics of structural response to earthquakes, this decision did not make sense. A structure cannot develop more lateral force than that limited by the properties of its components. An earthquake shakes a building. It does not load a building. A building loads itself during a strong earthquake depending on how stiff and strong it is. Nevertheless, the procedure based on force seemed to work in general. Besides it conformed to the thinking related to gravity loading and made it convenient to combine effects related to gravity and earthquake. Admittedly, an engineering design procedure can be good even if it is wrong.

Because it worked, a whole near-science was built around the concept of lateral force. Today, it is not an exaggeration to claim that the peak ground acceleration is the focal point of almost all that governs earthquake-resistant design.

In 1932, in a paper not filling a whole page in the Engineering News Record, Harald Westergaard (Westergaard, 1932) wrote that it was the ground velocity that was the driving factor for damage. His brilliant insight could have had the profession question whether force was the only issue for design, but it did not happen.

Over the period 1967-1990, a series of earthquake simulation tests were carried out at the University of Illinois, Urbana. Although the tests were targeted at the problem of nonlinear dynamic analysis, the most useful results that emerged were that drift (lateral displacement) was the critical criterion for earthquake response of a structure, that strength made little difference for the drift response, and that maximum drift response could be related to peak ground velocity.

The goal of the talk is to explain the changes in thinking inspired by what was observed in the laboratory and how developments on drift response are likely to affect preliminary proportioning of structures.

INTRODUCTION

There are two simple design rules to achieve satisfactory earthquake resistance of a building structure. Both rules are related to geometry.

Rule #1: Elevations of the floors must be at approximately the same level after the earthquake that they were before the earthquake and not as illustrated in Fig. 1. The object of the rule is to save lives.

Rule #2: Geometry of the building on the vertical plane must not differ from its original geometry by more than a permissible amount on the order of a drift ratio² of 1.5% to 2% and not as illustrated in Fig.2. The object of the rule is to save the investment.

REHUMANIZING ENGINEERING¹

by

Mete A. Sozen
Purdue University

To talk of formal engineering education in a country where it started is a folly. To talk about the future is another folly. Almost everyone who has spoken of the future of engineering has been wrong. Fools rush where angels fear to tread. This double-folly tract must continue with the courage that comes from innocence.

Engineering will change in the future. That is a prediction with a reasonably high level of confidence. To predict how it will change is another matter. It is not frivolous to look back before speculating about the future changes with the understanding that no looking back is without bias.

Whether one goes by Tredgold's optimism,² directing the natural sources of power for the use and convenience of man,³ or by Veblen's cynicism, "a profession of sheep educated at great public expense to do the bidding of corporations," engineering is a human enterprise. Human history does not repeat itself. The mistakes are repeated. Judging the future of a human enterprise by its past is likely to be a mistake almost as often made as judging past events by the criteria of the present. But it is less of a folly than ignoring the past and starting from first principles to derive the future shape of things.

The saga of engineering cannot be cleanly separated from that of other societal enterprises until the time engineering education was formalized (Schemnitz Mining Academy, 1733) and civil engineering defined as an academic discipline (Ecole des Ponts et Chausees, 1747). Agamemnon's "fast ships" required engineering as did the accoutrements of the war-horse. Engineering stood close to war for much of human history. The qualifier "civil" is a strong reminder of that era even though it was used initially to identify those engineers who were not in government service. (Considering that the main function of government has been defense, a euphemism for the capability to make war, the differentiation appears consistent.) Indeed, engineering might not have survived the dark ages of western society when there was hardly any commerce, had it not found its sustenance in war and faith. The reappearance of stone bridges in Europe coincides with the crusades.

¹ Paper presented at Pecs, Hungary

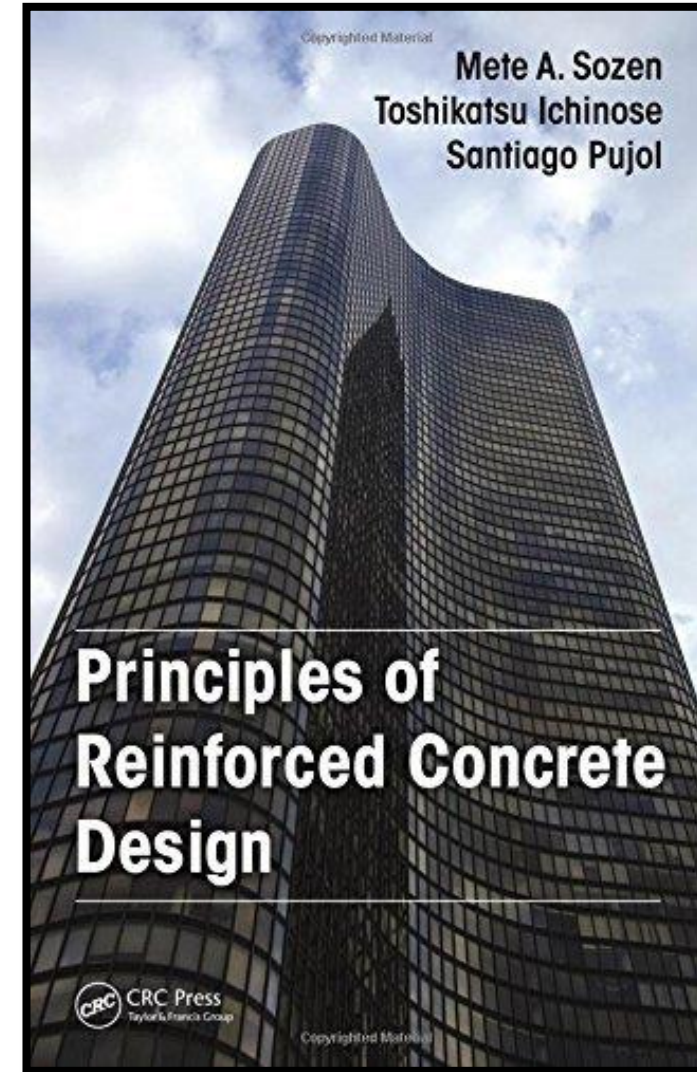
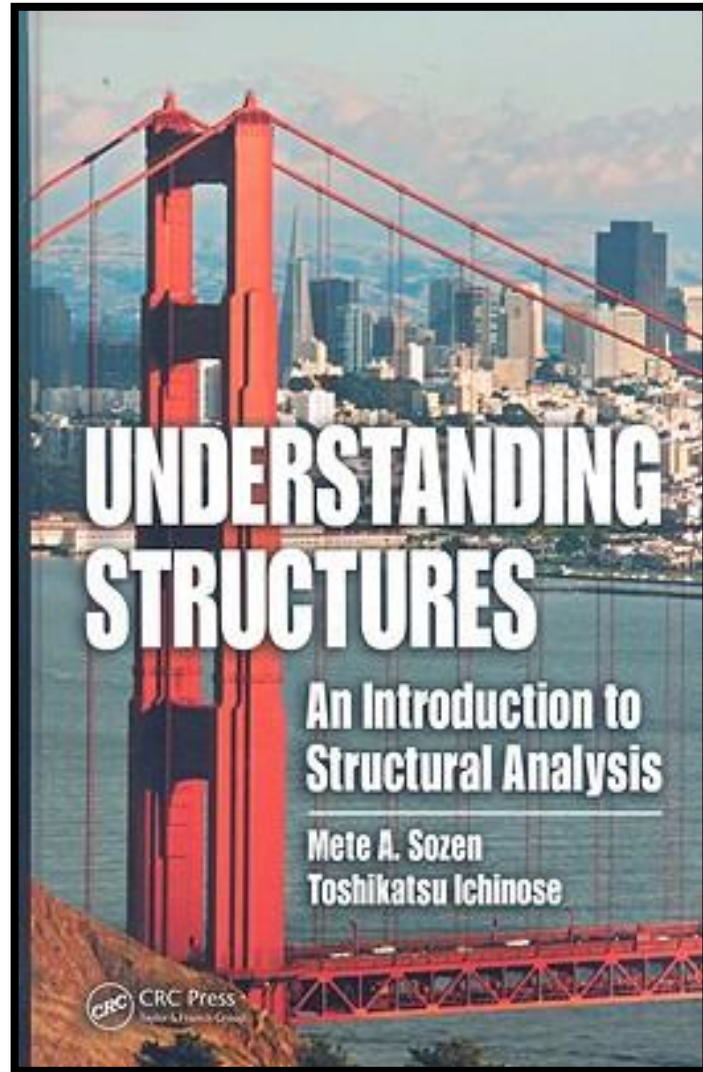
FROM DUZCE TO THE CITY

METE A. SOZEN

*Department of Civil Engineering, Purdue University, West
Lafayette, IN 47905.*

Alice : “...what is the use of a book without pictures and conversations?”





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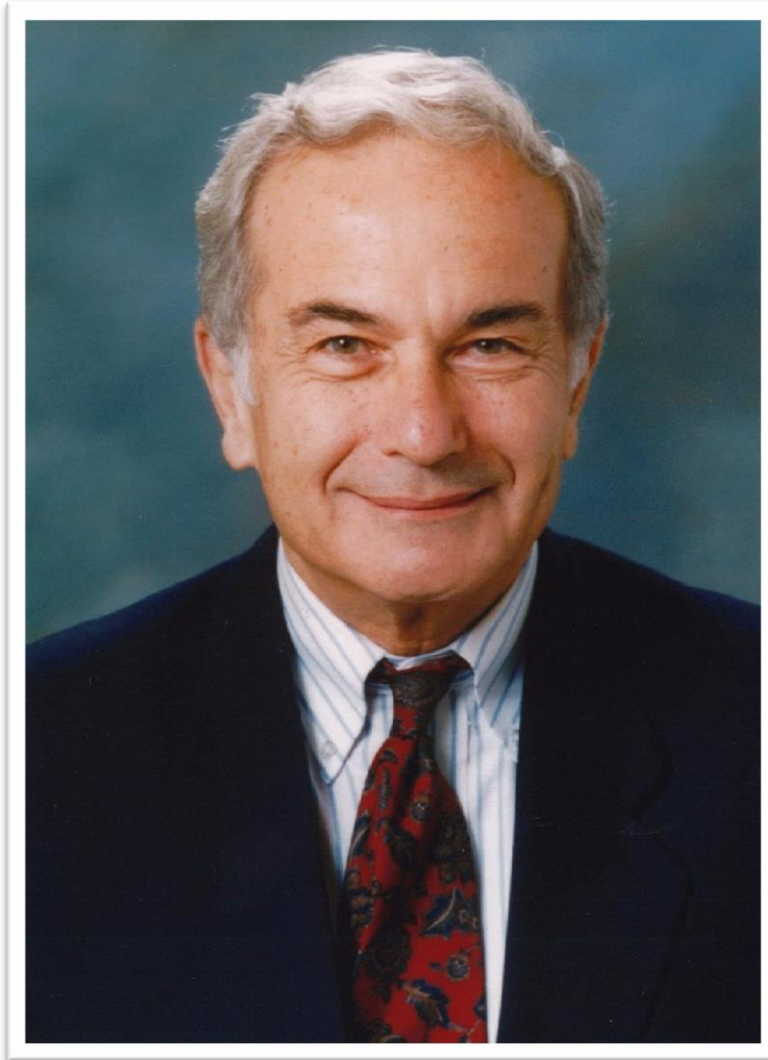
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