

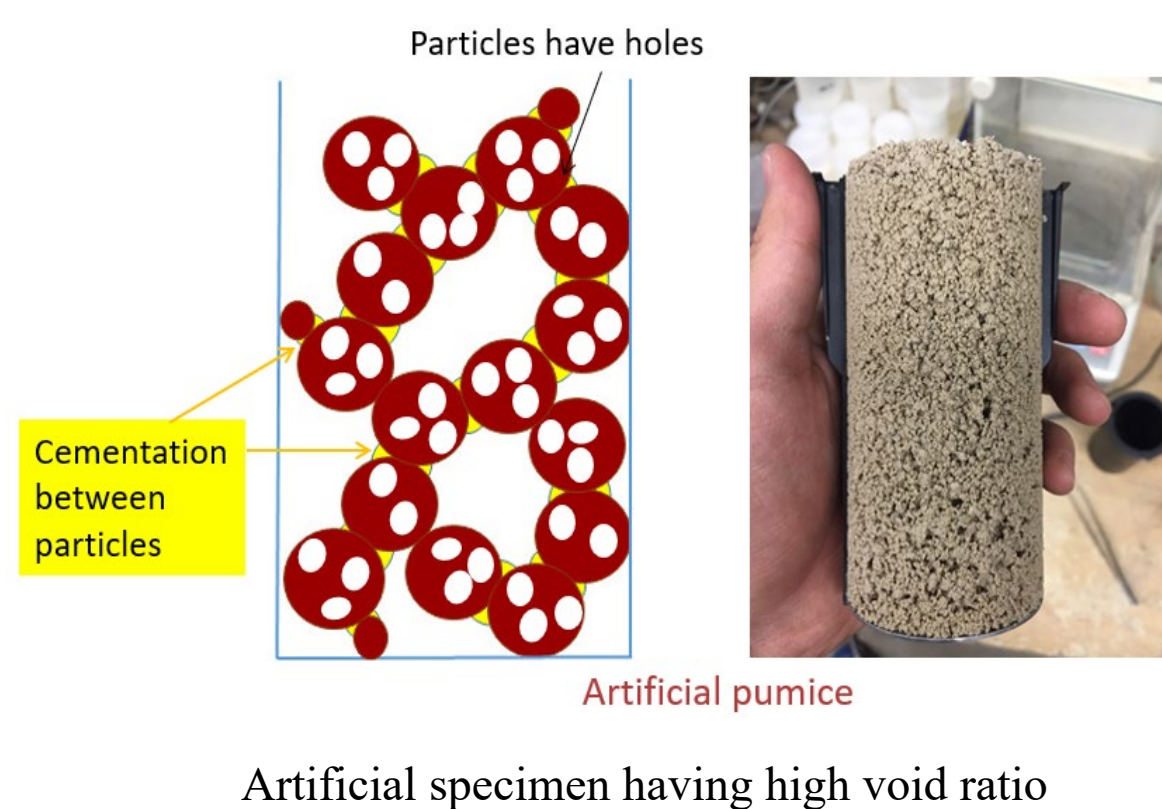
Many slope disasters occur every year all over the world, and a lot of human lives are deprived by them. Sometimes, disasters at gentle slopes and disasters that flow long distance, with destructive energy, are observed in Japan. In such cases, the trigger layer is often volcanic extremely loose soil. Although the cause of destructive long-distance flow has been explained by liquefaction, there are some cases which occurred at unsaturated layer, i.e. liquefaction may not be a major cause. Focusing on those facts, artificial loose soil samples consisting of silt and cement were prepared and a series of triaxial tests with unsaturated condition was performed to discuss how air trapped in voids affects the shear strength properties. It is indicated that extremely loose soil can be vulnerable against risk of landslides even if it is not fully saturated.

日本には火山由来の高間隙構造を有する土が各地に分布し、斜面災害の起因層になっている。事例の中には災害時に起因の軽石層が不飽和状態であったものもある。これらの特殊土のように非常に高い間隙比が不飽和層や緩斜面で起こる災害の被害の大きさに与える影響について、これまでセメンテーションや粒子破碎性を持つ人工供試体を作製し飽和状態における三軸試験を行った。その結果、飽和時においては超高間隙土は一定の強度を見せた後に大変形を起こしうる steady state に至る可能性があることが示唆された。本研究では不飽和排水圧密・非排水非排気圧縮三軸試験を行い、超高間隙土における不飽和せん断特性について考察した。

### セメントを用いて超高間隙構造土を再現

Reproduce high void ratio structure soil using ordinary Portland cement

非塑性細粒土であるDL-CLAYにセメントを加え、七日間養生することでセメンテーションや破碎性を持つ高間隙の火山性軽石層を再現する。By cementing DL - CLAY which is non - plastic fine granular soil and curing it for seven days, I reproduced the high void ratio volcanic pumice layer with cementation.



### 人工供試体の物性値 Properties of artificial specimen

Specimen	$\rho_s$ ( $g/cm^3$ )	$\rho_r$ ( $g/cm^3$ )	$e$
Specimen A (Artificial pumice)	2.69	0.89	2.02
Loose DL clay	2.65	1.03	1.58

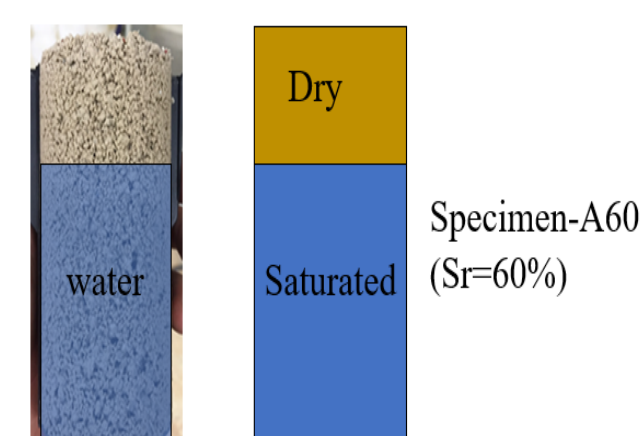


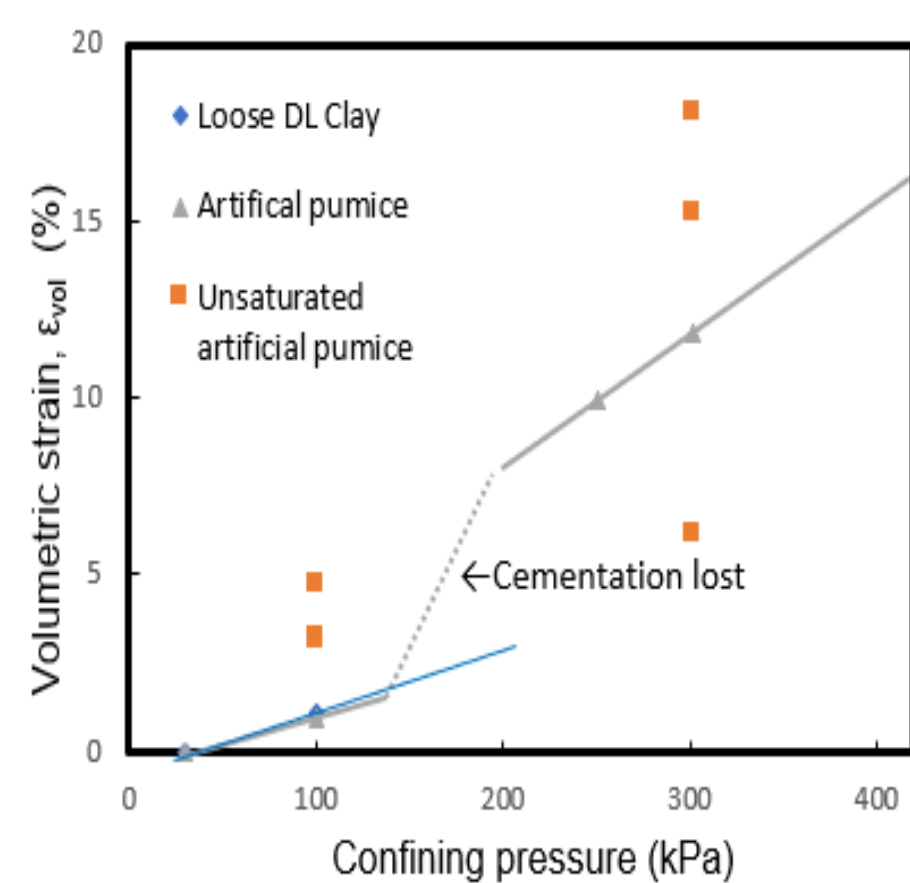
Illustration of partially saturated specimen.

### Experimental cases.

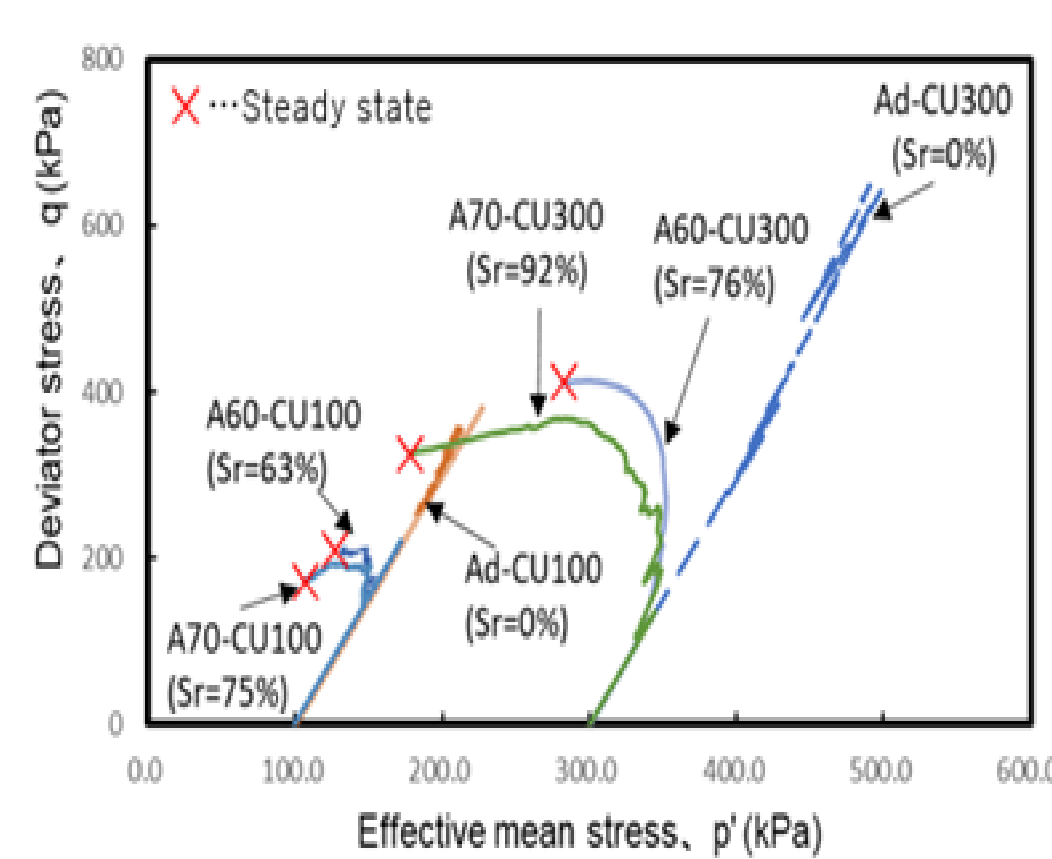
Test	Specimen	Type	Degree of saturation before consolidation, $S_r$ (%)	Consolidation pressure(kPa)
A-CU50	Artificial Pumice	CU	100	50
A-CU100				100
A-CU250				250
A-CU300				300
D-CU100	Loose DL clay	CU	100	100
Ad-100	Artificial Pumice	Partially saturated CU	0 (oven dried)	100
Ad-300				300
A60-CU100				60
A60-CU300	Artificial Pumice	Partially saturated CU	70	100
A70-CU100				100
A70-CU300				300

### 圧密排水・非排気非排水不飽和三軸試験結果

Results of unsaturated CU tests



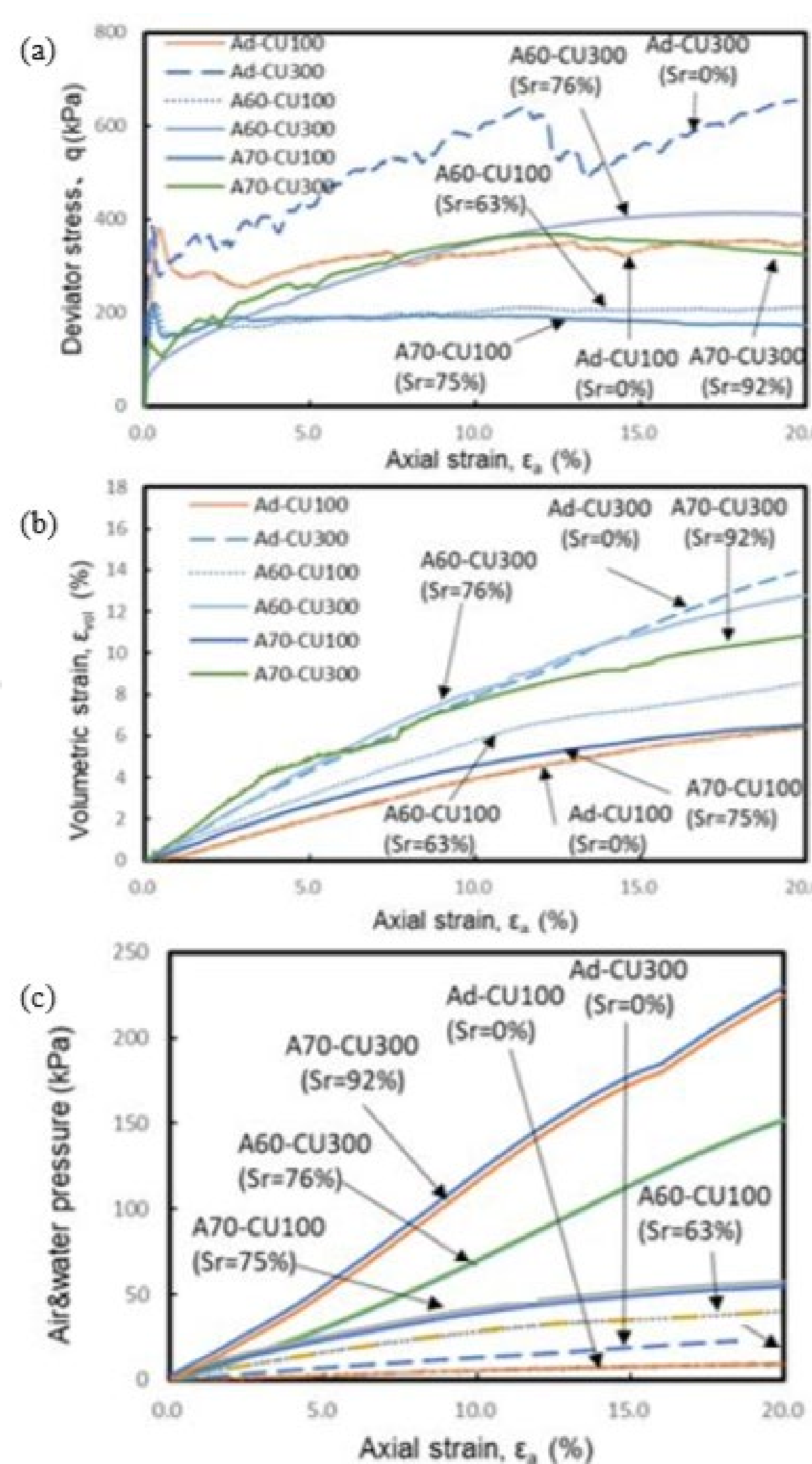
Test	$\epsilon_{vol}$ (%)
A-CU50	0.4
A-CU100	0.9
A-CU250	9.9
A-CU300	11.8
D-CU100	1.0
Ad-100	3.2
Ad-300	6.1
A60-CU100	3.2
A60-CU300	15.2
A70-CU100	4.7
A70-CU300	18.1



Effective stress path in unsaturated (partially saturated) CU tests.

Volumetric strain during consolidation stage.

人工的にセメンテーションや粒子破碎性を持つ超高間隙構造土を作製し、三軸非排水試験を行った結果。超高間隙土は、粒子間セメンテーションを持つ場合は 0.3%程度の軸ひずみでセメンテーションに起因するピーク強度を示し、さらに粒子破碎を起こす一定以上の拘束圧では軸ひずみ1~1.5%で粒子破碎に起因するピークを示した。超高間隙土は、拘束圧によらず、その非常に緩い構造によって、軸ひずみが進行しても軸差応力が上昇せず一定に収束する定常状態（脆弱な状態）に至った。Artificial pumice exhibits a high shear strength and a low compressibility when cementation is maintained. However, once cementation is lost, a high compressibility is observed. In some cases, even if the specimen is not fully saturated, after the shear strength reached its peak and the cementation was lost, a brittle behavior was observed in which the shear strength converges to a residual state, called steady state.

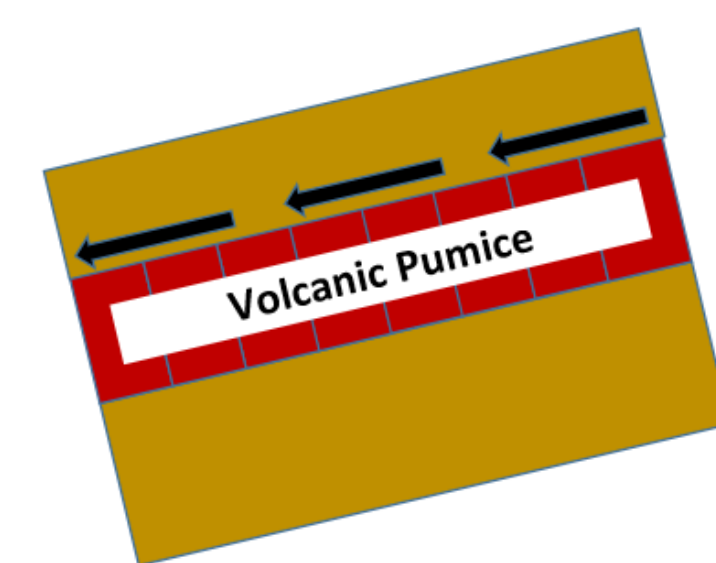


Relationship between (a) stress and strain, (b) volumetric strain and strain and (c) pore pressure and strain in unsaturated (partially saturated) CU tests.

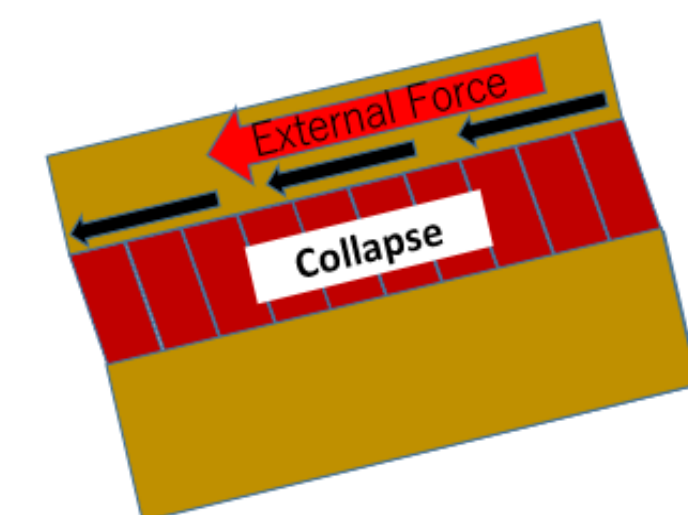
### 崩壊のイメージ

Illustration of the collapse mechanism

Extremely loose structure is kept in natural condition.



Earthquake breaks soils structure and reaches peak strength



Rapid decrease of strength & Large deformation

→ It can occur even if it is unsaturated.  
→ Compressed high-pressure air can cause local destruction in the ground.

