

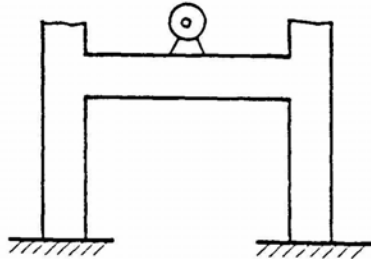
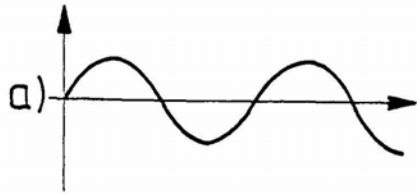
Content of lecture „Soil Dynamics“ (Master course: 2 Semester)

1. Introduction in the fundamentals of the soil dynamics and dynamic loads (traffic, earthquake etc.)
2. Classification and description of mechanical vibrations
Description in time- and frequency domain
3. Vibration of systems
Models, equations of motions, solutions in the time- and frequency domain
4. Linear single degree of freedom lumped mass systems (linear SDOF)
free and forced vibrations, response spectra, eigenvalues, modal analysis
5. Linear multi degree of freedom lumped mass systems
forced vibrations, eigenvalues, modal analysis
6. Wave propagation in the soil - Free vibration of the layered halfspace
3D-, 2D-, 1D- propagation of body waves, Amplification and filtering processes, surface waves, amplification functions
7. Dynamical behaviour of materials, dynamical soil parameter
Elasticity, Damping, Stiffness, nonlinearities, experimental evaluations
8. Forced vibrations of the halfspace
Models, Block vibrations, Impedance's, examples
9. Dynamical soil-structure-interaction
Modelling, Substructure method, examples
10. Design of the machine foundations
Modelling, dynamic loads, eigenvalues, tuning of the frequencies, analysis of dynamic response, calculations of block foundations
11. Geotechnical earthquake engineering
Natural seismicity Intensities, geoseismical effects and damages, site dependent influences: filtering and amplifications, Microzonation, Design of buildings and foundations, repair and strengthening measures, geotechnical investigations
Effects of mining on surface and buildings (regular, irregular, seismic);
Building design and special measures for the foundations, repair measures
12. Shock vibrations on buildings and people
measurements and evaluations, measures for mitigation / reduction

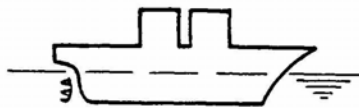
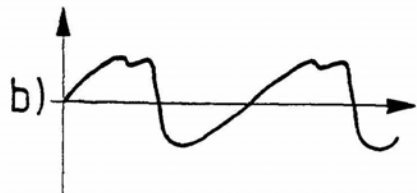
1. Introduction in soil dynamics and dynamic loadings

1.1 Overview, problems

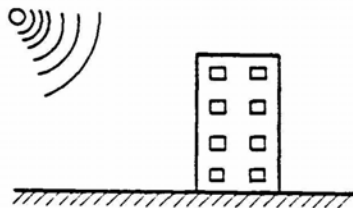
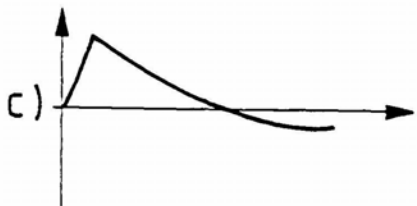
1.1.1 Dynamic loadings



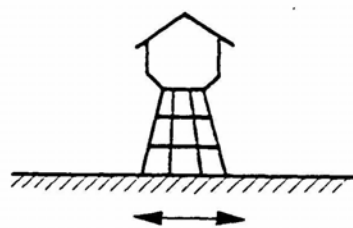
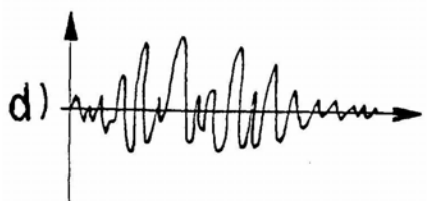
Machines in Buildings



Ship's propeller water waves



Air pressure of a bomb explosion



Earthquakes

1 Time history

Example

Typical dynamic loads

(a) harmonic

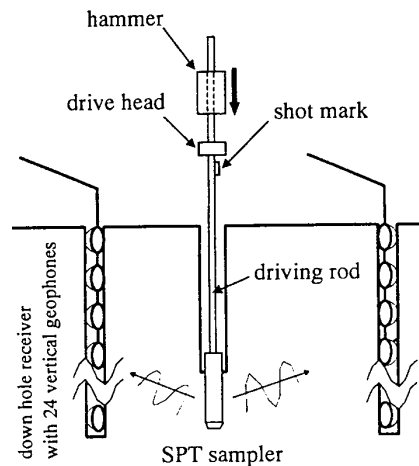
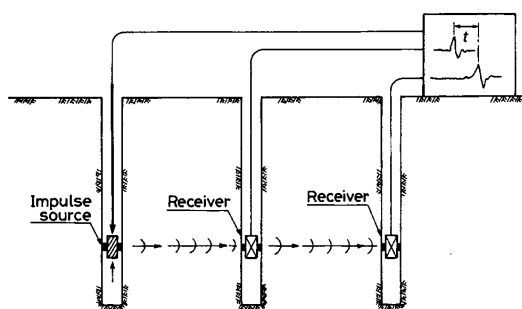
(b) periodic

(c) impuls load

(d) stochastic

1.1.2 General problems

- a) Prevention of resonances
 - ⇒ Classical field: tuning of frequencies of machine foundations
- b) Computation of the dynamic response of structures: dynamic induced additional stresses in the structures in connection with the kind of dynamic loads, the dynamic characteristic of the structure in interaction with the ground
- c) Evaluation of the stability of structures under the action of static and dynamic loadings: internal and external stability
 - ⇒ Difficult: material parameter under cyclic and dynamic loads
- d) Decrease / defence of damaging vibrations due to traffic, machines, constructions works
 - ⇒ Mitigation / protection with measures in buildings (basic isolations)
 - ⇒ geotechnical measures (improving of the damping behaviour of the soil due to material reduction in the soil by means of slots and borings and infill of isolation material)
- e) Upgrading and actualisation of codes
 - ⇒ DIN 4149 / EC 8 – Earthquake engineering
 - ⇒ DIN 4150 – damaging vibration on building and people
 - ⇒ Harmonisation of the measures for earthquake resistant constructions
- f) Evaluation of construction sites using seismic methods; Geotomography,



Crosshole – Measurements and Geotomography – Simultaneous measurements of wave velocities with many geophones under using of a deep varying source (SPT – Sonde)

1.1.3 Problems in earthquake engineering

a) Influences of the extent of damages by earthquakes

Natur	Zivilisation	Mensch
<ul style="list-style-type: none"> • Seismology • Soil resonance • Amplifications of amplitudes • Cracks, fissures • Land slides • liquefactions • Tsunamis 	<ul style="list-style-type: none"> • Living conditions • Quality of structures • Building Conditions • Fire protection • Regional planing • Infrastructure • 	<ul style="list-style-type: none"> • precaution measures • misunderstandings of the people • Catastrophe protection • Emergency plans • Social factors • Public Media

b) Analysis of the damaged regions

- ⇒ Control of the social aspects during an earthquake (information of the people, training's, emergency plans, evacuation measures, housing problems)
- ⇒ Damage analyses, documentation's and tools for the evaluation and interpretation , Interpretation
- ⇒ Analysis of the constructions for repair and strengthening of damaged buildings
- ⇒ important: Decision tools for the elimination of damaged buildings

c) Development of suffices knowledge to the load conditions

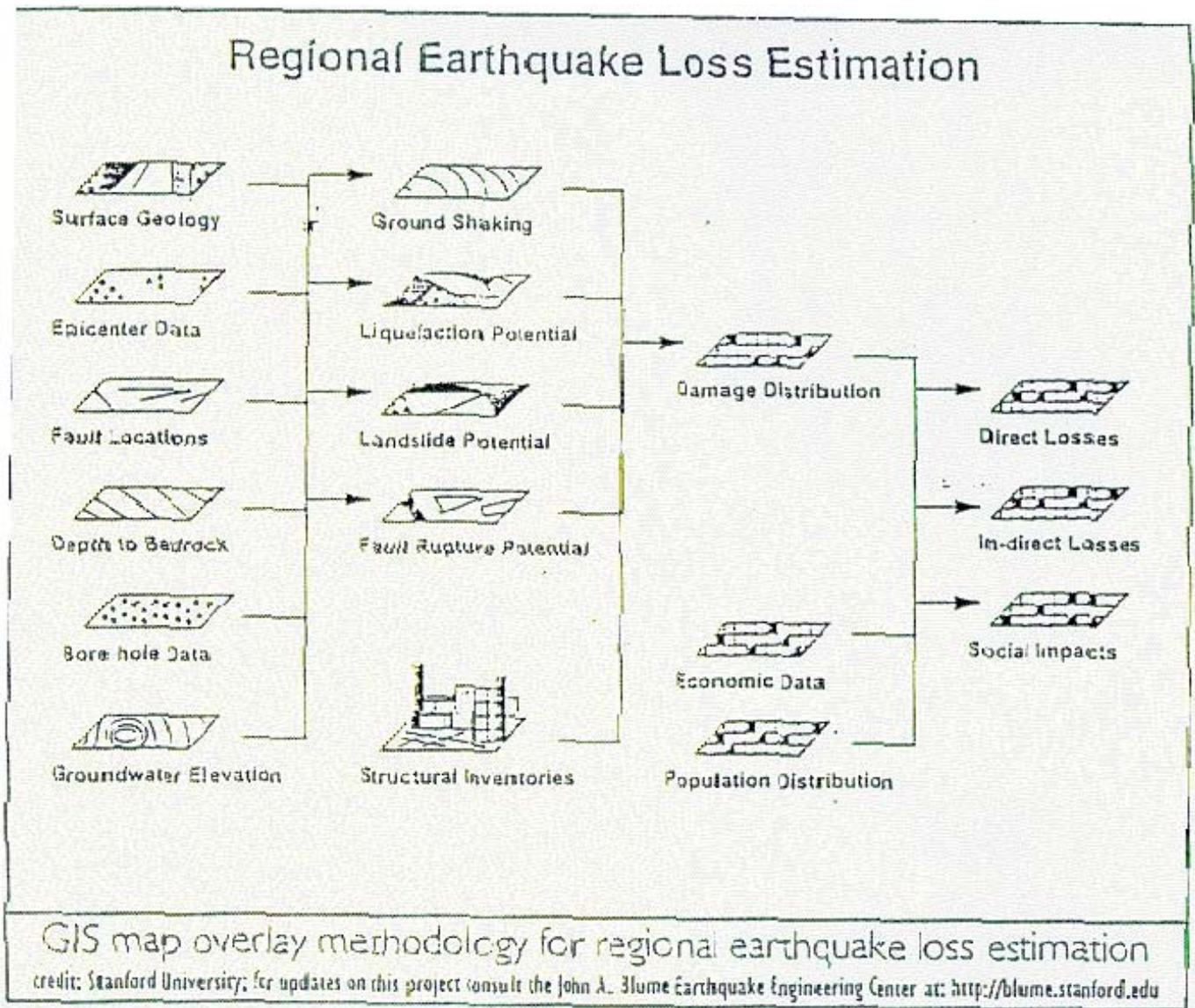
- ⇒ Earthquake loads: regional relevant time histories, frequency contents, amplitudes connect6ng with the return period of the earthquakes
- ⇒ Site effects on the earthquake excitation
- ⇒ In this point of view we need an earthquake adequate design and calculation of the buildings and geotechnical constructions / Lifelines

d) Mitigation of the effects of natural disasters

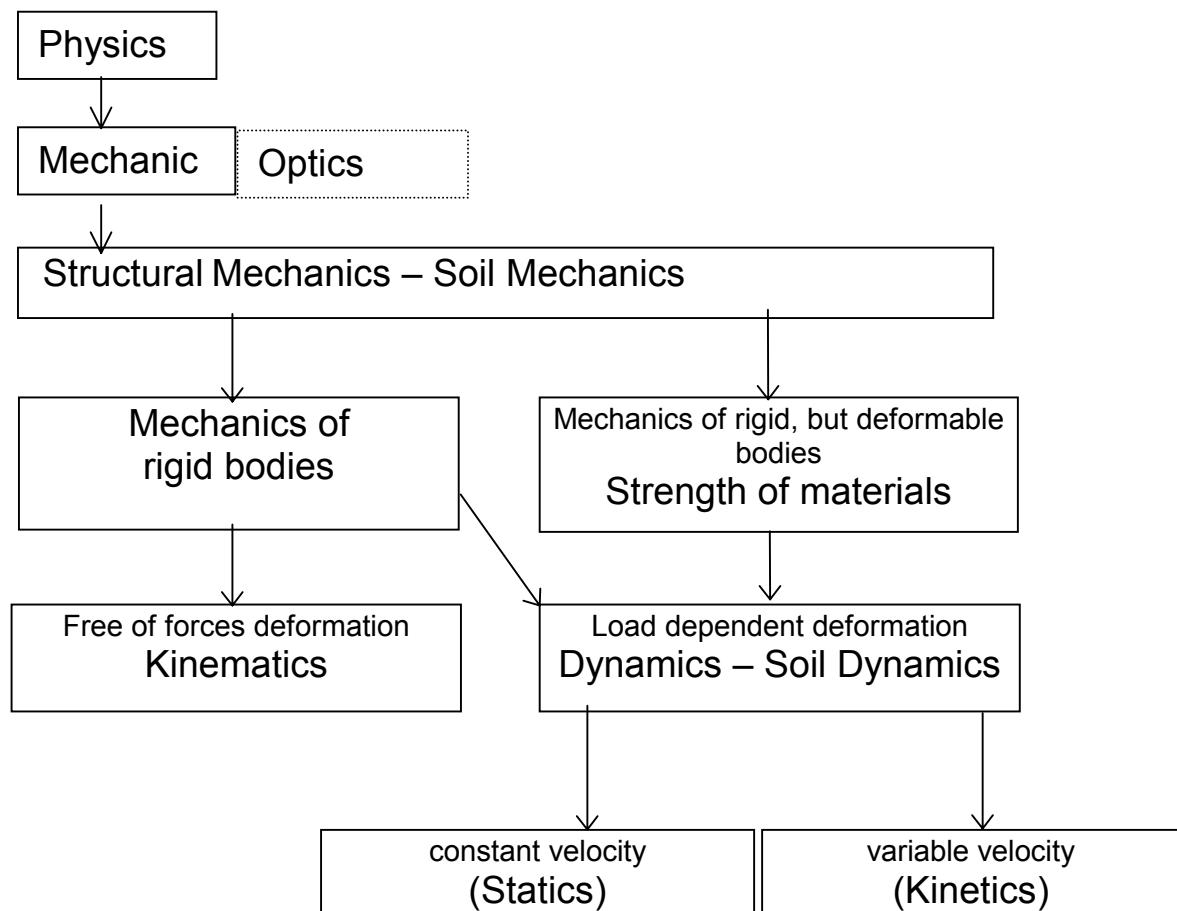
- ⇒ IDNDR - International **D**ecade of **N**atural **D**isaster **R**eduction 1990-1999
- ⇒ New since 2000: ISDR – International **S**trategy for **D**isaster **R**eduction und “Inter Agency Task Forces”
- ⇒ Risk evaluation: GIS – orientated analyses for damaged regions and megacities
- ⇒ Interdisciplinary cooperation necessary with geophysics, geologists, engineers, regional planners

1.1.4 Evaluation of the regional losses due to an earthquake

(nach: GIS map overlay methology for regional earthquake loss estimation; Stanford University: <http://blume.stanford.edu>)

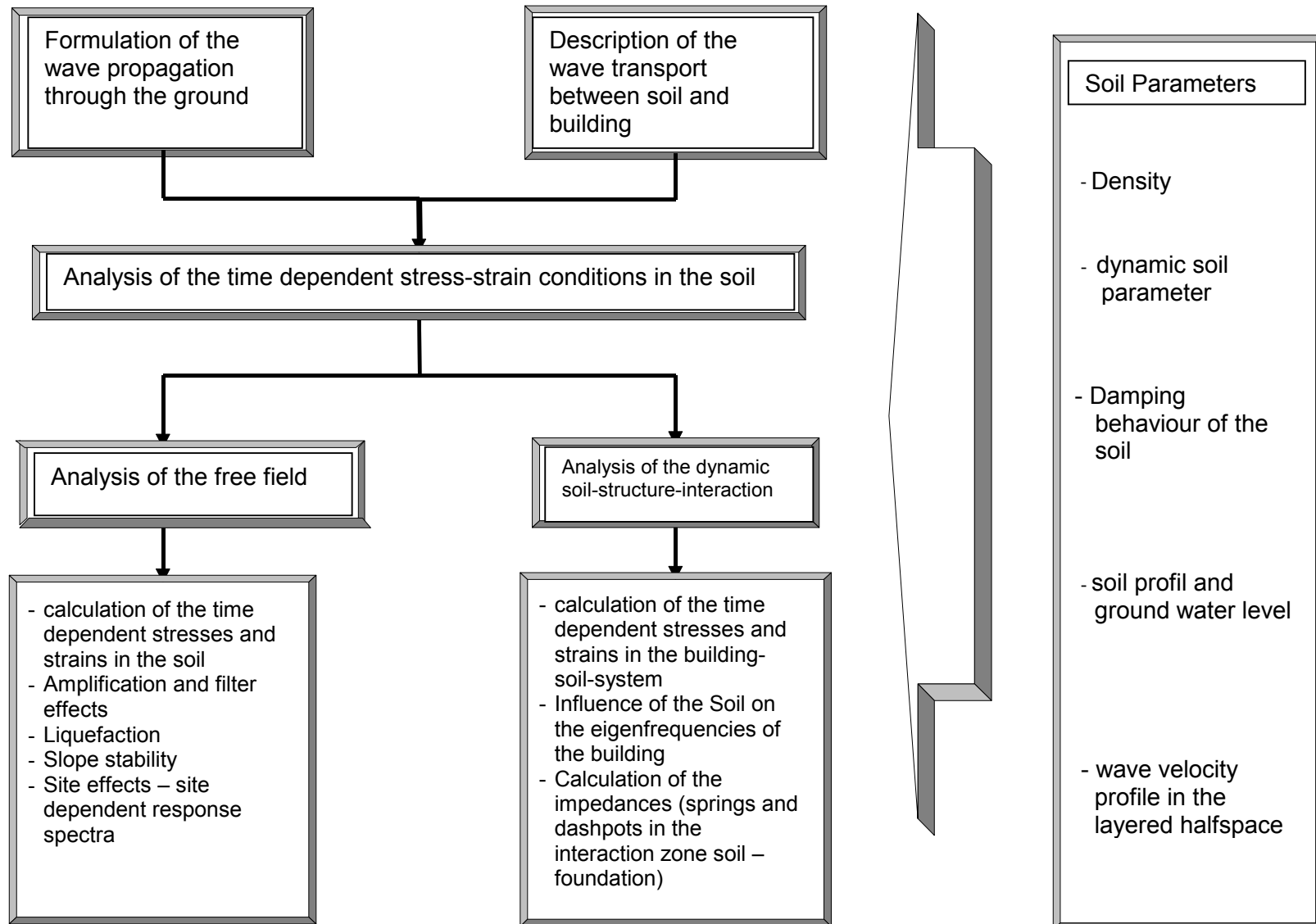


1.2 Soil Dynamics: Position in the Structural Mechanics und goals



>>> in recent calculation methods (f.e. FEM) we don't have a subdivision in the mechanics of rigid bodies and in the strength of materials

Tasks of the Soil dynamics



DIN's in der Dynamik

DIN 1311: Schwingungslehre (1974)

- Blatt 1: Kinematische Begriffe
- Blatt 2: Einfache Schwinger
- Blatt 3: Schwingungssysteme mit unendlich vielen Freiheitsgraden
- Blatt 4: Schwingende Kontinua, Wellen

DIN 1311 – 1: Schwingungen(Entwurf Oktober 1994)

- Teil 1: Schwingungsfähige Systeme: Begriffe, Einteilungen
- Teil 3: Lineare, zeitinvariante schwingungsfähige Systeme mit endlich vielen Freiheitsgraden

DIN ISO 1940: Mechanische Schwingungen

- Anforderungen an die Auswuchtgüte starrer Rotoren
- Teil 1: Bestimmung der Restunwucht (Dez. 1993, identisch 1986)
- Teil 2: Abweichungen beim Auswuchten (Okt. 94, identisch 1993)

VDI 2056: Beurteilungsmaßstäbe für mechanische Schwingungen von Maschinen (1964)

VDI 2057: Einwirkung mechnischer Schwingungen auf den Menschen(Mai 1987)

- Blatt 1: Grundlagen, Gliederung, Begriffe
- Blatt 2: Bewertung
- Blatt 3: Beurteilung
- Blatt 4.1: Messung und Beurteilung von Arbeitsplätzen in Gebäuden
- Blatt 4.2: Messung und Beurteilung von Arbeitsplätzen auf Landfahrzeugen

VDI 2062: Schwingungsisolierung (Jan. 1976)

- Blatt 1: Begriffe und Methoden

VDI 3831: Schutzmaßnahmen gegen die Einwirkung mechanischer Schwingungen auf den Menschen – Allgemeine Schutzmaßnahmen und Beispiele

DIN 4024: Maschinenfundamente (April 1988)

- Teil 1: Elastische Stützkonstruktionen für Maschinen mit rotierenden Massen

DIN 4025: Fundamente für Amboßhämmer (Schabotte – Hämmer) (Okt. 1958)
Hinweise für die Bemessung und Ausführung

DIN 4149: Bauten in deutschen Erdbebengebieten (in Überarbeitung)

DIN 4150: Erschütterungen im Bauwesen

- Teil 1: Grundsätze , Vorermittlungen und Messungen (Sept. 1975)
- Teil 2: Einwirkungen auf Menschen in Gebäuden(Dezember 1992)
- Teil 2–A/1: Änderung A1 zu Teil 2 (Entwurf Aug. 1995)
- Teil 3: Einwirkungen auf bauliche Anlagen (Mai 1986)

DIN 4178: Glockentürme – Berechnung und Ausführung (August 1978)

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