

CECW-EG  Engineer Regulation 1110-2-1802	Department of the Army U.S. Army Corps of Engineers Washington, DC 20314-1000	ER 1110-2-1802  25 July 1979
	Engineering and Design  REPORTING EARTHQUAKE EFFECTS	
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Regulation  
No. 1110-2-1802

25 July 1979

Engineering and Design  
REPORTING EARTHQUAKE EFFECTS

1. Purpose. This regulation states policy, defines objectives, assigns functions, and establishes procedures for assuring the structural integrity and operational adequacy of major Civil Works structures following the occurrence of significant earthquakes. It primarily concerns damage surveys following the occurrences of earthquakes.
2. Applicability. This regulation is applicable to all field operating agencies having Civil Works responsibilities.
3. References.
  - a. ER 1110-2-100
  - b. ER 1110-2-1806
  - c. ER 1110-2-8150
  - d. ER 1130-2-419
  - e. State-of-the-Art for Assessing Earthquake Hazards in the United States - WES Miscellaneous Papers S-73-1 - Reports 1 thru 14. Available from U.S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, Mississippi 39180.
4. Policy. Civil Works structures, which could be caused to fail or partially fail by an earthquake and whose failure or partial failure would endanger the lives of the public and/or cause substantial property damage, will be evaluated following potentially damaging earthquakes to insure their continued structural stability, safety and operational adequacy. These structures include dams, navigation locks, powerhouses, and appurtenant structures, (intakes, outlet works, buildings, tunnels, paved spillways) which are operated by the Corps of Engineers and for which the Corps is fully responsible. Also included are major levees, floodwalls, and similar facilities designed and constructed by the Corps of Engineers and for whose structural safety and stability the Corps has a public obligation to be aware of although not responsible for their maintenance and operation. The evaluation of these structures will be based upon post-earthquake inspections which will be conducted to detect conditions

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of significant structural distress and to provide a basis for timely initiation of restorative and remedial measures.

#### 5. Post-Earthquake Inspections and Evaluation Surveys.

a. Limitations of Present Knowledge. The design of structures for earthquake loading is limited by the infrequent opportunity to compare actual performance with the design. Damage which would affect the function of the project is unlikely if peak accelerations are below 0.1g.; but it cannot be assumed that a structure will not be damaged from earthquake loadings below that for which it was designed. Furthermore, earthquakes have occurred in several parts of the country where significant seismic activity had not been predicted by some seismic zoning maps. This indicates the possibility that earthquake induced loads may not have been adequately considered in the design of older structures.

b. Types of Reportable Damage. Many types of structural damage can be induced by ground motion from earthquakes or from large nuclear blasts (which also tend to induce ground vibrations in the more damaging lower frequency ranges). Any post-earthquake change in appearance or functional capability of a major Civil Works structure should be evaluated and reported. Examples are symptoms of induced stresses in buildings made evident by cracked plaster, windows or tile, or in binding of doors or windows; cracked or shifted bridge pier footings or other concrete structures; turbidity or changed static level of water wells; cracks in concrete dams or earth embankments; and misalignment of hydraulic control structures or gates. Induced dynamic loading on earth dams may result in loss of freeboard by settlement, or cause localized quick conditions within the embankment sections or earth foundations. Also, new seepage paths may be opened up within the foundation or through the embankment section. Ground motion induced landslides may occur in susceptible areas of the reservoir rim, causing embankment overtopping by waves and serious damage. All such unusual conditions should be evaluated and reported.

#### 6. Inspection and Evaluation Programs.

a. If the project is located in an area where the earthquake causes significant damage (Modified Mercalli Intensity VII or greater) to structures in the vicinity, the Chief, Engineering Division, should be immediately notified and an engineering evaluation and inspection team should be sent to the project.

b. If the project is located in an area where the earthquake is felt but causes no or insignificant damage (Modified Mercalli Intensity VI or less) to structures in the vicinity of the project, project operations personnel should make an immediate inspection. This inspection should determine (1) whether there is evidence of earthquake damage or disturbance, and (2) whether seismic instrumentation, where present, has

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been triggered. The Chief, Engineering Division, should be notified by phone of the results of the inspection. If damage is observed, which is considered to threaten the immediate safety or operational capability of the project, immediate action should be taken as covered in paragraph 6a. For other situations, the Chief of Engineering Division will determine the need for and urgency for an engineering inspection.

c. When an engineering inspection of structures is deemed necessary following a significant earthquake, HQDA (DAEN-CWE) WASH DC 20314 will be notified of the inspection program as soon as it is established.

d. As a general rule, the structures which would be of concern following an earthquake are also the structures which are involved in the inspection program under ER 1110-2-100. Whenever feasible, instrumentation and prototype testing programs undertaken under ER 1110-2-100 to monitor structural performance and under ER 1110-2-8150 to develop design criteria will be utilized in the post-earthquake safety evaluation programs. Additional special types of instrumentation will be incorporated in selected structures in which it may be desirable to measure forces, pressures, loads, stresses, strains, displacements, deflections, or other conditions relating to damage and structural safety and stability in case of an earthquake.

e. Where determined necessary, a detailed, systematic engineering inspection will be made of the post-earthquake condition of each structure, taking into account its distinctive features. For structures which have incurred earthquake damage a formal technical report will be prepared in a format similar to inspection reports required under ER 1110-2-100. (Exempt from requirements control under paragraph 7-2b, AR 335-15). The report will include summaries of the instrumentation and other observation data for each inspection, for permanent record and reference purposes. This report will be used to form a basis for major remedial work when required. Where accelerometers or other types of strong motion instruments have been installed, readings and interpretations from these instruments should also be included in the report. The report will contain recommendations for remedial work when appropriate, and will be transmitted through the Division Engineer for review and to DAEN-CWE for review and approval. For structures incurring no damage a simple statement to this effect will be all that is required in the report, unless seismic instrumentation at the project is activated. (See paragraph 8d.)

7. Training. The dam safety training program covered by paragraph 6 of ER 1130-2-419 should include post earthquake inspections and the types of damage operations personnel should look for.

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## 8. Responsibilities.

a. The Engineering Divisions of the District offices will formulate the inspection program, conduct the post-earthquake inspections, process and analyze the data obtained from instrumentation and other observations, evaluate the resulting condition of the structures, and prepare the inspection reports. The Engineering Division is also responsible for planning special instrumentation felt necessary in selected structures under this program. The Engineering Division is responsible for providing the training discussed in paragraph 7.

b. The Construction Divisions of the District offices will be responsible for the installation of the earthquake instrumentation devices and for data collection if an earthquake occurs during the construction period.

c. The Operations Division of the District offices will be responsible for the immediate assessment of earthquake damage and notifying the Chief, Engineering Division as discussed in paragraphs 6a and b. The Operations Divisions will also be responsible for earthquake data collection after the construction period in accordance with the instrumental observation programs, and will assist and participate in the post-earthquake inspections.

d. The U.S. Geological Survey has the responsibility for servicing and collecting all data from strong motion instrumentation at Corps of Engineers dam projects following an earthquake occurrence. However, the U.S. Army Waterways Experiment Station (WES) is assigned the responsibility for analyzing and interpreting these earthquake data. Whenever a recordable earthquake record is obtained from seismic instrumentation at a Corps project, the Division will send a report of all pertinent instrumentation data to the Waterways Experiment Station, ATTN: WESGH, P.O. Box 631, Vicksburg, Mississippi 39180. The report on each project should include a complete description of the locations and types of instruments and a copy of the instrumental records from each of the strong motion machines activated. (Exempt from requirements control under paragraph 7-2v, AR 335-15).

e. The Engineering Divisions of the Division offices will select structures for special instrumentation for earthquake effects, and will review and monitor the data collection, processing, evaluating, and inspecting activities. They will also be specifically responsible for promptly informing HQDA (DAEN-CWE) WASH DC 20314, when evaluation of the condition of the structure or analyses of the instrumentation data indicates the stability of a structure is questionable. (Exempt from requirements control under paragraph 7-2o, AR 335-15).

f. Division Engineers are responsible for issuing any supplementary regulations necessary to adapt the policies and instructions herein to the specific conditions within their Division.

9. Funding. Funding for the evaluation and inspection program will be under the Appropriation 96X3123, Operations and Maintenance, General. Funds required for the inspections, including Travel and Per Diem costs incurred by personnel of the Division office or the Office, Chief of Engineers, will be from allocations made to the various projects for the fiscal year in which the inspection occurs.

FOR THE CHIEF OF ENGINEERS:



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