A HISTORICAL PERSPECTIVE ON GEOTECHNICAL CASE HISTORIES COURSES

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for the

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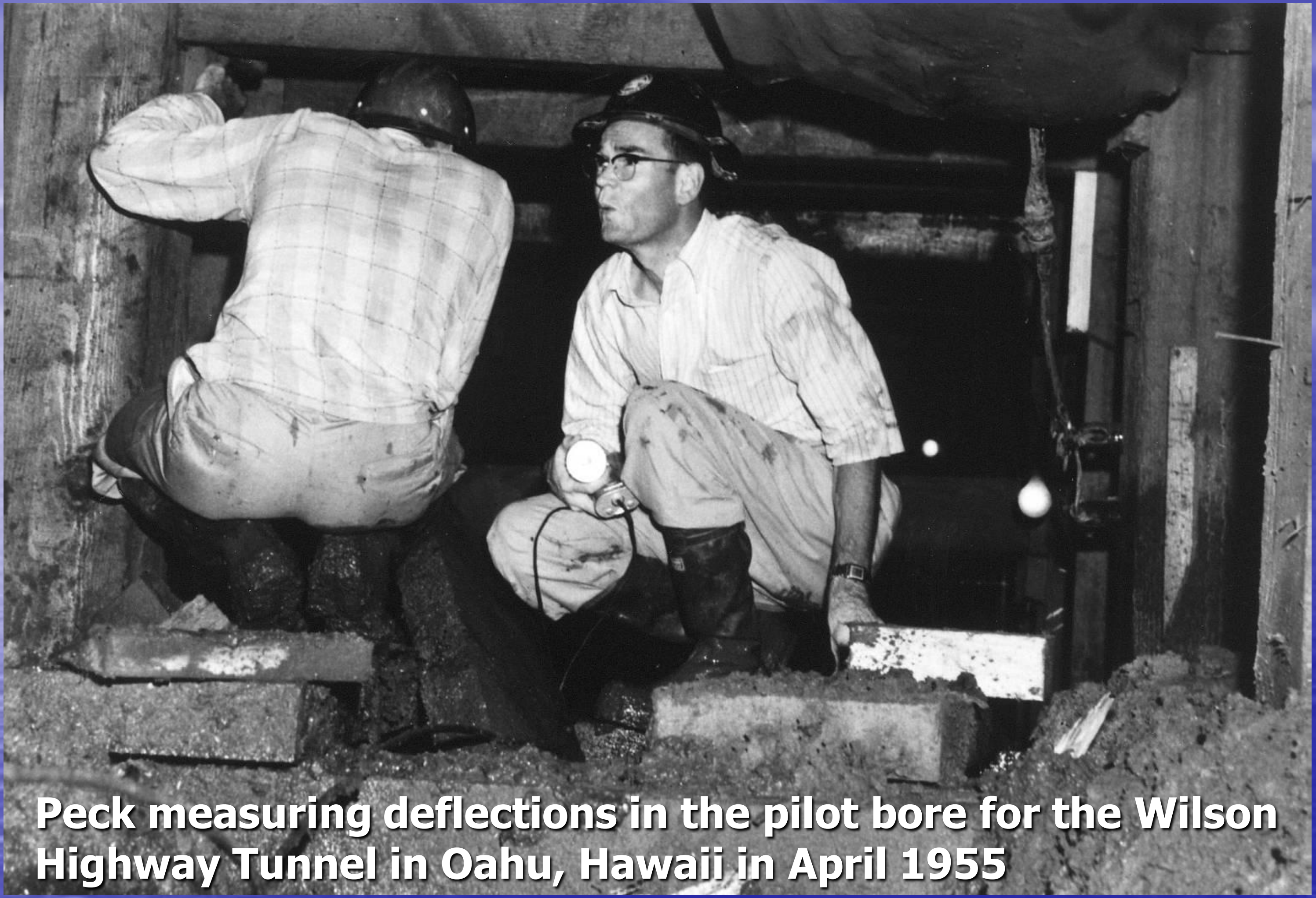
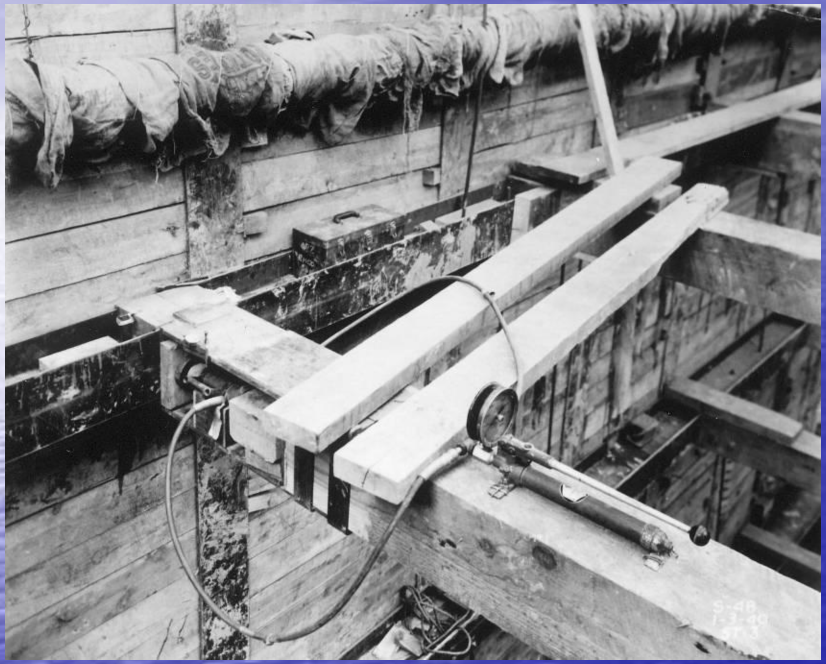
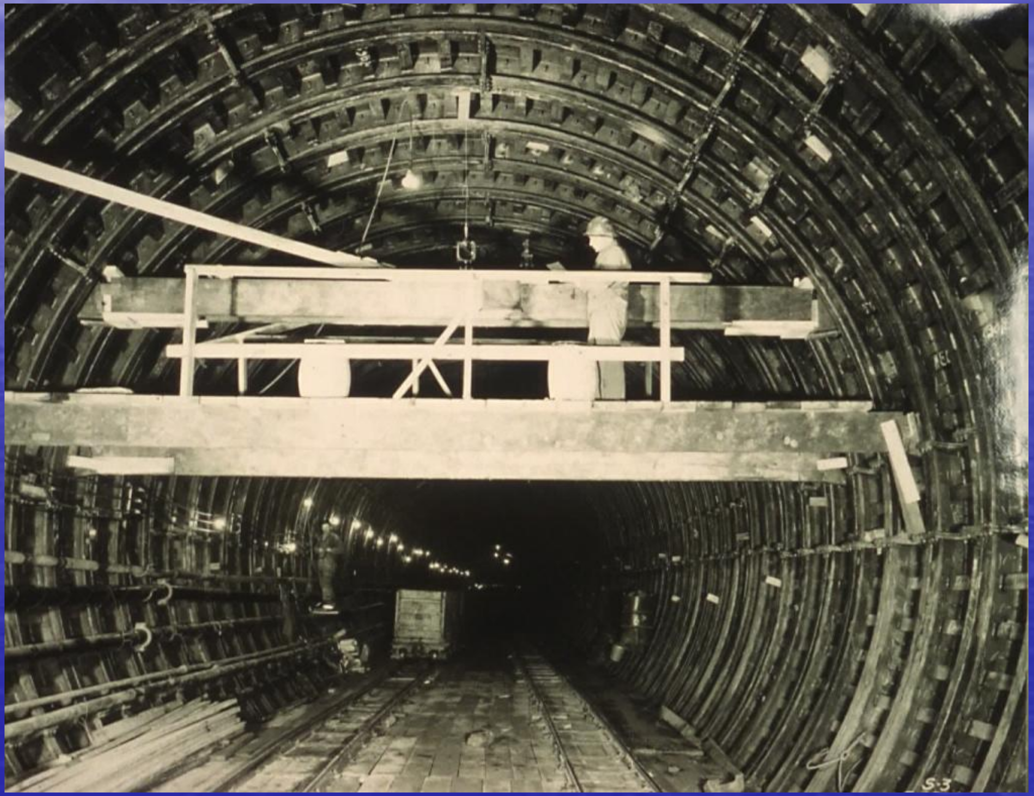

Peck measuring deflections in the pilot bore for the Wilson Highway Tunnel in Oahu, Hawaii in April 1955

- Our story begins with Professor Ralph Peck at the University of Illinois. His engineering expertise was sought on a wide range and scale of fascinating projects, world-wide, between 1942 and 2007.

Ralph Peck - Chicago Subway and birth of the Observational Method





Ralph Peck measured strut loads and deflections in braced open cuts and inside driven tunnels of the Chicago Subway project between 1939-42. He and Karl Terzaghi developed apparent pressure theorems from these data.

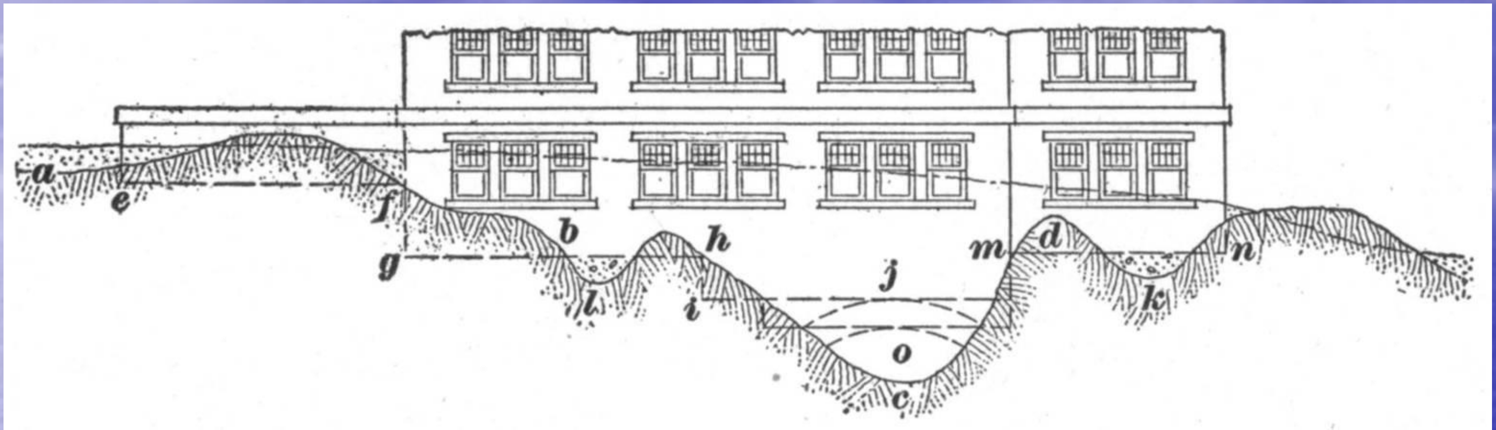
Impact on existing foundations

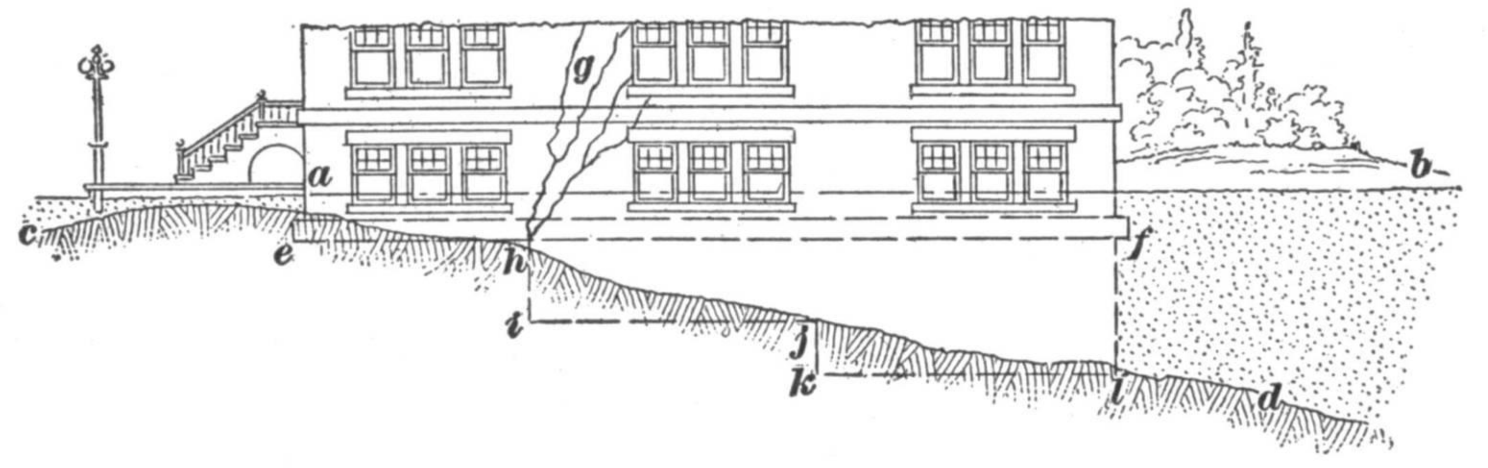
- The primary reason subway engineer Ray Knapp engaged Terzaghi, and he, in turn, recommended hiring Peck, was to monitor deflections of adjacent building foundations and to advise the city on the best practices to avoid costly damage to these older structures

Teaching foundation engineering

- In fall of 1949 Peck, Walt Hanson, and Tom Thornburn began teaching a course on foundation engineering at the University of Illinois
- Used case studies of structures built in Chicago
- The three faculty wrote a text on Foundation engineering between 1948-52, which appeared in the fall of 1953

Lack of suitable case histories





- When Peck began teaching foundation engineering right after the war, very few case studies of foundation problems had been published. These are from Lowndes (1928).

Peck studied the foundations for all the taller structures

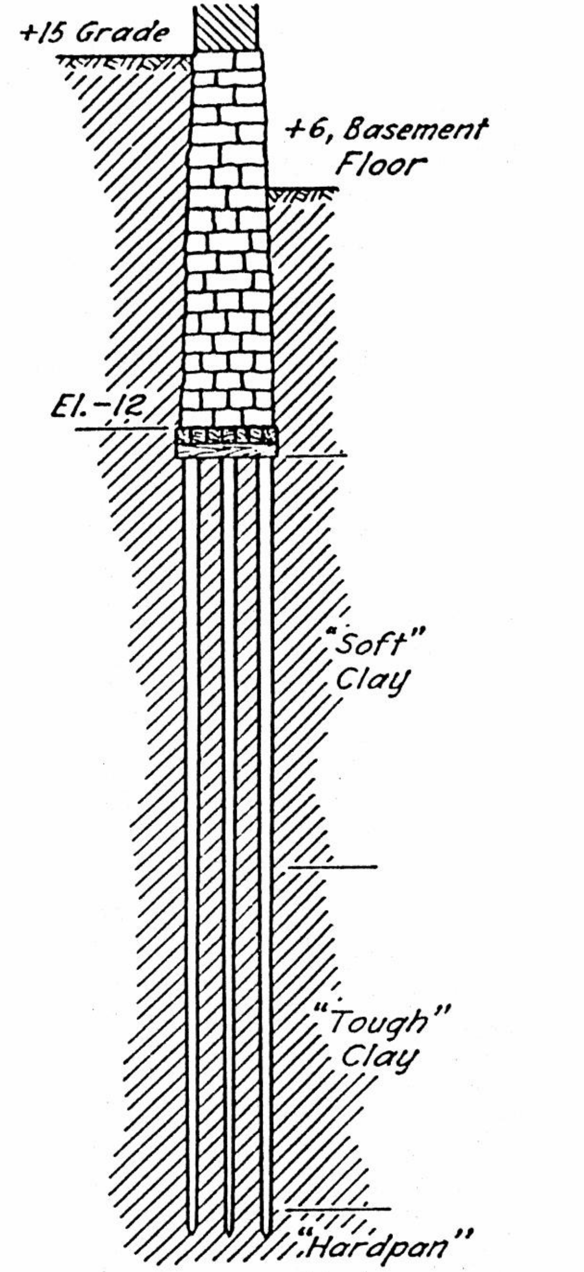


FIG. 29. BEARING-WALL FOUNDATION FOR PUBLIC LIBRARY

Above- Home Insurance Building in Chicago

Left- Wood piles founded on the hardpan

Right – Chicago caissons founded on the hardpan

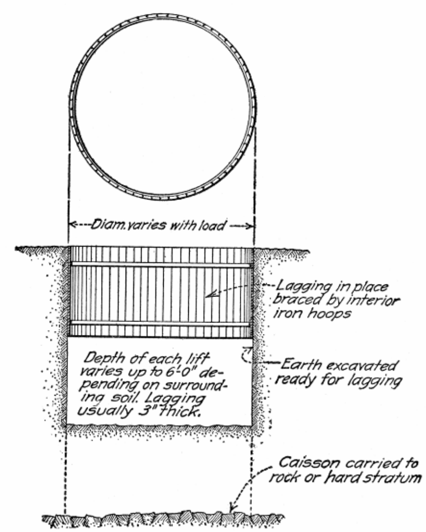


FIG. 4.—Chicago open caisson.

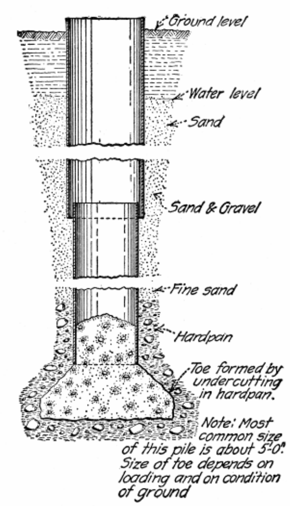


FIG. 5.—Gow pile.

History of Building Foundations in Chicago (1947)

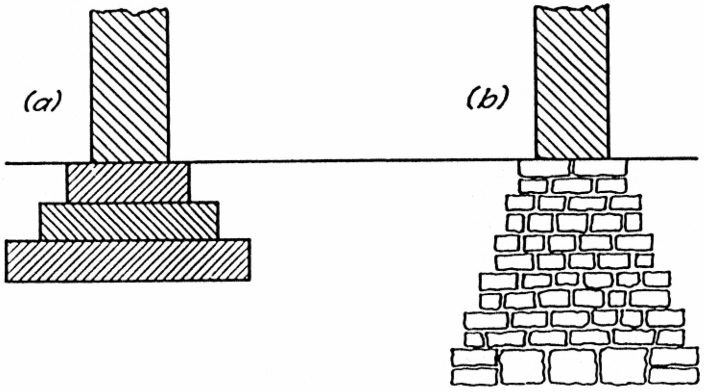


FIG. 4. (a) TYPICAL FOOTING OF DIMENSION STONE; (b) RUBBLE STONE PIER

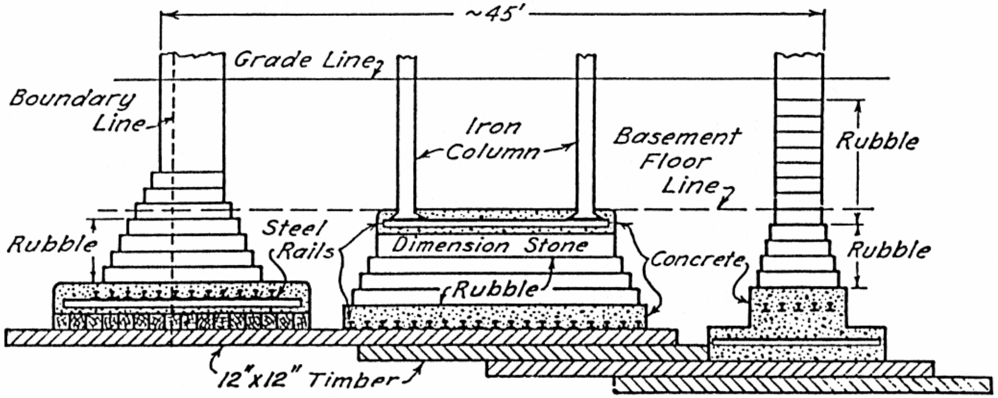


FIG. 10. SECTION THROUGH COMBINED FOOTINGS OF AUDITORIUM

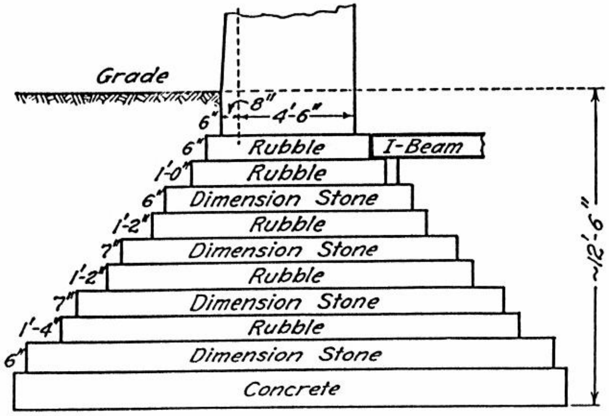


FIG. 6. SECTION THROUGH EXTERIOR PIER OF HOME INSURANCE BUILDING

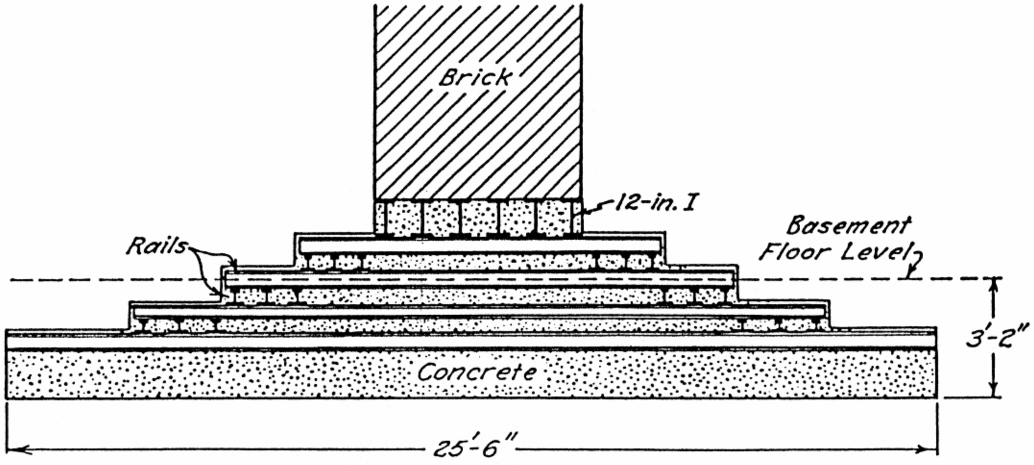


FIG. 7. SECTION THROUGH RAIL-GRILLAGE FOOTING OF MONADNOCK BLOCK

CE 484–Geotechnical Case Histories

- Evolved from course titled "*Advanced Foundation Construction,*" around 1957; Taught until 1974 by Ralph Peck
- Prerequisites were a full year of graduate study in soil mechanics and foundation engineering
- Open to graduate students in geotechnical engineering, structural engineering, construction management, and applied geology

Three principal goals of the case histories course….

- Problem Solving: learn how to solve real engineering problems
- Develop an appreciation of the intimate relationships between foundation engineering, industry, finance, politics, and human relations
- Learn how to express one's view, conclusions, and recommendations clearly and succinctly in writing

Most common scenario used in Peck's course

- The students assumed the role of a *board of consultants*, comprised of various specialists
- The instructors presented a synopsis of the situation, as presented to the geotechnical engineer
- In some instances, the client was an engineering company with considerable skill and ability, which had amassed expansive geodata
- This allowed presentation of a rather comprehensive engineering picture to the inexperienced students

Student’s expected response

- The students were expected to play role of a consulting board, asking very specific questions
- The instructors played the role of the client's engineer and endeavored to answer whatever questions the “board” proposed; *nothing more* and *nothing less…*

Student’s duties…..

- It was the duty of each class to discuss the problem amongst themselves, to determine whether a solution could be reached with the available data, and to determine what additional information, if any, was required, and to make specific request for said additional information.
- If the class decided that further exploration, tests, or measurements were needed, they had to request these data.

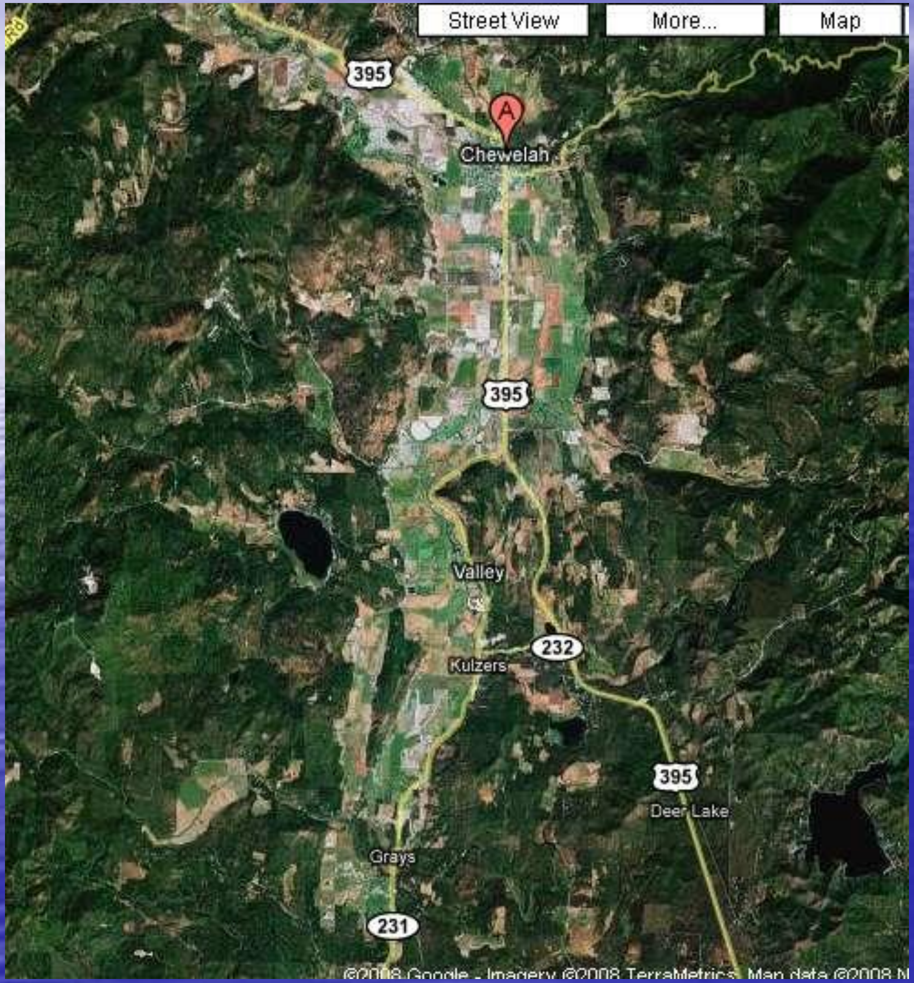
Honing engineering judgment…

- The class was advised that they must ultimately reach a decision as to when additional information could not profitably be utilized, and they must then arrive at a satisfactory conclusion.
- After the class had presented their decisions, the instructor would tell the class about the conclusions reached on the actual project and how the project performed after completion.

The Chewelah Chimney case

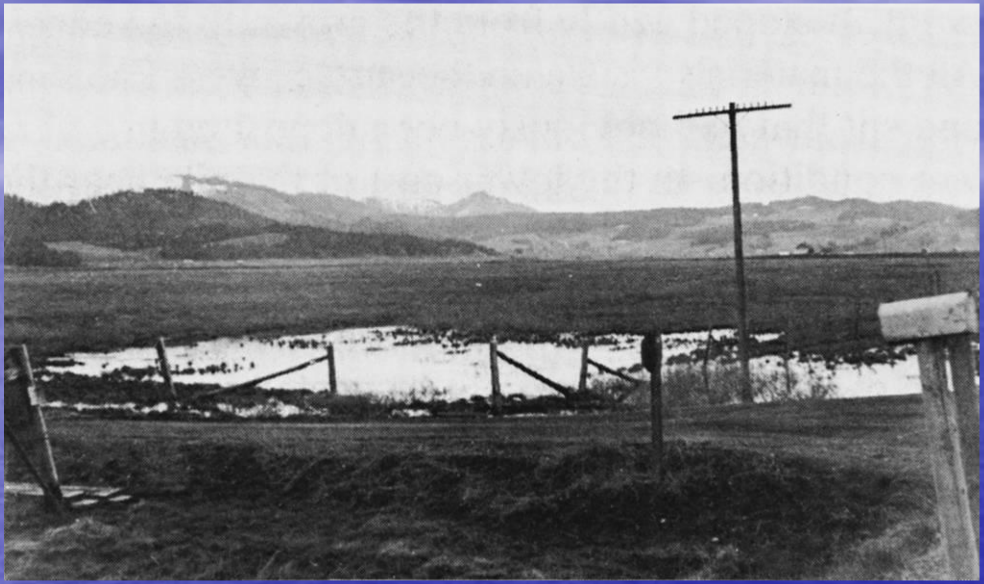
- Smelter chimney for a mine just south of Chewelah, WA-late 1940s
- The mining co drilled a hole 100 ft deep, about 100 ft from the proposed site
- The casing dropped 45 ft under its own weight and soft soils oozed upward 60 to 80 ft

Noting the geologic setting and backing out the bearing capacity…



- Peck noted that the mine was located in a valley that had been blocked by a glacial ice dam, forming a deep lake
- Back-analyses of two 20-ft diameter storage silos suggested an average soil pressure of about 2 tsf (192 kN/m3)

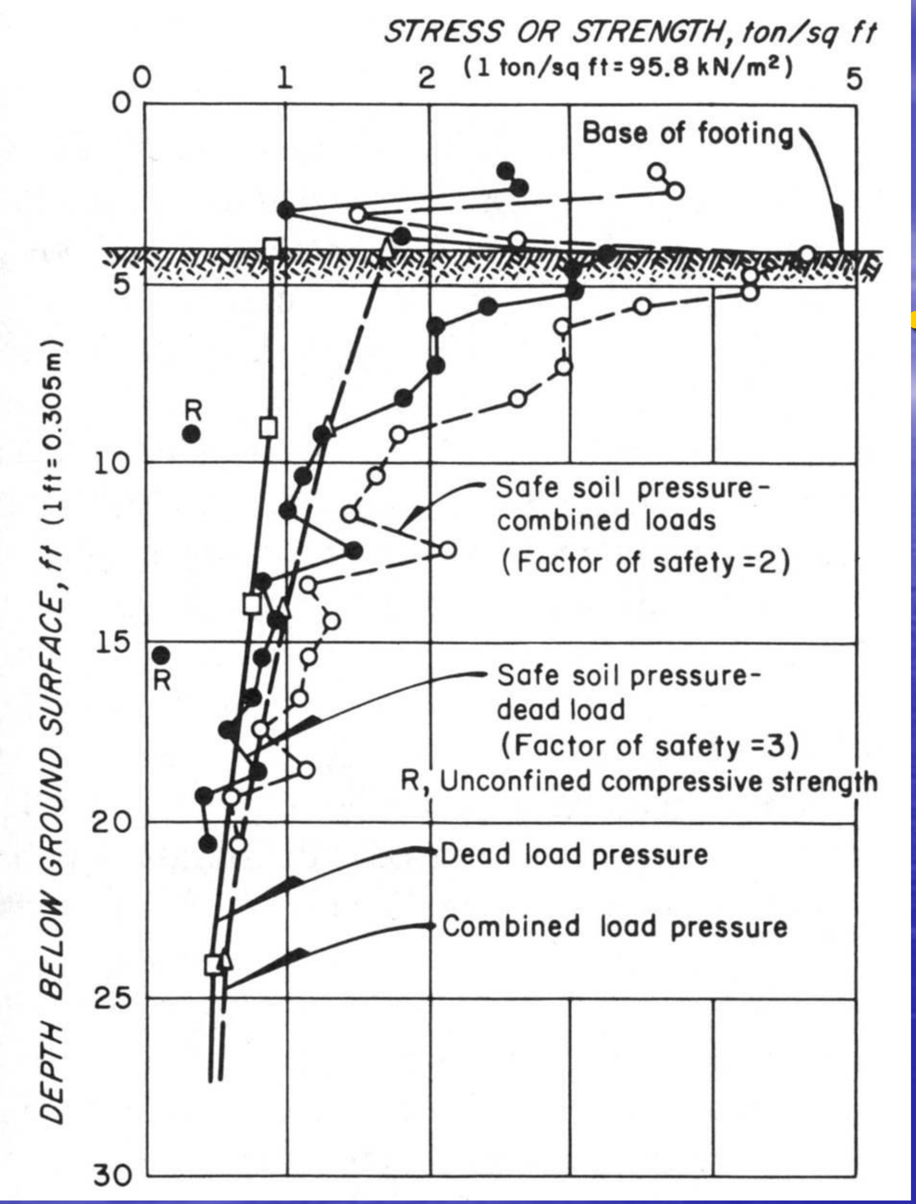
Dissecting the drill spoils pile…



- Peck reconstructed the boring log by dissecting a 20 ft diameter pile of drill spoils…
- Cap was 4 ft zone of wet sand and silt, capped by oxidized clay, underlain by 16 to 26 ft of blue lacustrine clay, underlain by fine sand
- The overconsolidated crust allowed the 2 tsf bearing capacity

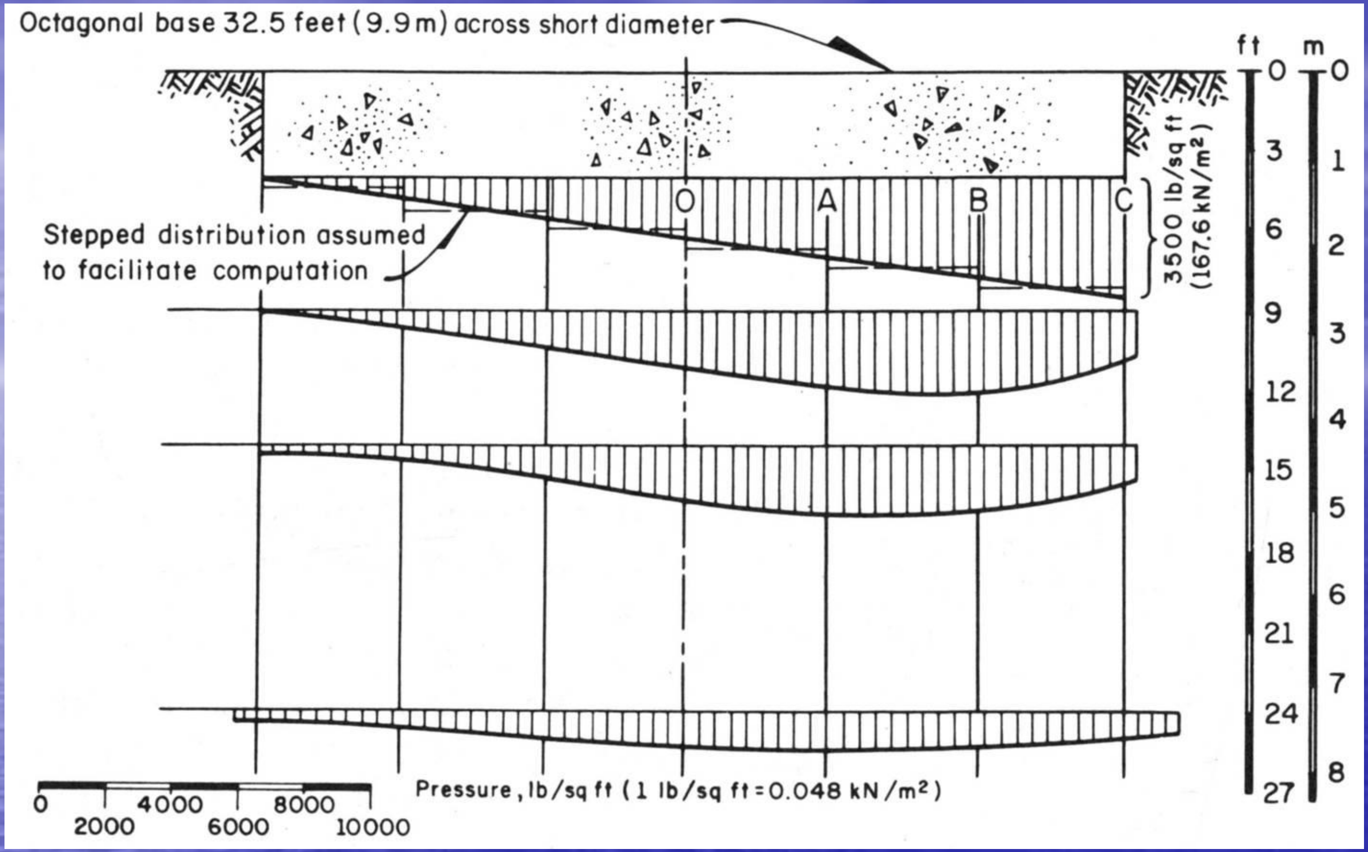
- Peck reasoned that if the bearing loads for the proposed chimney 100 ft away could be kept below 2 tsf, it would work
- The proposed octagonal footing for the chimney exerted a pressure of 3,500 psf, about 500 psf less than the ore silos
- Peck asked for a simple auger boring 25 ft deep with Shelby Tube samples….

Elegant but simple work products



Freeze-thaw effects cause spurious results in upper few feet

- Chart relating unconfined compressive strength (soild circles), safe soil pressures (open circles), dead load pressures (open squares) and combined load pressures (open triangles) for the Chewelah chimney site, from one 25 ft deep auger with thin wall sampling.



- Newmark pressure diagrams beneath the proposed chimney footing under maximum wind loading. Students found this to be a valuable graphic representation of the field situation, which required more than a simple check of bearing capacity of the hardpan layer

Alternative scenarios - 1

- Instructor plays role of a *non-technical client* who feels he has a problem
- Facts are present from client's perspective
- Students are asked to determine how the geotech investigation should proceed
- As student make decisions and request information, said information or data was provided by the instructor

Alternative scenarios - 2

- Instructor plays role of a *lawyer* requiring advice in regards to a controversy…
- Or, a *contractor* who started a job and has run into difficulty; or,
- An *architect* seeking foundation recommendations for a building he is beginning to design

Peck only supplied that information requested by the students

- He did so in a manner so that the class felt they had participated in gaining the data (*this was key element*).
- If the class felt that additional field observations were necessary, they had to identify what it was they would be observing, and Peck would only answer their specific inquiries, e.g. telling them what was observed or measured at a particular place and time

One of Peck's main goals was to recognize one's own limitations

- Students should realize that regardless of their formal training and experience, they will someday find themselves ***deficient*** in some particular aspect of a consultation
- They must learn how to search out and retrieve this needed information, by whatever means necessary…
- Examples: site geology or history, certain kinds of equipment or construction techniques, how other engineers treated similar challenges, incl case histories

The one page summary

- One week after a case study involving 2 to 10 hours of interchange, students were asked to submit a *one page summary* of the project studied.
- It had to include: 1) statement of the general setting; 2) statement of the specific problems that required solutions; 3) the solution agreed upon by the 'board of consultants'; 4) the student's evaluation of the solution reached by the group

Vexing problems with the one page summaries…

- The one page limitation was very difficult for most students, *especially those with actual work experience!*
- The problems covered a variety of foundation types, from simple to complex, and a variety of professional situations.
- The class might be told that the economic benefit to be derived from further investigations, or in some cases, any formal investigation at all, may not justify the expenditure!
- The aim was to teach engineers to *separate the wheat from the chaff.*

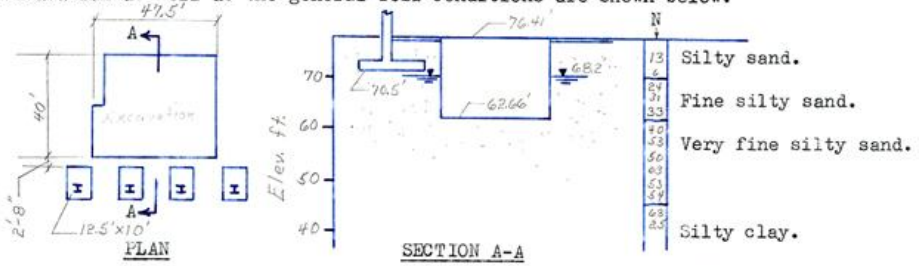
Engineers more likely to be effective if they also cultivate good communications skills…

- Another over-arching goal was to convey to the students that a sound engineering solution to a construction problem may be determined as much by the way in which the consultants deal with the personalities of the owner and the contractor as by any technical considerations.
- Never forget who is paying your bill, and what their needs and concerns are

No. 7. U.S. Navy Missile Launching Pad. 10' Elmo DiBiagio

Description of Project. This project deals with an excavation made in 1958 for the specific purpose of installing a training missile lauch pad inside the Gunners Mate Building at the Great Lakes Naval Training Station in Chicago.

Significant Problem. The exterior walls of the 237 by 241 ft Gunners Mate Building consist primarily of glass panels; the flat roof of the structure is supported entirely by roof trusses and columns located along the exterior building walls. These columns are supported by spread footings on sand at a depth of approximately five feet. The proposed excavation was to be made in the southeast corner of the building adjacent to two existing gun mounts and within 2 ft-8 in. of the line of spread footings that support the walls and roof columns. A plan and cross section of the excavation as well as the general soil conditions are shown below.



The specific problem was to devise a means of carrying out the excavation without damaging the building or disturbing the gun mounts. The major concern was to prevent settlements of the column footings and thereby avoid cracking of the exterior glass panels. Engineers at the Training Station estimated that footing settlements greater than 1/4 in. could not be tolerated.

Approach to the Problem. The Navy engineers had proposed a system consisting of steel sheeting embedded 16 ft below final excavation depth, timber braces in both directions at two levels and a well point installation between the footings and the sheeting. The cost of the project according to this scheme was $86,000.

Our Board of Consultants proposed two schemes for carrying out the excavation. The first of these utilized a well point dewatering system and a bracing system consisting of H-pile soldier beams, wooden lagging and three levels of struts. Soldier beams were selected instead of continuous sheeting because they would be easier to drive or jet and drive through the compact sand.

The second approach was based on the assumption that the well points could be eliminated and steel sheeting could be used to avoid loss of ground and subsequent settlement of the footings. This method required at least four feet of embedment of the sheeting below final grade in order to prevent a hydraulic heave of the bottom; dewatering was to be achieved by pumping from a sump in the center of the excavation. The major objection to this method was the uncertainty regarding the effects on the building of the shock and vibrations associated with driving the sheeting through the compact sand.

Solution. The procedure adopted for carrying out the excavation was as follows.

1. Vertical 8 in. soldier beams were driven on 5 ft centers around the periphery of the excavation. Jetting was required.
2. The soil beneath the four adjacent footings was stabilized to a depth of 18 ft by chemical injections around the periphery of each footing (Cost $12,000).
3. One line of well points was installed along the outer edge of the footings. This location was chosen because it would result in a more uniform drawdown and consequently more uniform settlements beneath the footings.
4. Top strut was positioned before excavation and installation of lagging began.

Evaluation. The excavation was successfully made without breaking any of the glass panels in the building; however it was noted that at the completion of construction the footings were 7/8 in. higher then they were prior to the start of construction. The battle was won but they lost the war because of poor field control.

1-page summaries

- Many of the summaries included simplified plans and/or geologic cross sections;
- Note specific topic headings, including 'Solution' and 'Evaluation'

Grading of the one page summaries

- Peck graded the one page summaries with a "heavy hand;" scoring students on:
- 1) absolute 1-page limit, typewritten, with neat sketches;
- 2) overall organization of facts and thoughts; and
- 3) recognition of the pertinent factors, and
- 4) English grammar

Downsides of Peck's course

- It relied heavily upon the *personal experience of the instructor* because one cannot anticipate the questions students will pose.
- This is because the students often approached the problems quite differently from what occurred on the actual jobs
- They tried to write several of these up for other instructors to use, and this failed miserably

Equipping students for success

- Peck maintained that case studies were the most effective way to teach engineering judgment and design innovation in the broad sense of the term, and simultaneously increase the student's knowledge of their own specialty, while stimulating their appreciation of influences they had not previously realized were related to geotechnical engineering.

Ralph Peck's philosophy on teaching engineering ....

- If all the pertinent facts of a consultation are merely lined up in some written document, the student's efforts are reduced to the selection of significant facts, and one of the essential aspects of engineering design is lost
- The art of deciding on *what information should be obtained*, and how, and when, to get it, is at the very heart of the geotechnical design process.

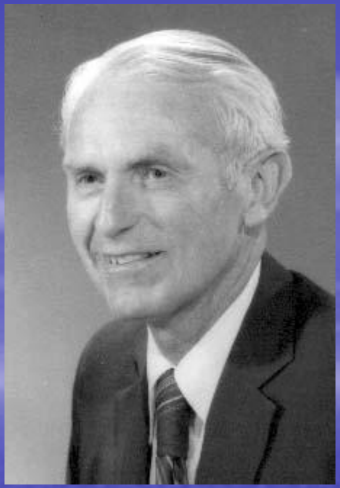
So, what did all the other schools do, who didn’t have a Ralph Peck on their faculty?

Most came to employ the ABET Capstone Design Course Model

- The more traditional model for teaching various aspects of professional practice is to employ *student teams* to undertake *term projects* that involve some real or imagined design problem.
- Teams often comprised of students of diverse technical backgrounds
- Actual sites often chosen, with actual geotechnical data, and field visits often carried out…

Harry Seed

Bill Houston



Ben Gerwick

Harry Seed of U.C. Berkeley invited Ralph Peck to come and teach his case histories course during a summer session in the mid 1970s, shortly after he had retired. The Berkeley faculty decided that none of them had the sufficient breadth of first-hand experience to teach a similar course, so they opted to use a capstone design course taught by Bill Houston and Clarence Chan called *Graduate Soil Mechanics Laboratory Procedures, CE 270L*. With one hour lecture and two 3-hour labs each week, and lots of drilling and sampling on the weekends.

Ben Gerwick taught a companion course titled Foundation Construction CE 267A, which focuses on the various design and construction problems associated with depp retained excavations.

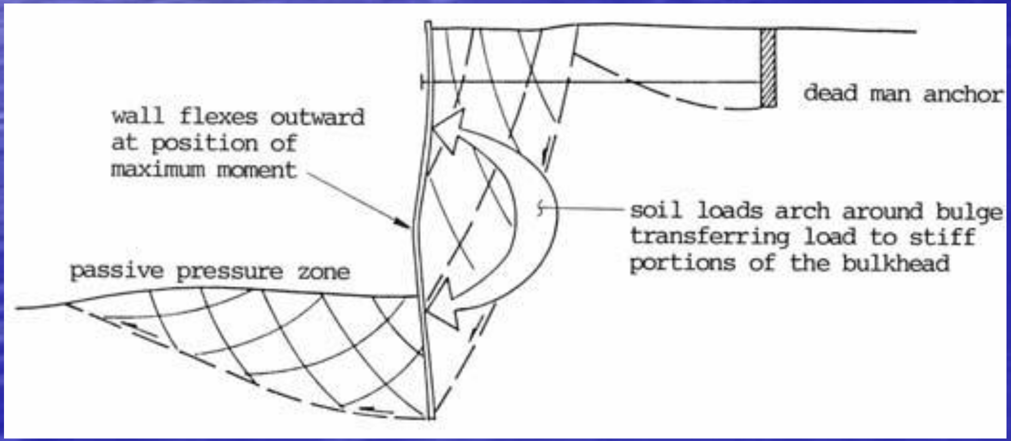
Hamilton Field Test Site

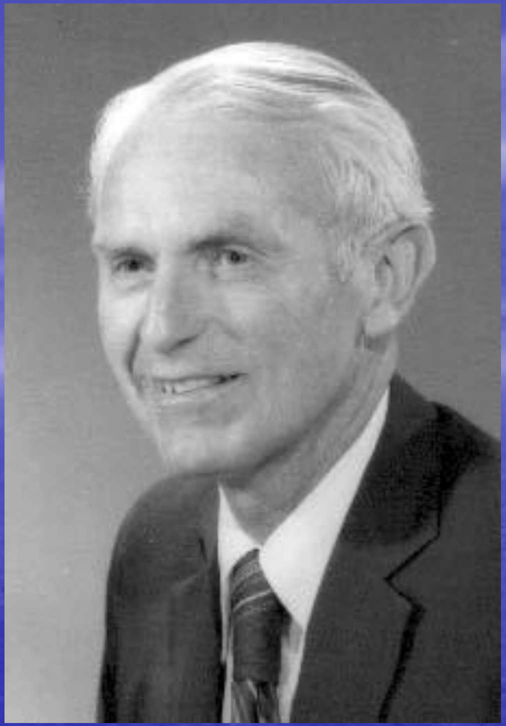
- The Berkeley soils courses did field sampling of Young Bay Mud and associated soft soils at Hamilton Field, along the northern shore of San Francisco Bay.

Design problem as term project

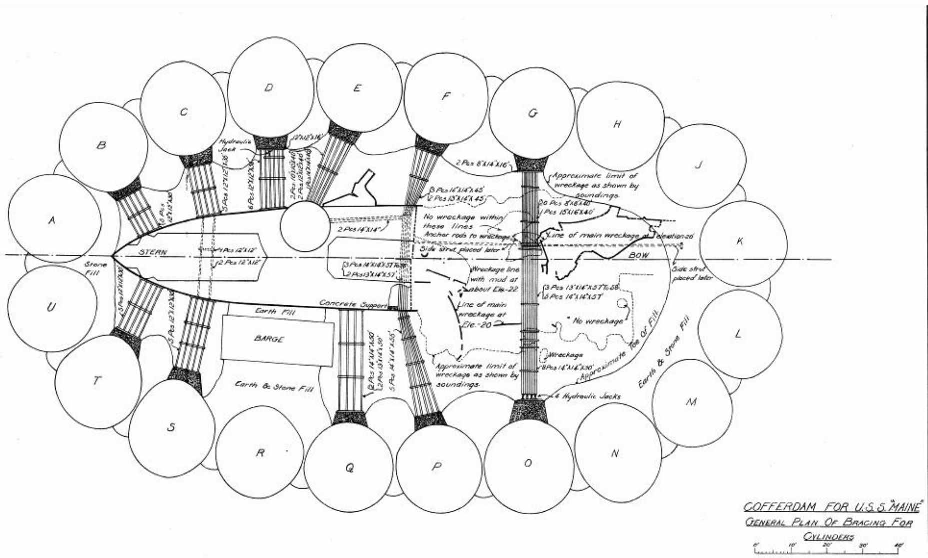
- CE 270L was the most practical of all the geotech courses offered at Berkeley, and many a graduate student failed to score their usual "A" grade.
- Enrollment was typically 25 to 35 students per year
- Intensive field exploration work, including vane shear and pressure meters
- Intensive lab testing, including dynamic triaxial tests
- Graded on final written report

Gerwick's Foundation Construction course



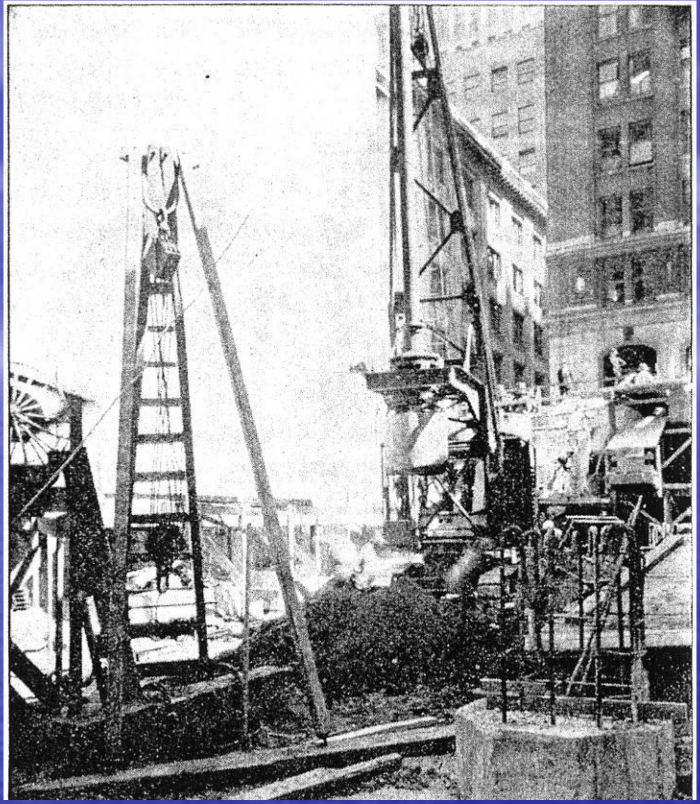


Berkeley didn't have Ralph Peck, but they did have Ben C. Gerwick, Jr., a world renown innovator, known for pioneering work in prestressed concrete piles and design of marine structures. He had worked in construction 30 years before he began teaching 267A in 1975.

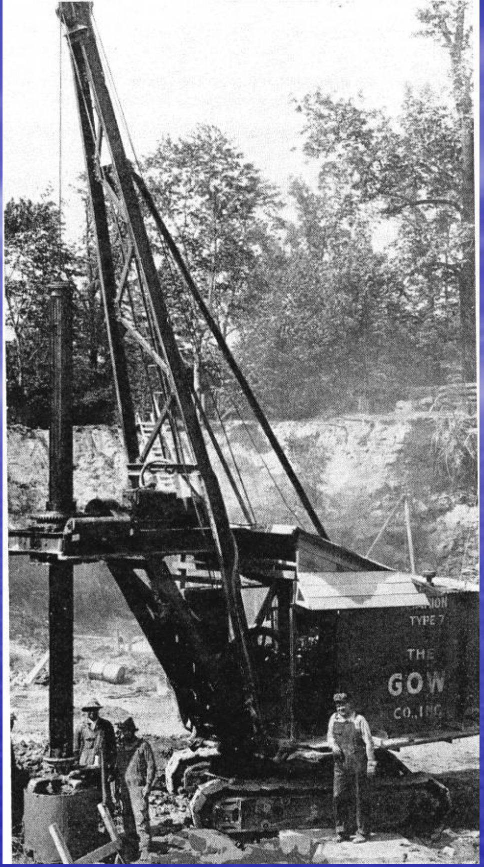


Gerwick's lectures began with Daniel Moran's work in New York around 1900, and moved forward. These images show the first use of circular sheetpile cofferdams for excavation of the battleship Maine in 1912-13.

Gas powered spud drill – early 1920's

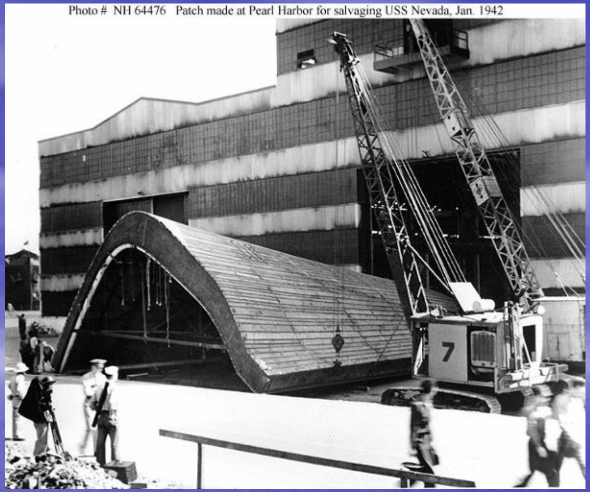


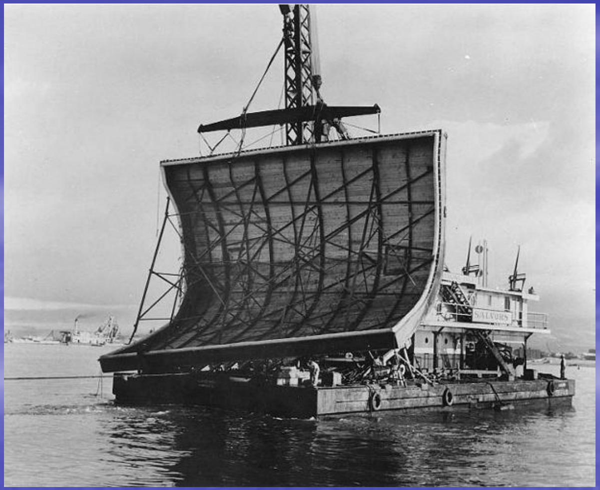
First mechanized drilling of large diameter caissons in San Francisco in 1928.

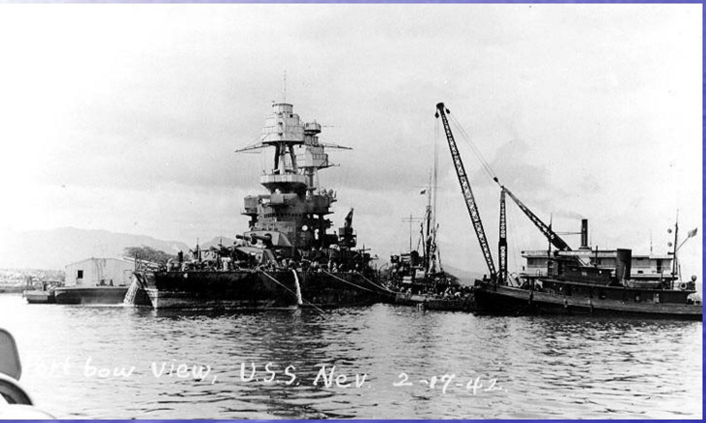


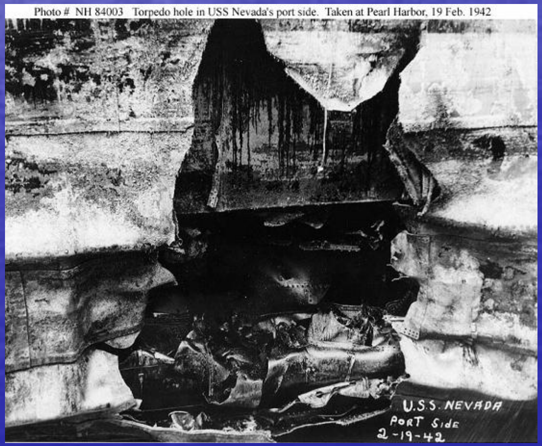
Bucket auger excavating caissons in 1946

Most of Gerwick's lectures ran like a History Channel mini-series on foundation construction; noting key advances, individuals, and organizations that made pioneering innovations.





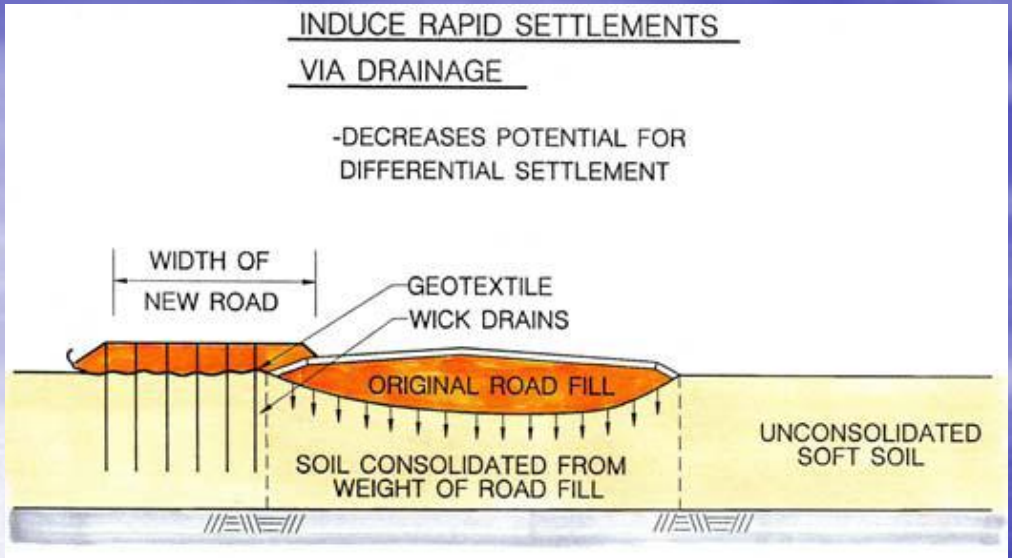


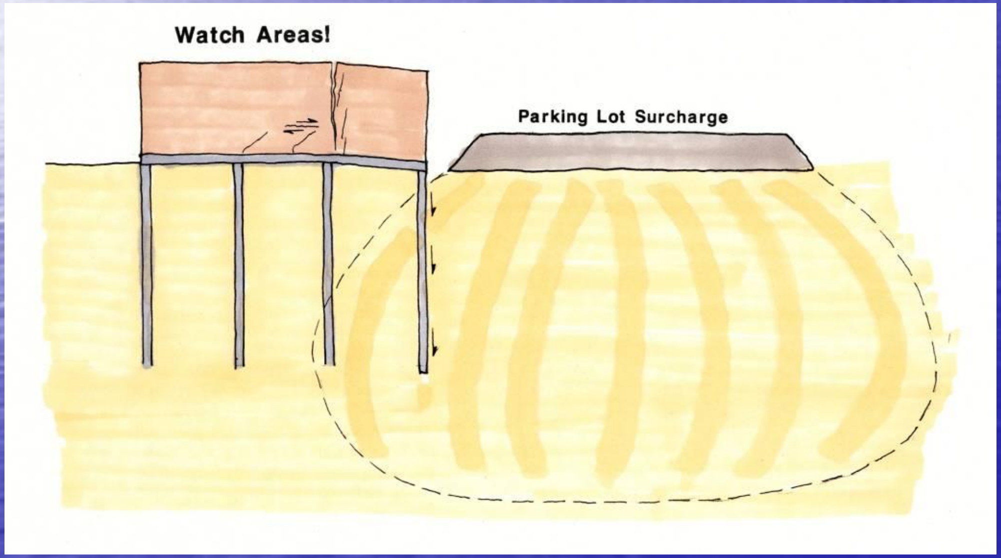


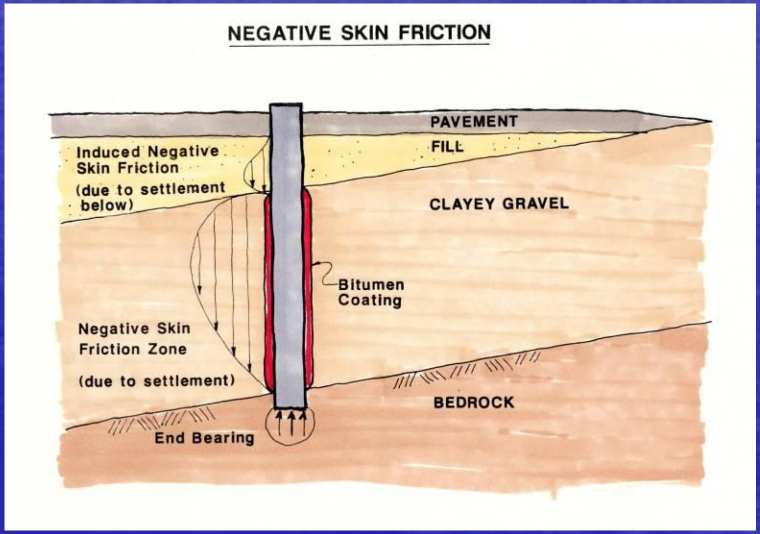
- Gerwick's father Ben Sr. was an accomplished marine construction specialist. This shows the temporary bulkhead caissons used to refloat the battleship Nevada, sunk in the attack on Pearl Harbor.

For use in landing on soft surfaces, each main gear is provisioned with eight wheels.

Gerwick had graduated #1 in his NROTC class at Berkeley in 1940, rising to the rank of full commander by war's end, and command of his own deep draft warship. He exposed students to all sorts of construction lessons learned during the war, including many of the runway and pavement problems shown here…

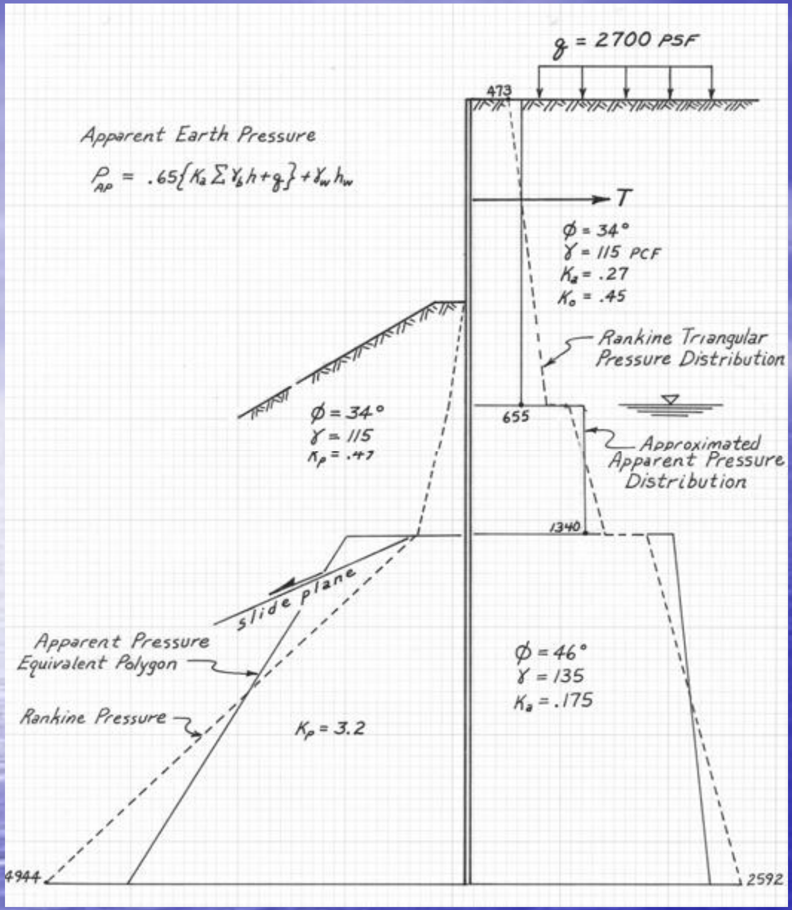


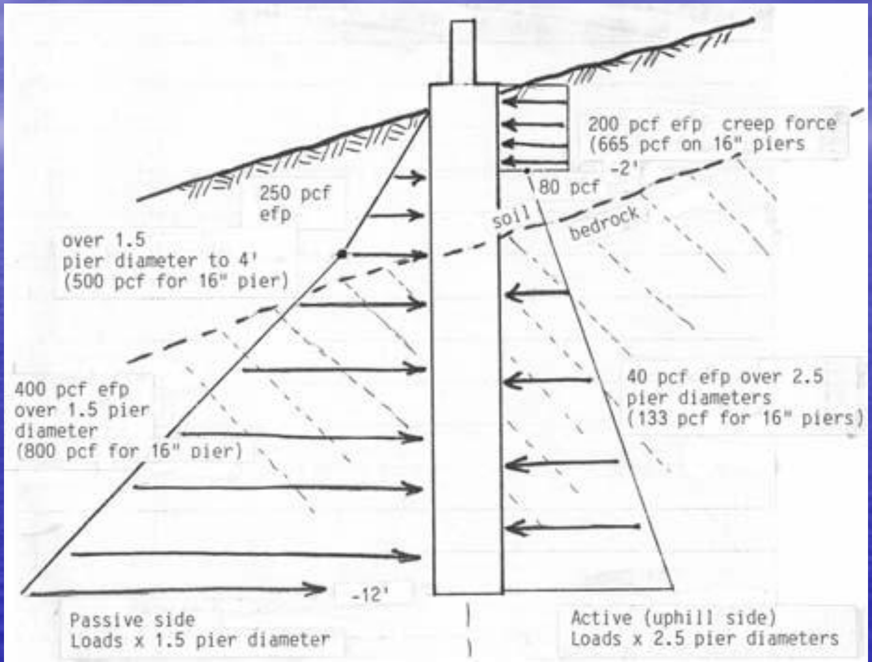




Gerwick emphasized all sorts of *geotechnical failure modes* that most of his students had not previously been exposed to….

Pearls of wisdom





Gerwick also passed out little tidbits about how to better communicate engineering data. For example, he felt that geotechnical loads should always be represented graphically in loading diagrams, so they would be interpreted correctly by others charged with designing these structural elements.

Final Product

- The seminal document produced by student teams for the Foundation Construction course was a full-blown consulting report
- It contained three distinct sections: 1) geotechnical site characterization, 2) structural design of temporary support systems, and 3) construction scheduling and sequencing, using CPM

CONCLUSIONS

- Capstone design courses are one method that forces students to work with one another on quasi design teams.
- Case histories course can be more effective in stimulating creativity, and alerting students to all sorts of real-world issues, such as developing engineering judgment, preparing executive summaries, and recognizing deficiencies in one's own professional pedigree.
- The latter requires instructors with a modest level of real world experience and the desire to teach non-traditionally, allowing the students to "drive" the course, through interactive discussions and role playing.

Thank You !

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