METU – Civil Engineering Department
CE 464 Ground Improvement - Fall 2016

Instructor: Asst. Prof. Nejan Huvaj Sarıhan
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Instructor Office Hours: Tuesdays 8:40-10:30, or email me for a meeting time
Lecture Hours: Mondays 13:40 – 16:30, CS1
Assistant: Emir Ahmet Oğuz
Room: K1-115b Email: eoguz@metu.edu.tr Phone: 2105468
Assistant Office Hours: send an email for a meeting time

Course website: https://odtuclass.metu.edu.tr/

PURPOSE AND SCOPE

The purpose of this course is to provide students the fundamental knowledge and familiarize them to ground improvement techniques.

At the end of this course, students will be able to:

determine what type of soil conditions may need ground improvement,

which type of ground improvement method can be preferred in each case,

understand advantages and limitations of each method,

design preloading with or without vertical drains, design ground improvement by compaction, design stone columns, design grouting, design geosynthetic reinforced walls and slopes, design soil nails.

Prerequisites: CE363 Soil Mechanics, CE366 Foundation Engineering

TENTATIVE WEEKLY SCHEDULE

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7	Deep Vibratory Methods (stone columns)
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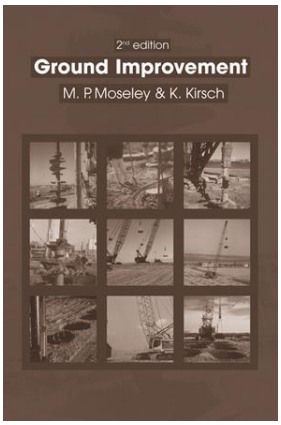
12	Soil Nails
13	Soil Nails Rocscience SLIDE exercise
14	Review on deep mixing methods, Rewiew on swelling soils, Ground improvement under existing structures

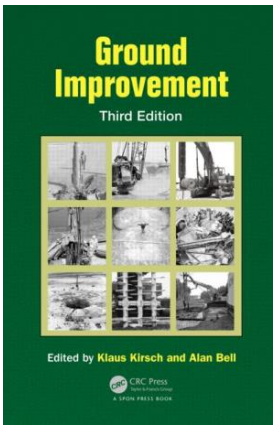
- Weekly assignments / class exercises
- Handouts and additional reading
- Computer Usage: Rocscience SETTLE3D and SLIDE
- Guest lecturers and a field trip

GRADING: 25%+25% Two Midterm Exams
15% Assignments and Class Exercises
30% Final Exam
5% Attendance and Participation

REFERENCE BOOKS: (available at METU Library Reserve)

- Ground improvement, 2004, Moseley and Kirsch., Library Call No: TA715.G76 2004
- Ground improvement, 2013, Kirsch and Bell, Library Call No: TA715.G76 2013





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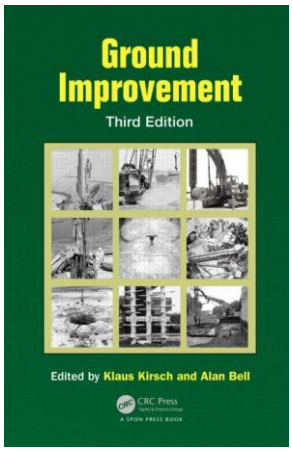
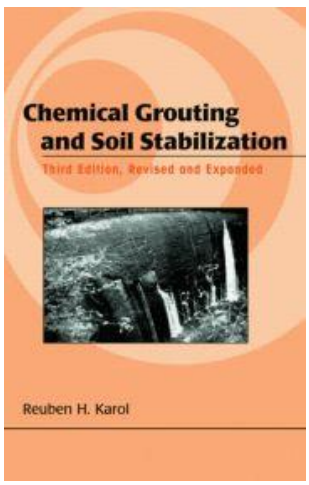
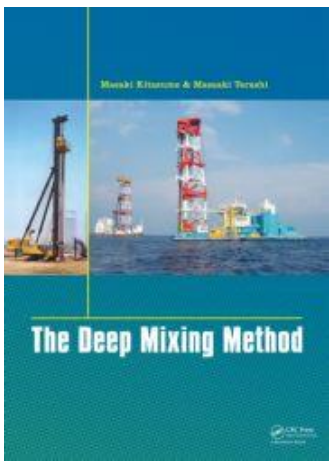






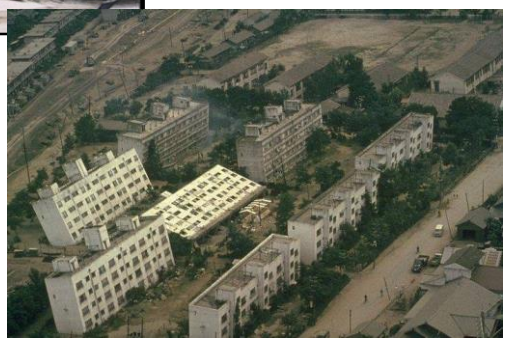
CE464 Ground Improvement
INTRODUCTION

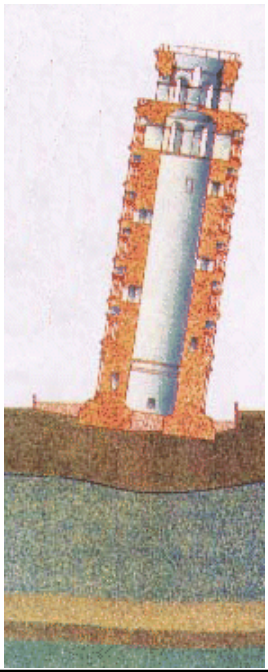
Need for Ground Improvement?

- Low bearing capacity,
- Significant amount of total settlement / time
- Significant amount of differential settlement
- Liquefaction
- Blocking Seepage
- Swelling soils
- Unstable slopes
- Karst and sinkholes

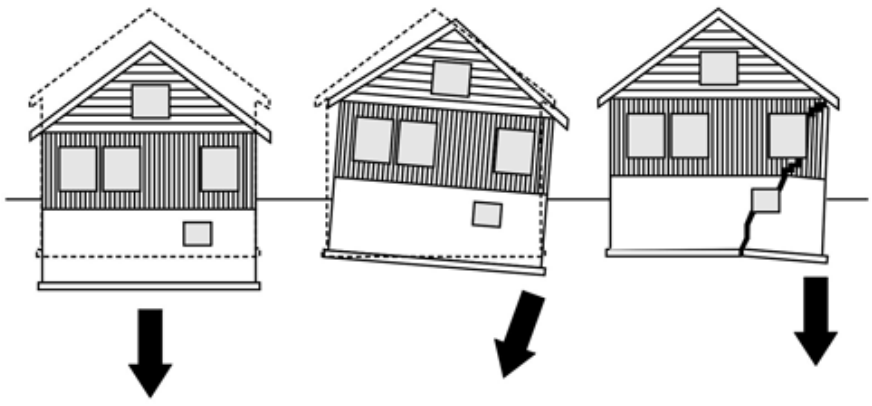
Strategies to deal with the need for ground improvement?

- Avoid the particular site
- Change the project / foundation system
- Remove and replace unsuitable soil
- Modify the existing ground:
  compaction, reinforcement, admixtures, grouting, dewatering etc

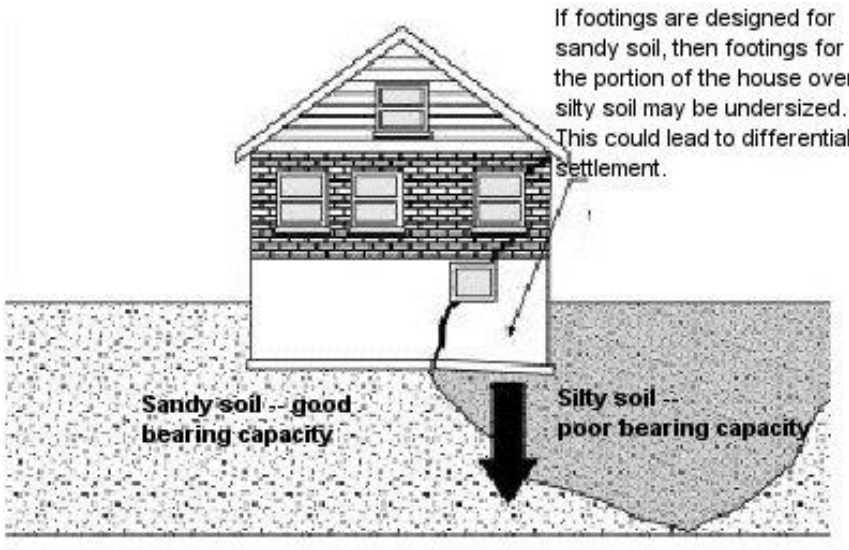




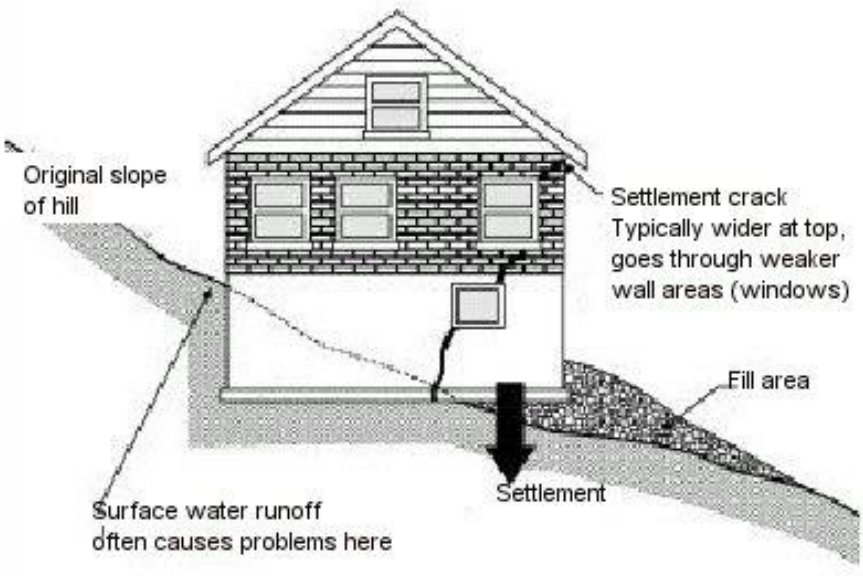
Types of settlement



Depends on foundation type! (single footing, mat foundation etc)

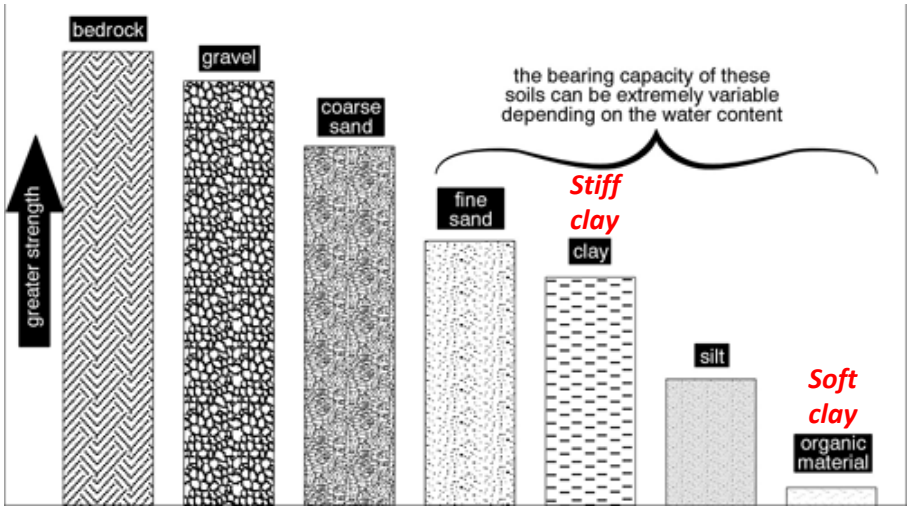


Differential settlement caused by variable soil types



Building settlement due to cut and fill excavation

Bearing capacity of soils
Gravel, sand, silt, clay



http://www.ashireporter.org/HomeInspection/Articles/A-Lesson-in-Basics-Foundation-Inspections-Part-1/646#bearingstrength.gif

TENTATIVE WEEKLY SCHEDULE

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1	Introduction (various ground improvement techniques, soils/projects that need improvement)
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https://www.youtube.com/watch?v=W5Uc0-EtOn4

Vertical Drains

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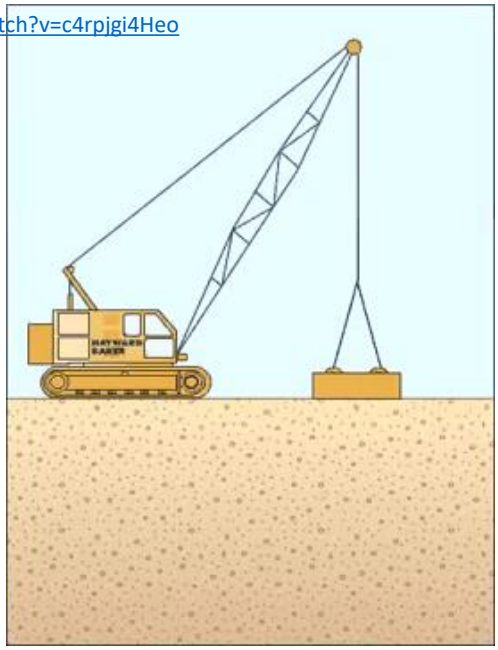
https://www.youtube.com/watch?v=c4rpjgi4Heo

dynamic compaction



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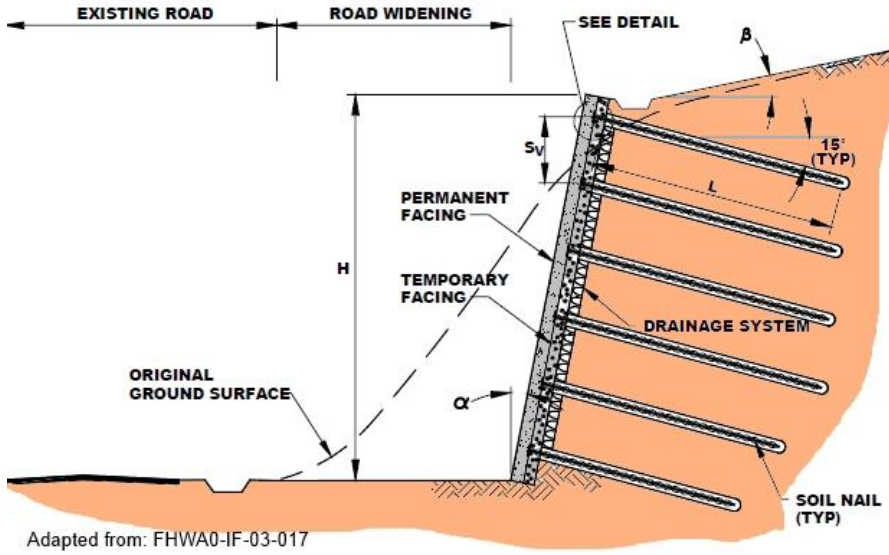

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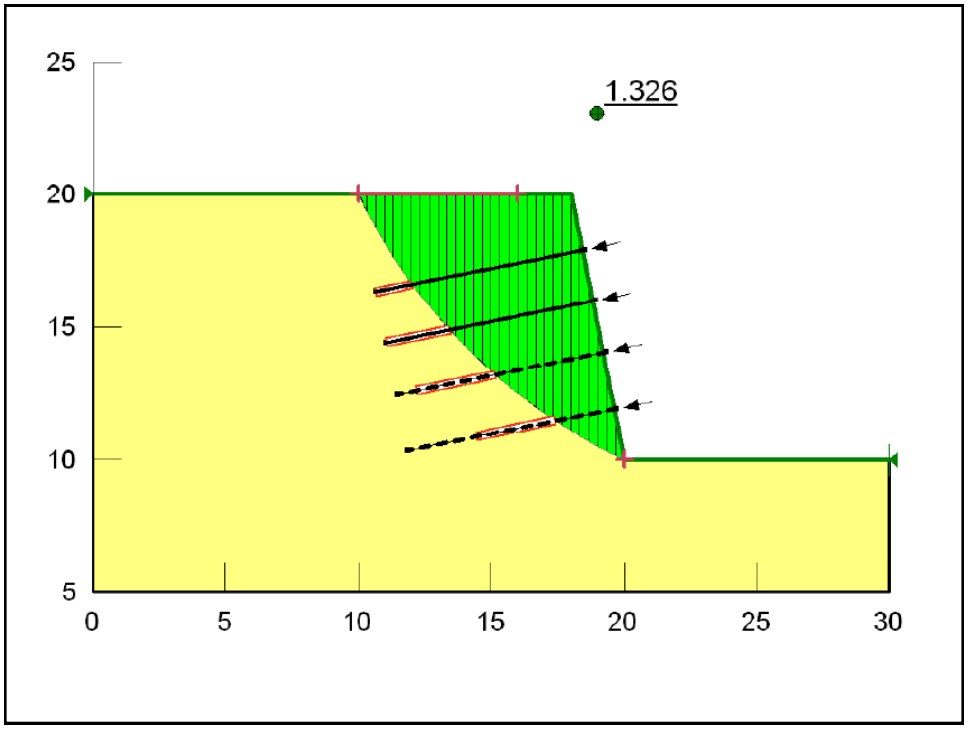
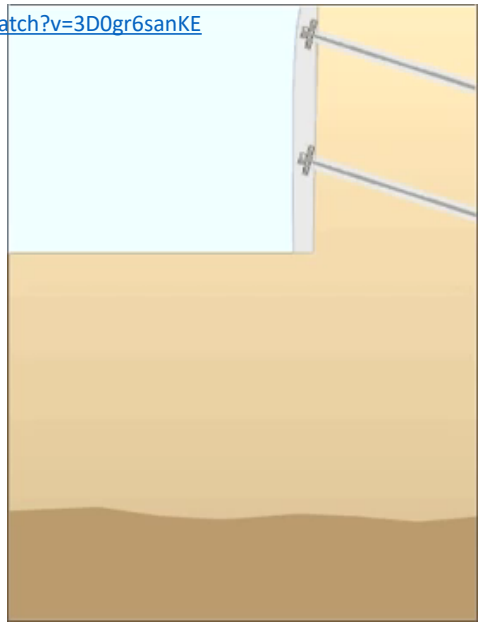
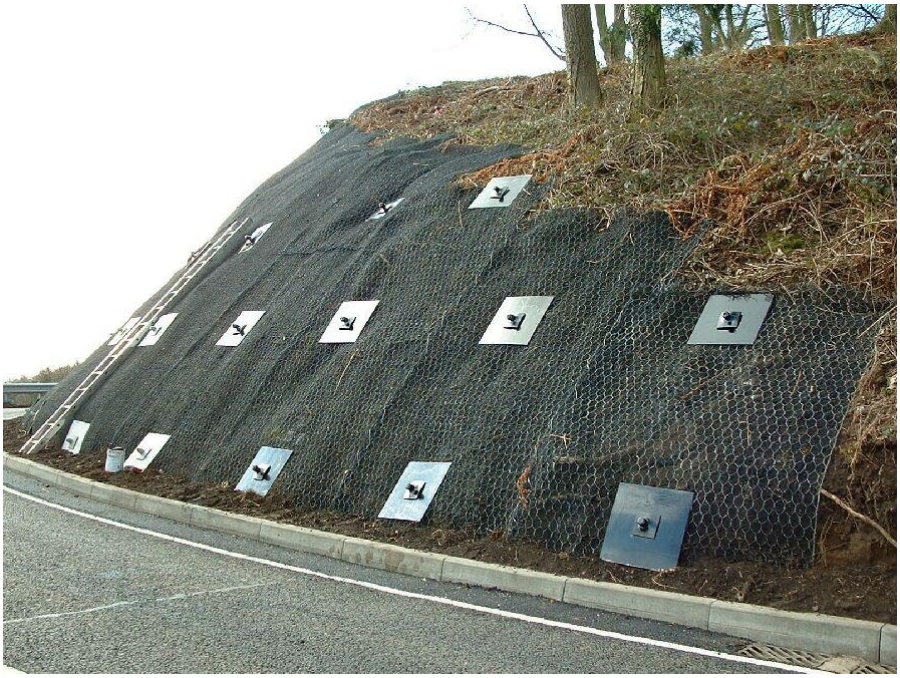


https://www.youtube.com/watch?v=3D0gr6sanKE

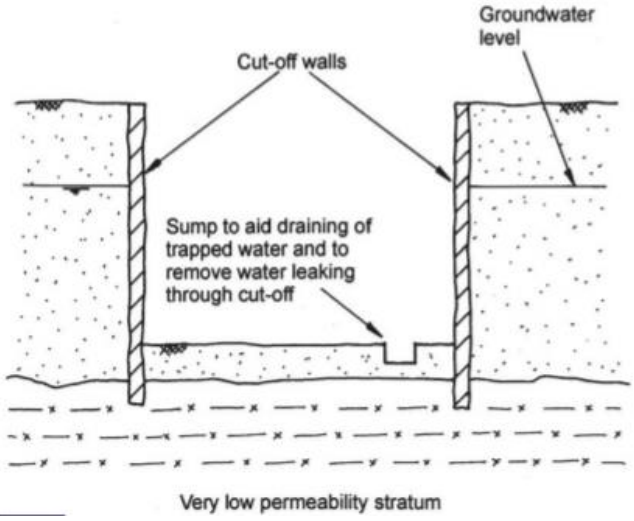
Soil Nails



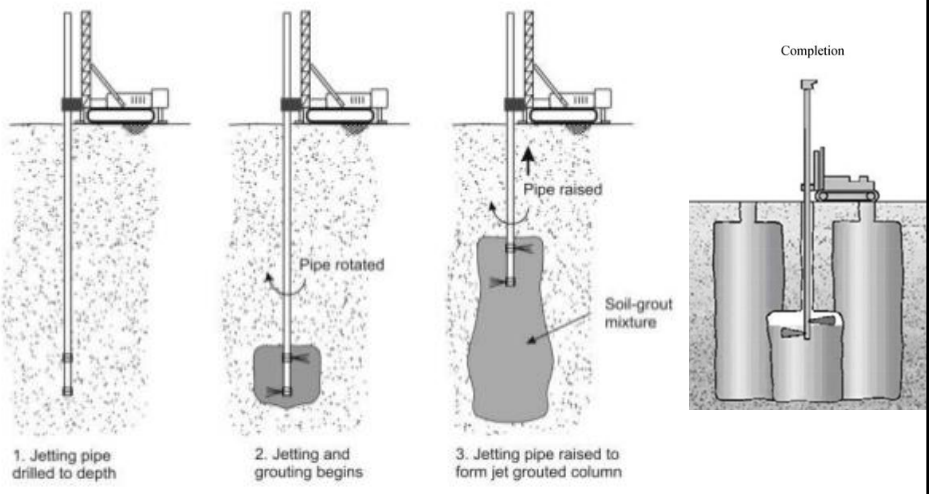


Creating a vertical cutoff wall for preventing seepage

Cut-off walls penetrate into underlying low permeability stratum

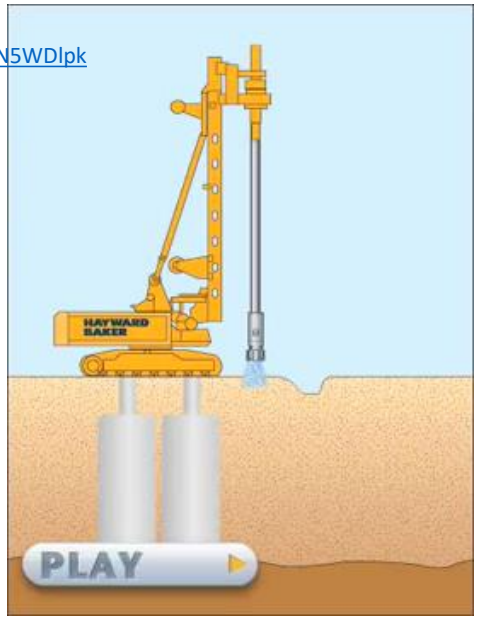


JET GROUTING



Jet grouting

https://www.youtube.com/watch?v=KgXRN5WDlpk



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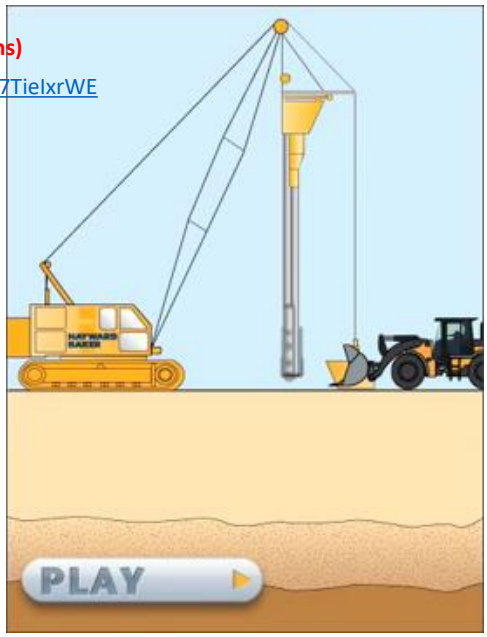
Deep Vibratory Methods (stone columns)

https://www.youtube.com/watch?v=bh7TieIxrWE



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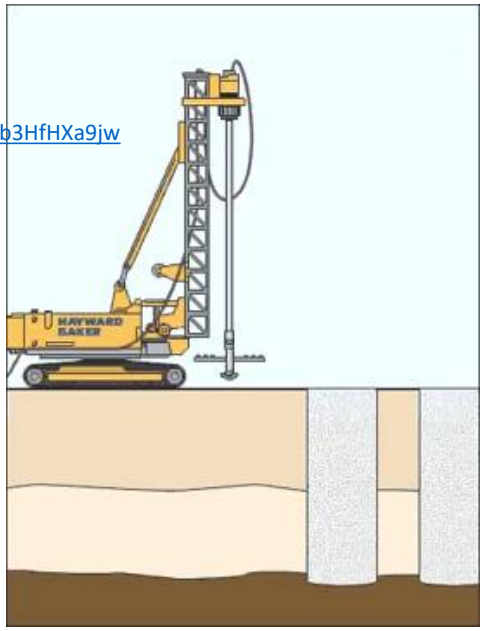
deep mixing methods

https://www.youtube.com/watch?v=5b3HfHXa9jw



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- Avoid the particular site
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- Ground improvement under existing structures!

	Tabaka Derinliği Layer Depth	Muhafaza Borusu Casing	Numune derinliği Sample Depth	Numune türü ve Nosu Sample Type and No	STANDART PENETRASYONI DARBE SAYISI 15	30	45	SPT GRAFİĞİ / SPT Graph 10	20	30	40	50	60	Zemin Türü Group symbol	JEOLOJİK KESİT Profile	TANIMLAMA DESCRIPTION
16																
			16,50 16,95	SPT- 12	1	1	1									
17			17,50 18,00	CORE 5										CH		Gri-siyahımsı gri, yumuşak-çok yumuşak, yüksek plastik, ıslak, Siltli KİL
18			18,00 18,45	SPT- 13	1	1	1									
			19,00 19,50	CORE 6												
19			19,50 19,95	SPT- 14	1	2	2									
20																KUYU SONU = 20,00 m