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**液状化を含む軟弱地盤の地震応答挙動及び  
その応答挙動が建物応答に与える影響**

—高知市の実地盤を対象とした検討—

**Influence that earthquake response behavior and  
the response behavior of soft subsoil including liquidizing give to  
building response**

—Examination intended for spot board of Kochi City—

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## 論文要旨

内閣府中央防災会議により作成された南海地震のシナリオ波に対して、高知市の実地盤を対象に、全応力時刻歴非線形解析、全応力等価線形解析、有効応力解析、等価有効応力解析を実施し液状化を含む軟弱地盤がどのような地震応答挙動を示すかについて検討を行った。また、その検討により得られた地表面加速度波形を入力波として、建物の時刻歴弾塑性応答解析を実施し最大塑性率に着目し検討を行った。更に、地盤・建物の検討に基づき正弦波パルスを作成し、建物応答について試算・考察を行った。これらの検討による結果および知見を以下に示す。

- 1)液状化地盤や工学的基盤までの深度が深い軟弱地盤の挙動によって、長周期側で加速度・速度成分の増幅する傾向が見られた。特に、液状化発生によって最大加速度は低下し短周期側で加速度・速度成分が減少するが、長周期側で加速度・速度成分は大きく増幅し、比較的耐力の低い建物に対して大きな影響を与えた。定性的には、低耐力の建物ほどその傾向が顕著に見られた。
- 2)有効応力解析による地表面加速度波形を建物モデルに入力して検討を行った結果、過剰間隙水圧比が1に達し、液状化に至る時刻以前の卓越した加速度によって低耐力の建物モデルは塑性化に至る。正弦波パルスによる試算・考察から、液状化を含む軟弱地盤の強震時等価固有周期程度に相当する周期の入力パルス波は、塑性化した建物に対して大きな影響を与え、また、その周期は建物モデルの塑性時固有周期と比較的近い周期であった。さらに、周期が長いパルス波は低耐力の建物の固有周期を、パルス波の周期に近づけるよう巻込む(引込む)現象が見られた。

これらの結果は、強震時に液状化を含む軟弱地盤の非線形化に伴う長周期化に、建物の塑性化に伴う長周期化が追随することに起因すると考えられた。特に、液状化地盤が建物応答に与える影響について、液状化発生前の卓越した加速度によって、建物が塑性域に入り長周期化すると、強震時の液状化地盤の非線形化に伴い長周期側で増幅した加速度・速度により、建物応答は更に大きくなる可能性があり、液状化を建物の応答低減要因とすることは非常に危険であることが示唆された。

## Thesis summary

Whether nonlinear all stress time analysis, all stresses equivalent, linear analyses, the effective stress analyses, and the equivalent effective stress analyses were executed to the scenario wave of the Southern sea earthquake having been made by the Cabinet Office Central Disaster Prevention Council for the spot board of Kochi City and what earthquake response behavior the soft subsoil including liquidizing showed were examined. Moreover, the ground level acceleration crimp obtained by the examination was made an input wave, bounce plasticity response analysis of the time of the building was executed, it paid attention to the maximum plasticity rate, and it examined it. The sine wave pulse was made based on the examination of the ground and the building, and in addition, the building response was calculated provisionally and considered. The result and the finding by these examinations are shown below.

- 1) The tendency that the acceleration and the speed element amplified on the length cycle side was seen by the behavior of the soft subsoil with deep depth to the liquidizing ground and a technological base. Especially, the acceleration and the speed element amplified greatly, and had a big influence on a low building of the bearing force comparatively on the length cycle side though decreased by the liquidizing generation the maximum acceleration and decreased on the short cycle side the acceleration and the speed element. Qualitatively, it was thought that the tendency was remarkable like the building of a low bearing force.
- 2) It reaches one compared with the excess pore water pressure since the ground level acceleration wave type by the effective stress analysis is input to the building model and it examines it, and the building model of a low bearing force becomes making to plasticity by the acceleration that the time to liquidizing former is superior. The input pulse wave at the cycle that corresponded at the equivalent proper period level at the severe earthquake of the soft subsoil including liquidizing had a big influence from the trial calculation and consideration by the sine wave pulse on the building that had been made plasticity, and the cycle was a cycle comparatively near the proper period at the plasticity of the building model. In addition, the phenomenon involved to bring the proper period in the building of a low bearing force close at the cycle of the pulse wave (Withdraw) was seen as for the pulse wave with a long cycle. It was thought that these results originated the fact that the length cycle according to making of the building plasticity making followed to the length cycle according to making of the soft subsoil including liquidizing nonlinear making at the severe earthquake.

Especially, when the building is made an entering length cycle in the plasticity region according to the acceleration that it is superior before liquidizing of the influence that the liquidizing ground gives to the building response is generated, the building response has the possibility of growing further depending on the acceleration and the speed amplified on the length cycle side along with making of the liquidizing ground of the severe earthquake nonlinear. It was suggested that it be very dangerous to assume liquidizing to be a response decrease factor in the building.