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STABILITY OF SURROUNDING SOIL BY USING UNDERPINNING PIPE JACKING MTEHOD

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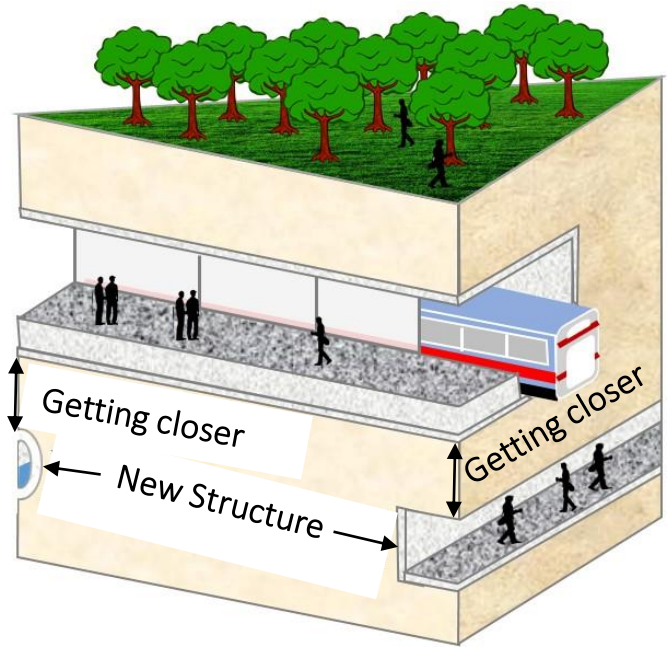
1. Address the background drives the idea
2. Describe the research's objective
3. Show how the study is constructed
4. Discuss how the method works in practice
5. Conclude the resume

BACKGROUND
No more space in surface

Tokyo Metropolitan crowded
(population: > 38 million)

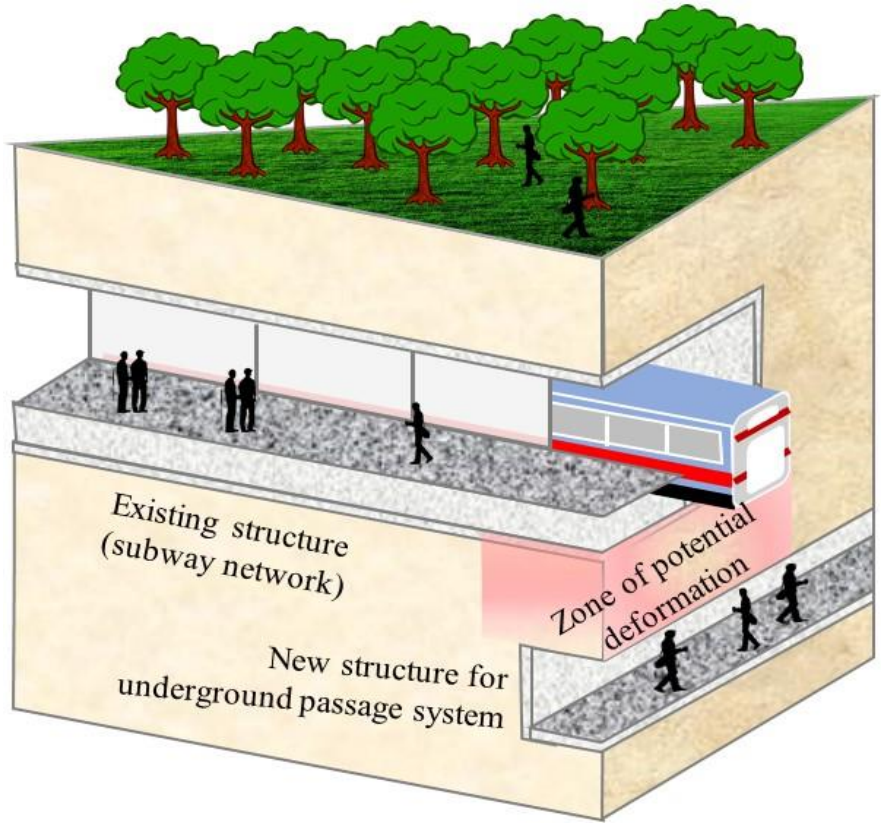
Challenge: Distance between structures
is getting closer



Concern: Stability of the existing structure

EFFECT OF ADJACENT NEW STRUCTURE

Challenge: Stability of the existing structure



Zone of potential failure:

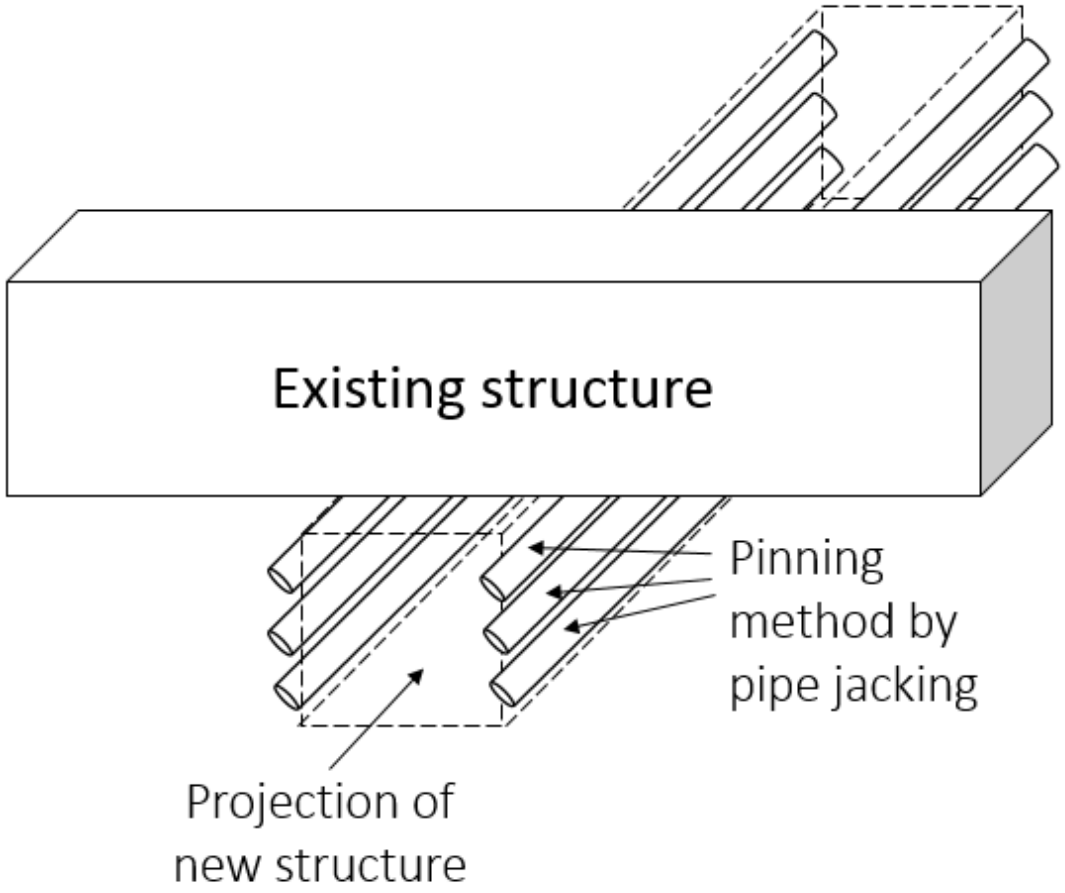
High induced stress is concentrated in between existing structure and new structure

Concern:

- Zone of influence of tunneling
- Risk from ground movement

UNDERPINNING PIPE JACKING METHOD

A series of pipe is jacked surroundings the new structure's projection area to control induced stress while excavation to protect the existing structure.

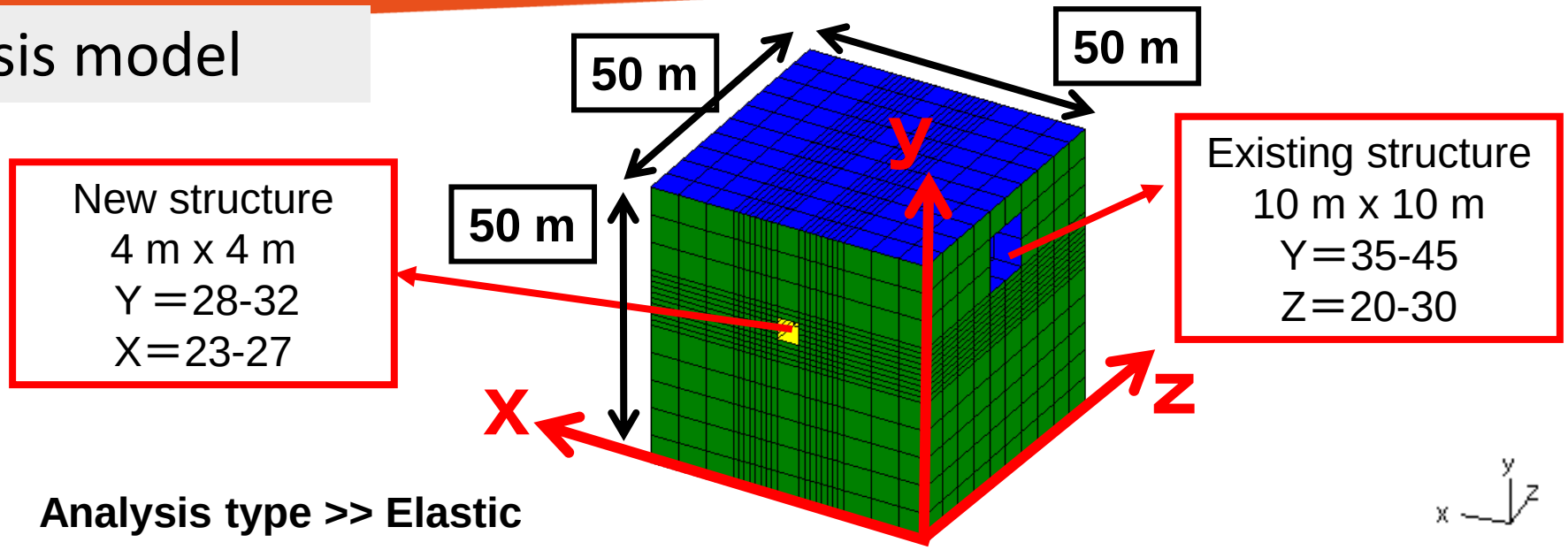


RESEARCH OBJECTIVE

1. Investigate how the underpinning method by using pipe jacking works in reducing induced stress.
2. Confirm stress behavior surroundings the structure when underpinning method by using pipe jacking is adopted:
    - Shape of pipe
    - Distance between pipe and new structure
    - Distance between pipe and existing structure

NUMERICAL ANALYSIS

Analysis model



Analysis type >> Elastic

Boundary conditions

(1) The surface is free plane.

(2) The vertical direction of the bottom is locked, and horizontal direction is free.

(3) The vertical direction of the side plane is free, and horizontal direction is locked.

Input parameters

	Clay	Pipe
Young's modulus (MPa)	20	23,500
Poisson's ratio (-)	0.4	0.2
Unit Weight (MN/m^3)	0.02	0.025

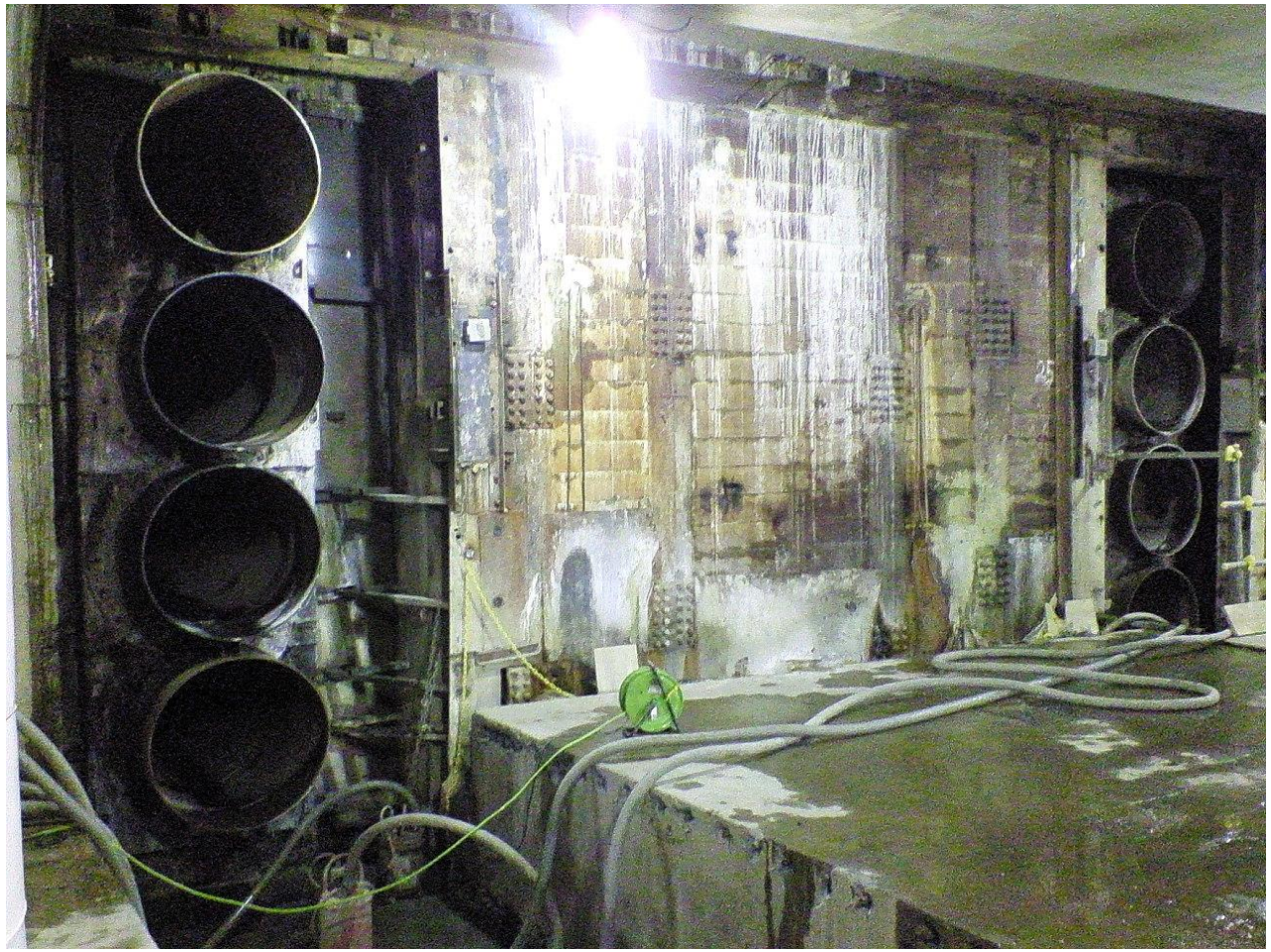
ANALYSIS STEP

Step 1
Initial stress condition (own weight only)

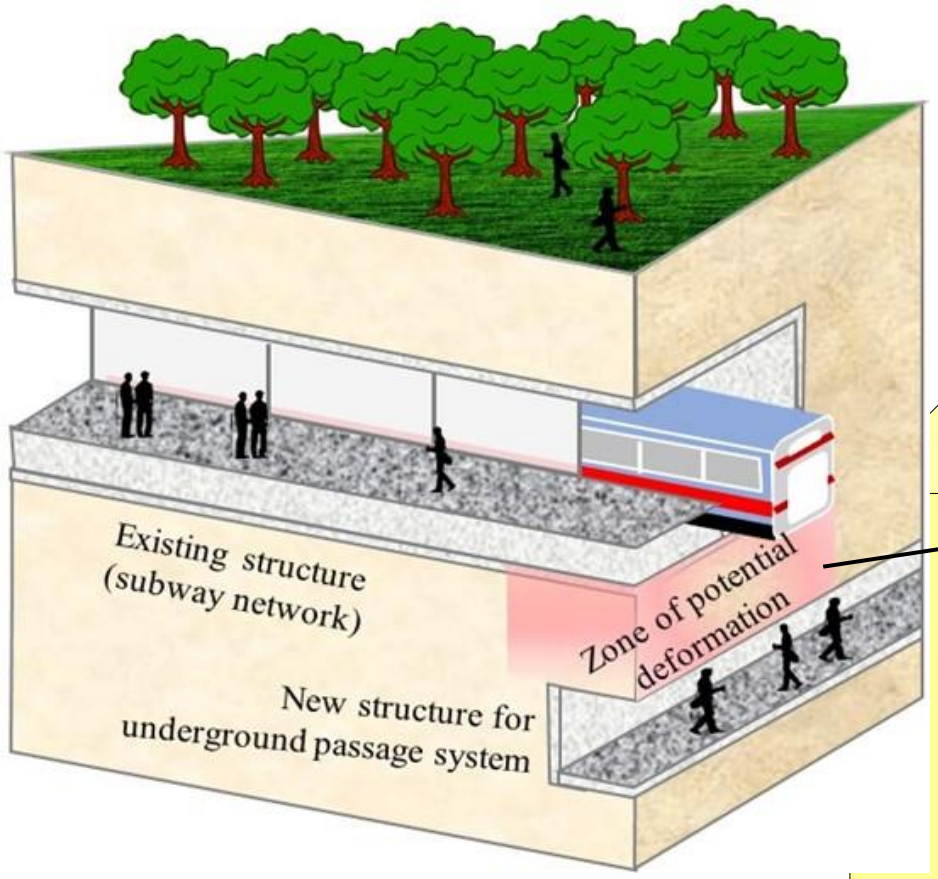
Step 2
5.0 m excavating

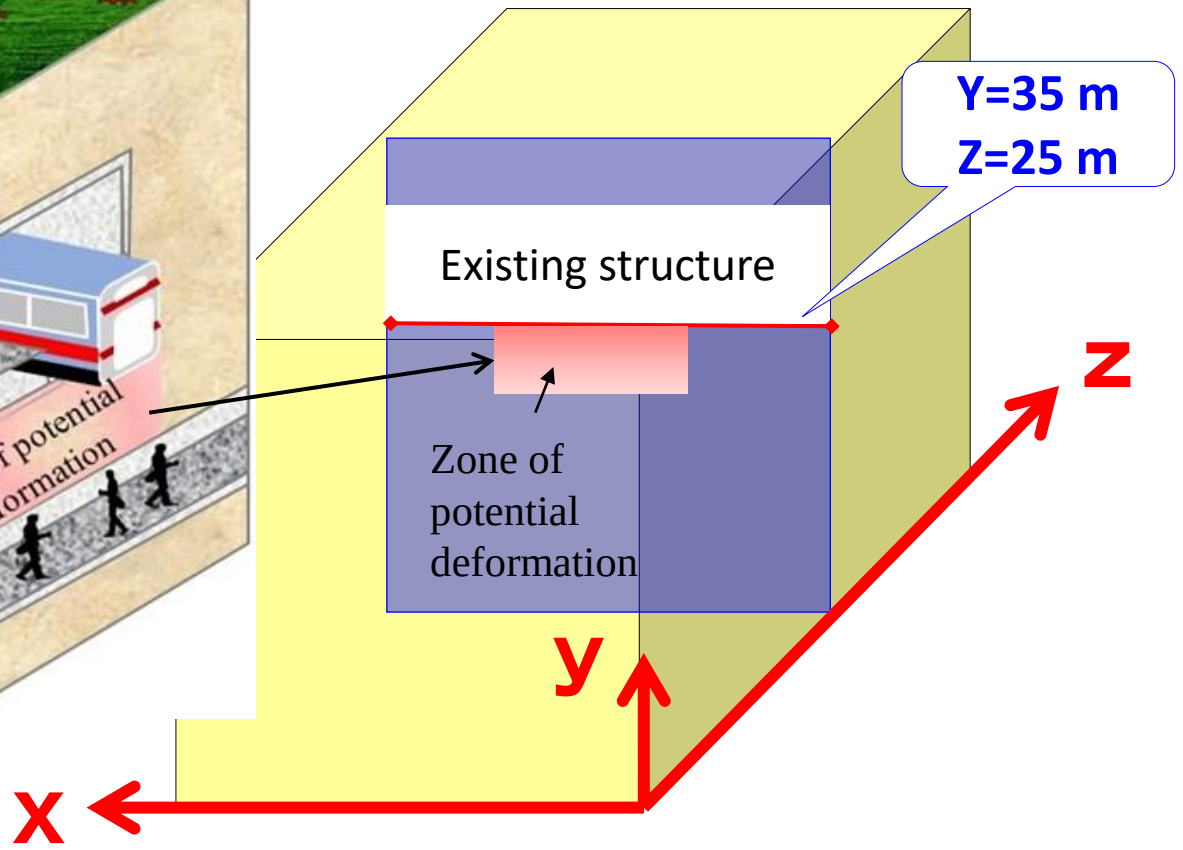
Step 3
Casting pipes and excavation of the next pipe area

Repeat step 3
Until length is 40 m long



OBSERVATION POINT
Ground movement





Pipe jacking length

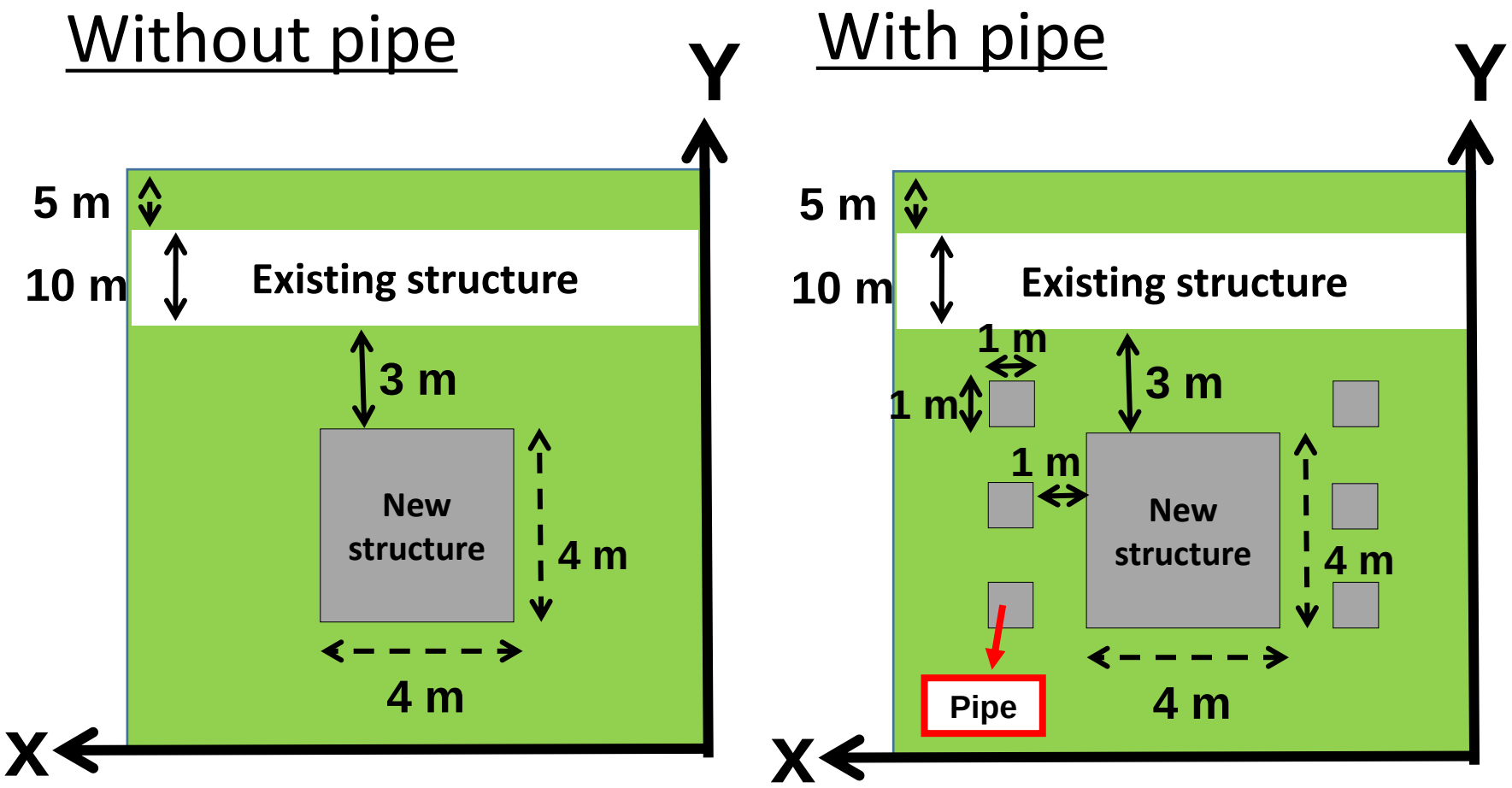
40 m (Z direction)

Observation point

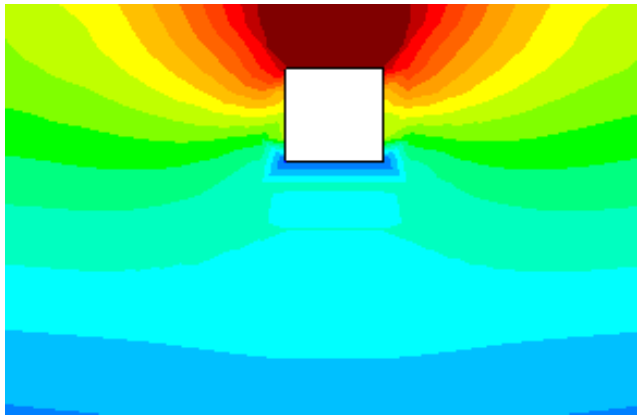
Y = 35 m, Z = 25 m
(X direction)

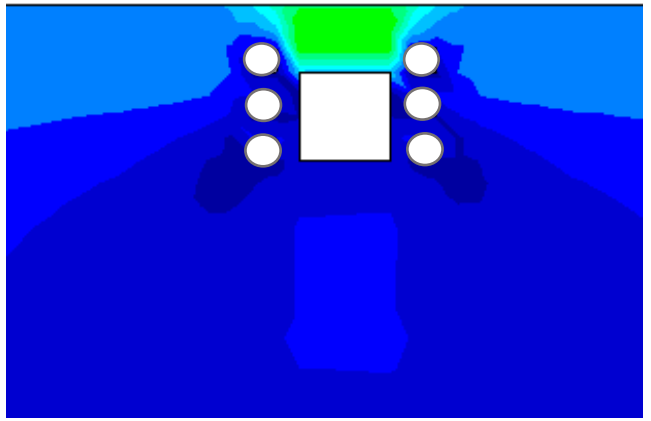
INFLUENCE OF PIPE PRESENCE

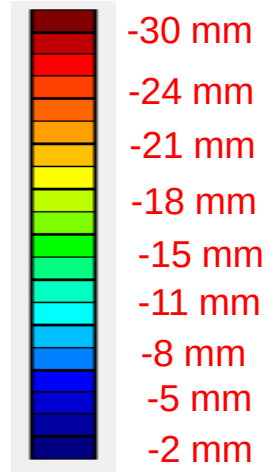
XY plan view(Z=0)



INFLUENCE OF PIPE PRESENCE
Ground Movement



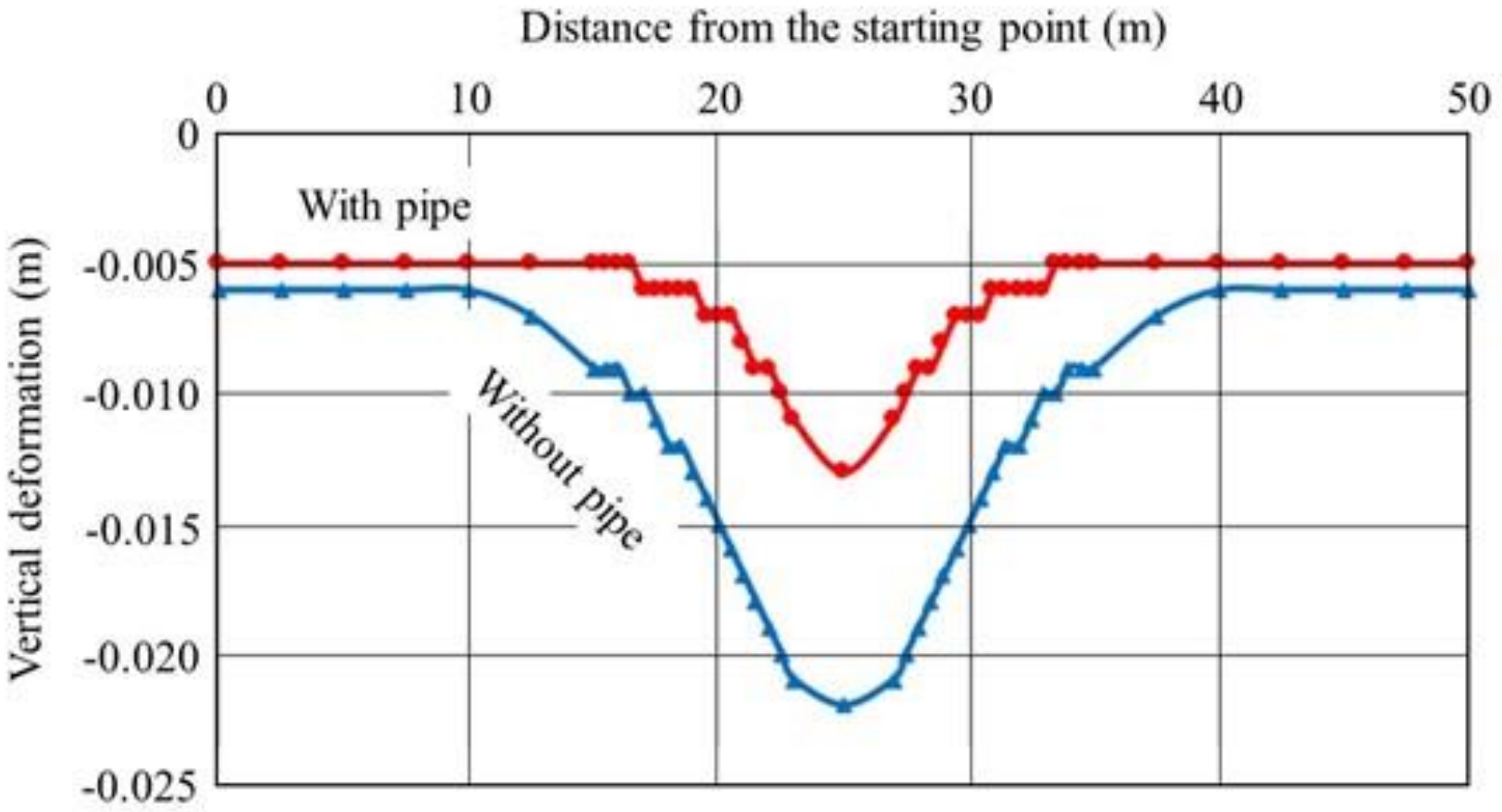




Suppression of the deformation by the pipes

Pipes have a role of earth retainer

INFLUENCE OF PIPE PRESENCE
Ground Movement



Underpinning method using pipe jacking, able to reduce:

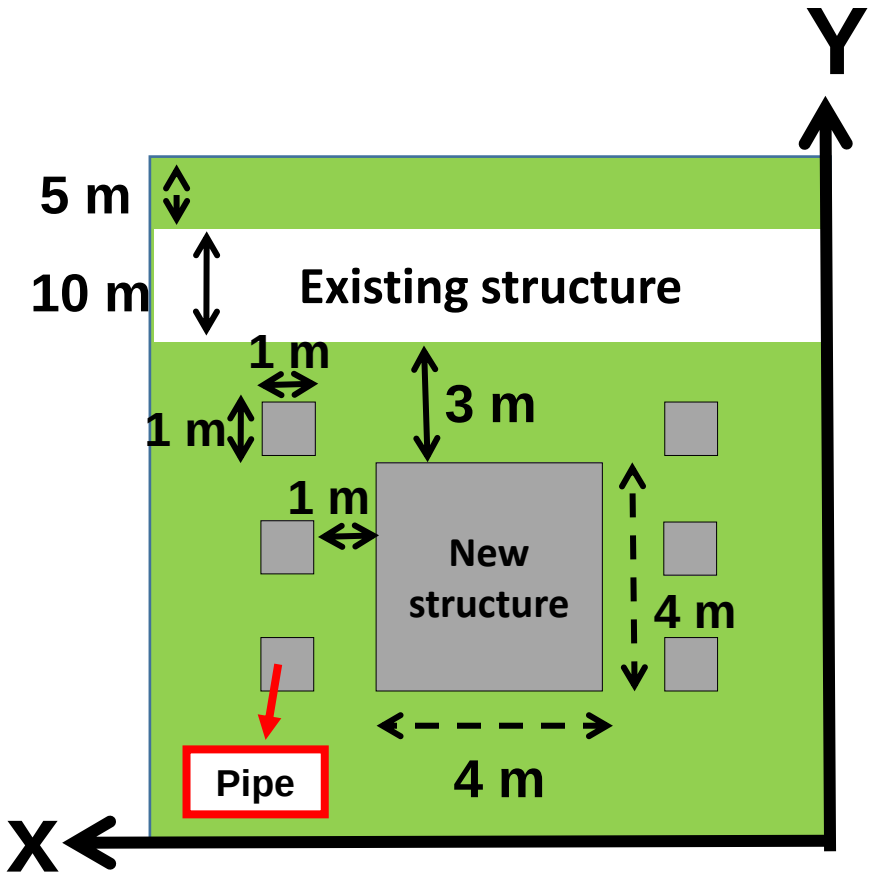
1. Existing structure's floor settlement,

2. Trough width of the settlement.

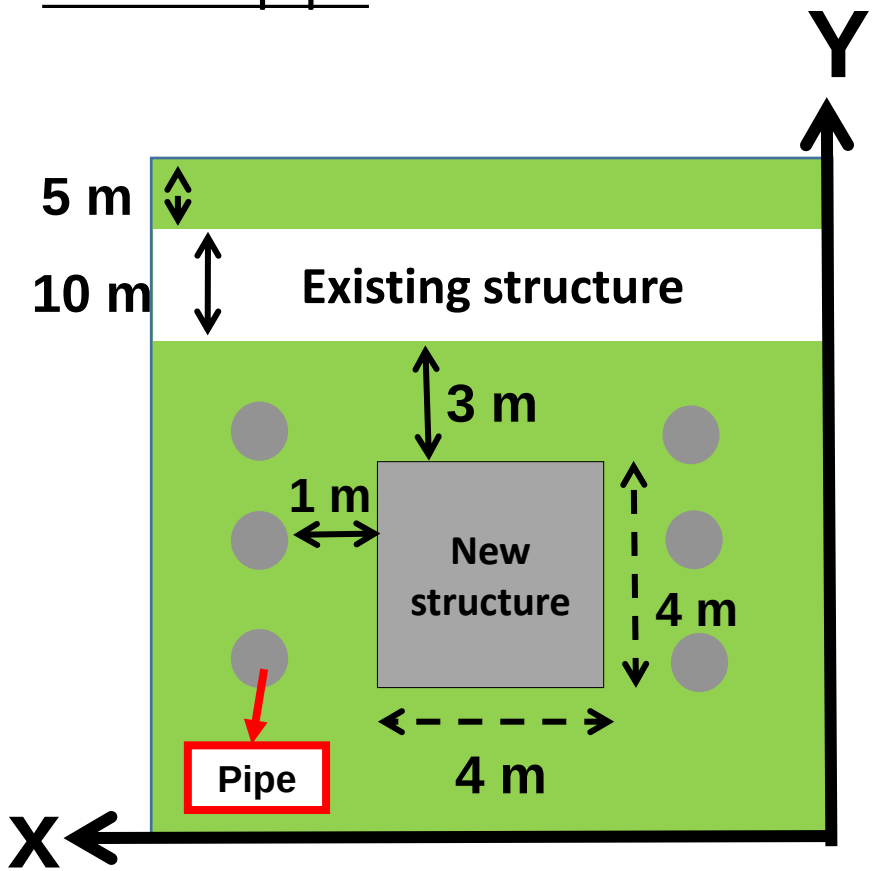
INFLUENCE OF DIFFERENT SHAPE OF PIPES

XY plan view(Z=0)

Rectangular pipe



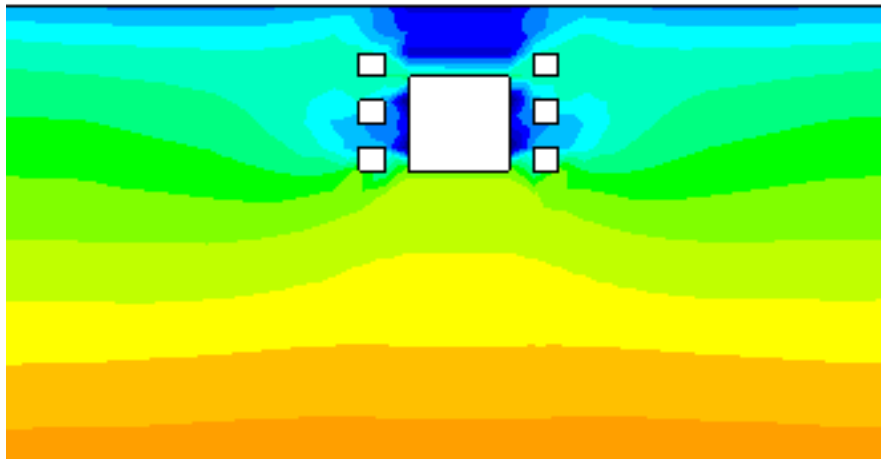
Circular pipe



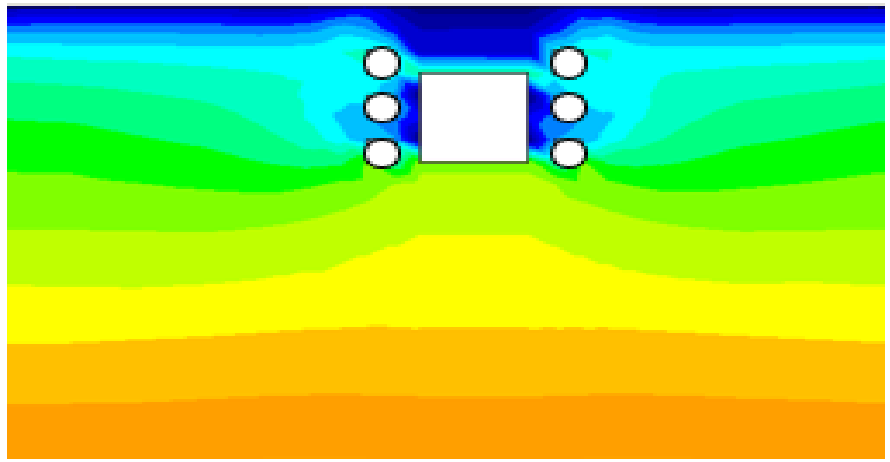
INFLUENCE OF DIFFERENT SHAPE OF PIPES

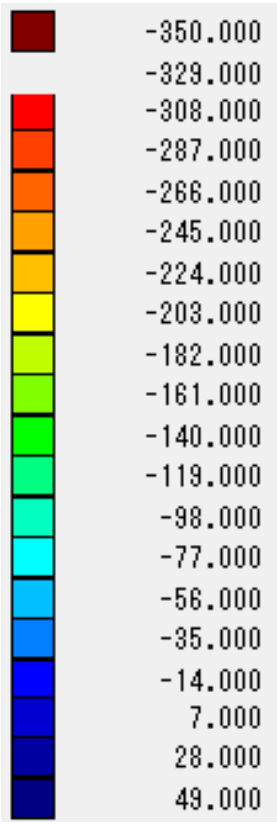
Maximum principal stress contour map
(Around the new structure)

Rectangular pipe



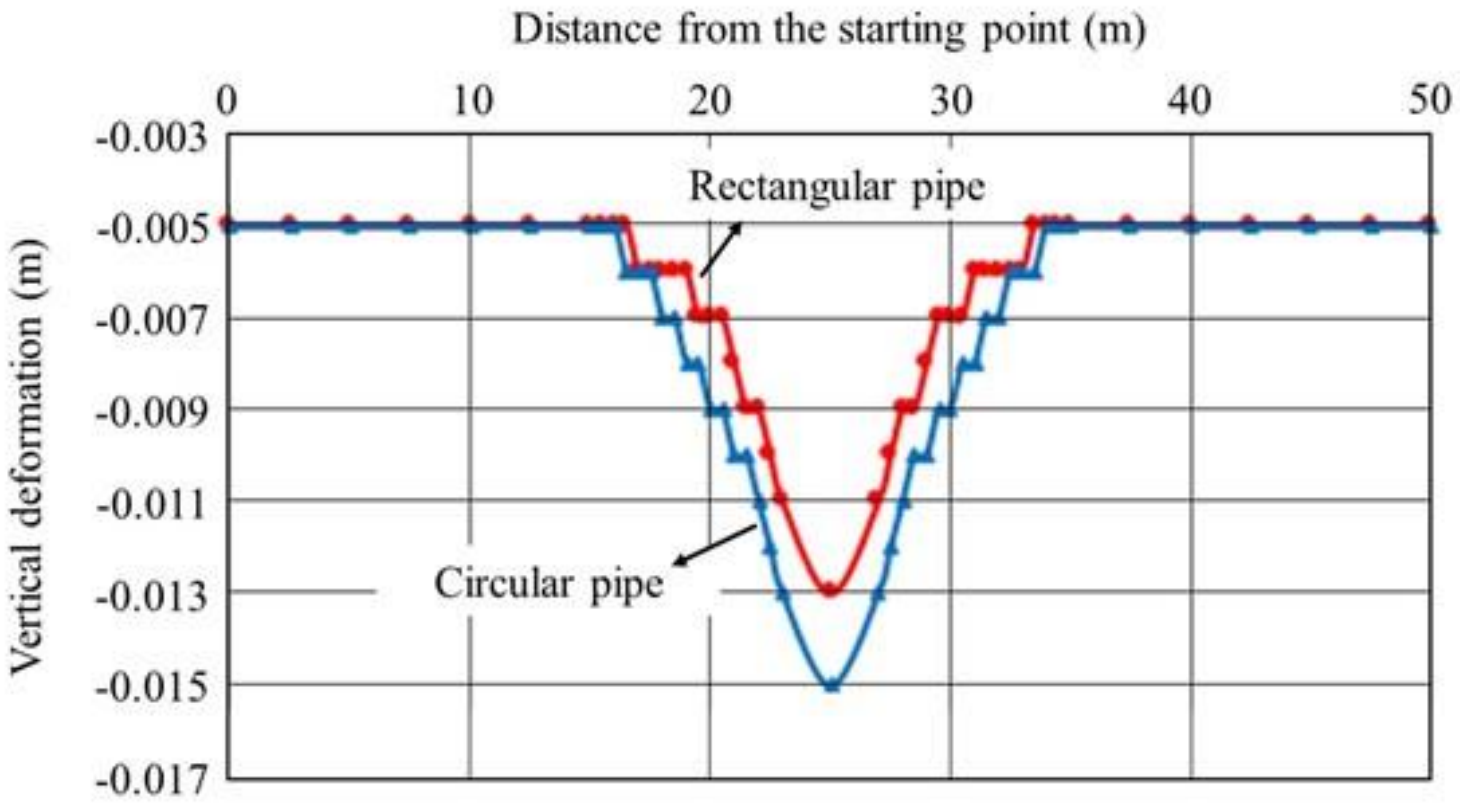
Circular pipe





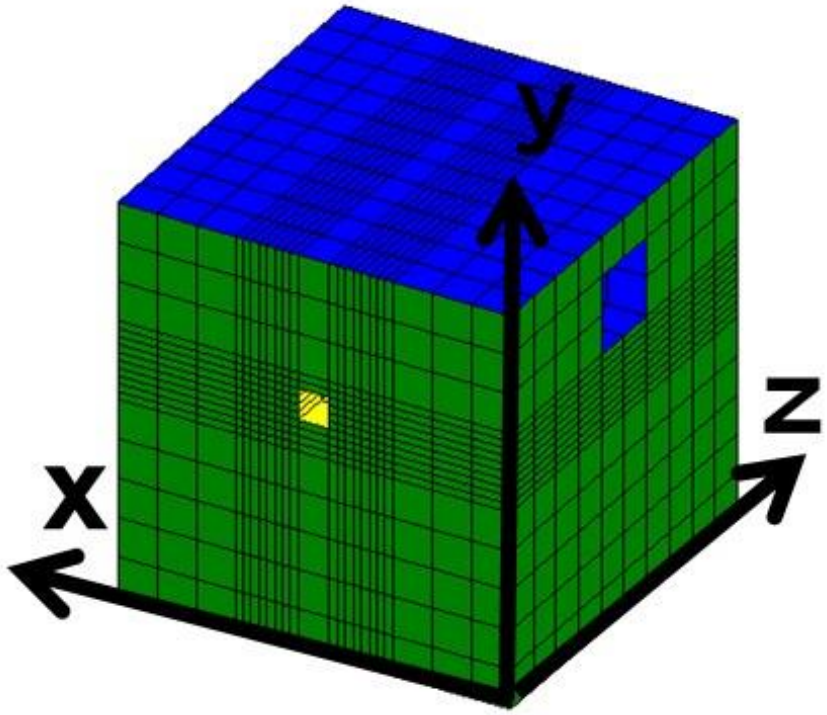
Tension at floor of existing structure and wall of new structure is higher for case of circular rather than rectangular shape (restraint ability).

INFLUENCE OF DIFFERENT SHAPE OF PIPES
Ground Movement

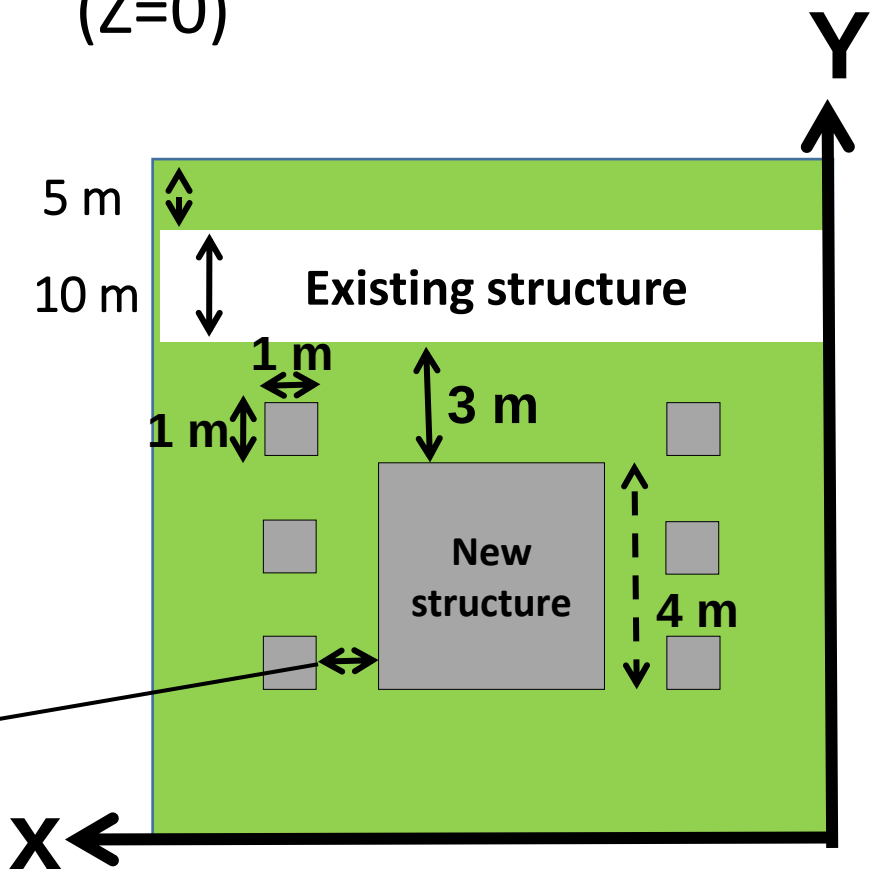


- Restraint ability of rectangular shape is better than circular shape.
- Pipe shape does not give significant effect on trough width of the settlement.

INFLUENCE OF DIFFERENT DISTANCE BETWEEN PIPE AND NEW STRUCTURE



XY plan view
(Z=0)

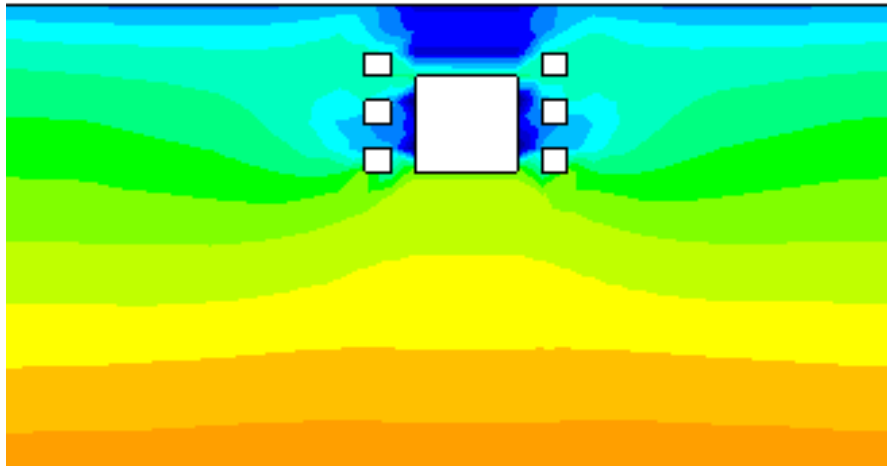


The distance between pipe and new structure: **1 m, 2 m, 3 m**

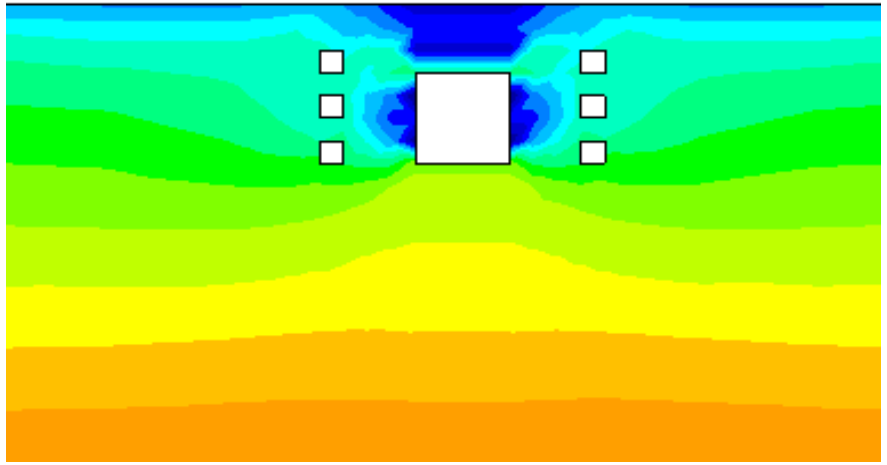
INFLUENCE OF DIFFERENT DISTANCE BETWEEN PIPE AND NEW STRUCTURE

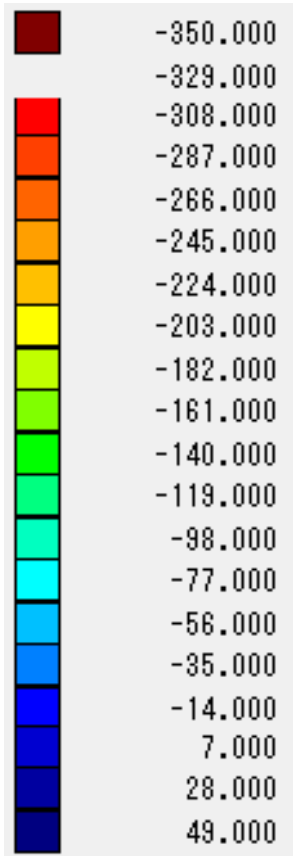
Maximum principal stress counter map
(Around the new structure)

1 m



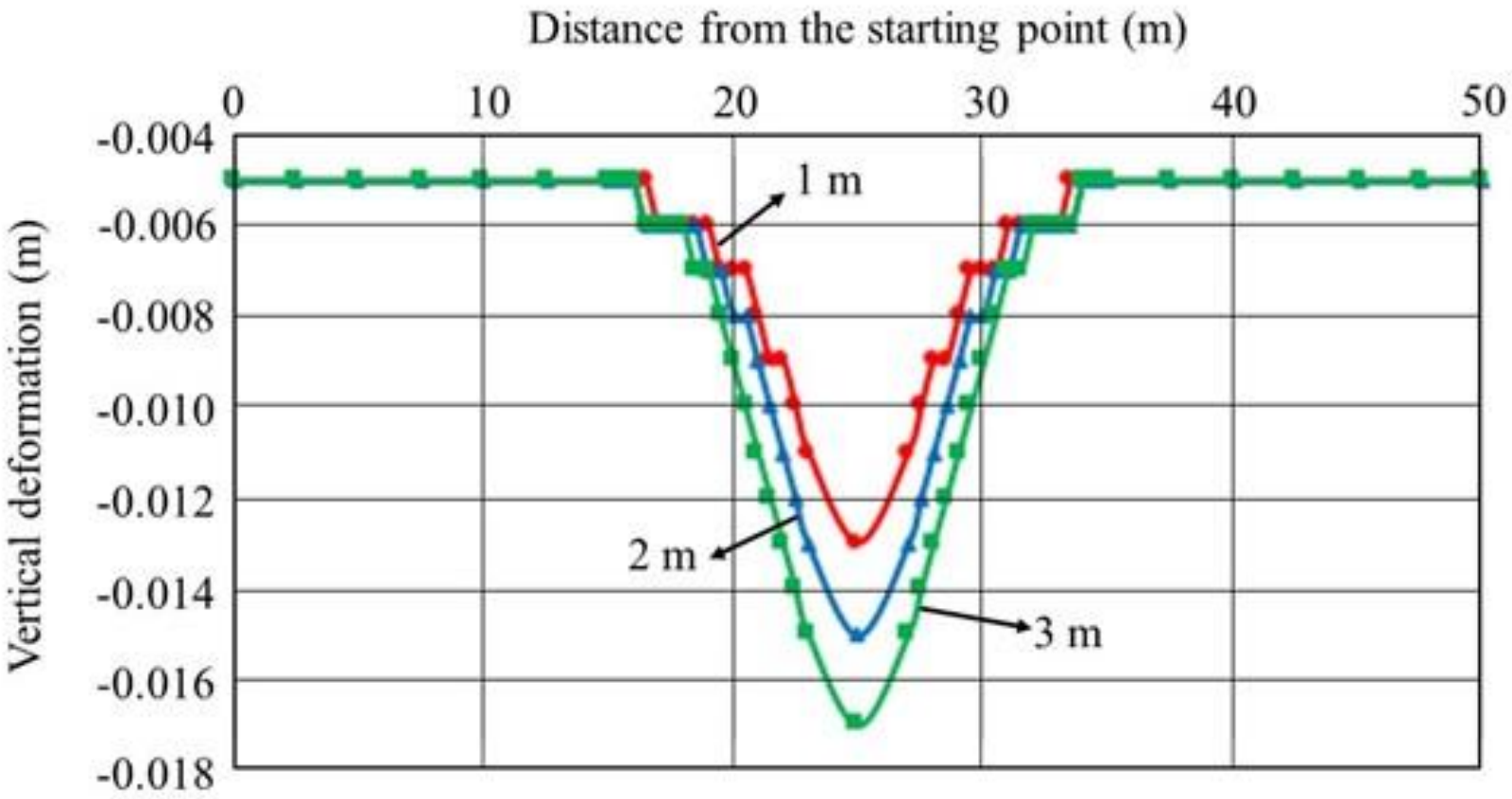
3 m





Increase in distance between pipe and new structure:
Tension along the wall of new structure increases.

INFLUENCE OF DIFFERENT DISTANCE BETWEEN PIPE AND NEW STRUCTURE
Ground Movement

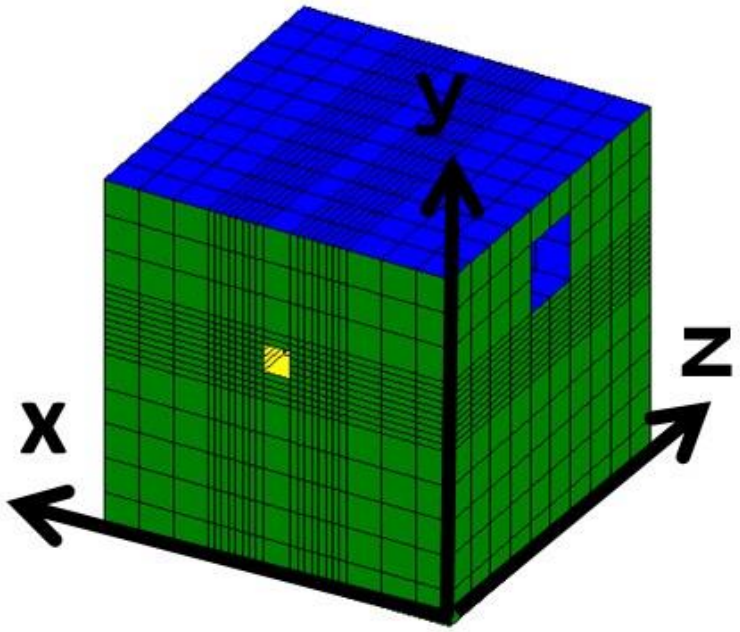


- Existing structure's floor settlement increases with increasing the distance,
- Give slight effect on trough width of the settlement.

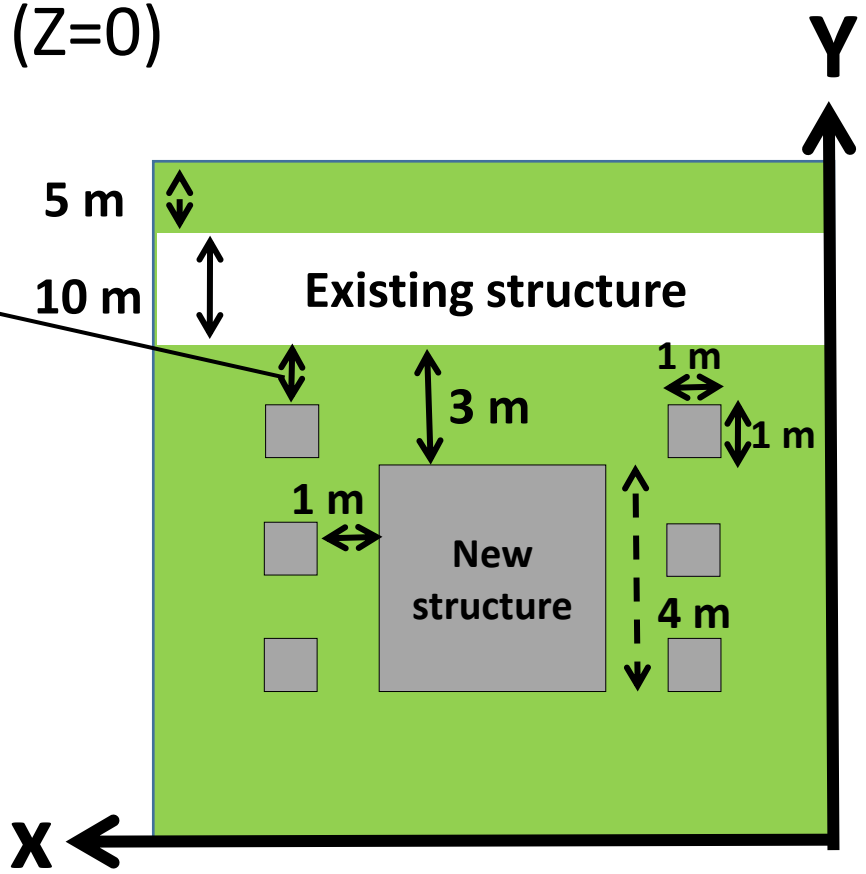
INFLUENCE OF DIFFERENT DISTANCE BETWEEN PIPE AND EXISTING STRUCTURE

The distance between pipe and existing structure:

1 m, 2 m, 3 m



XY plan view (Z=0)

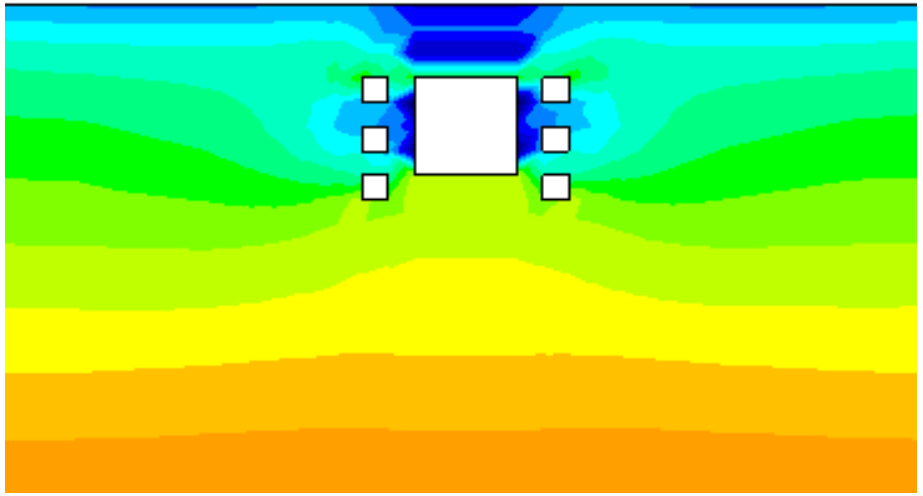


INFLUENCE OF DIFFERENT DISTANCE BETWEEN PIPE AND EXISTING STRUCTURE

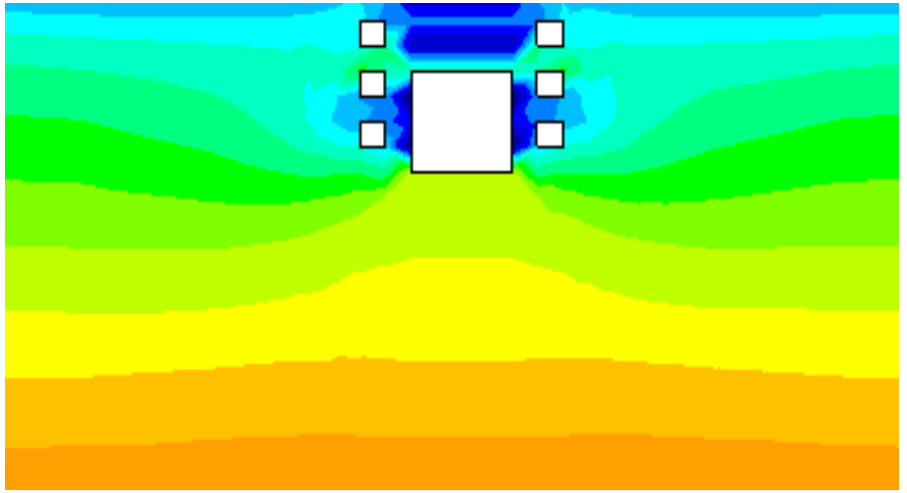
Maximum principal stress counter map
(Around the new structure)

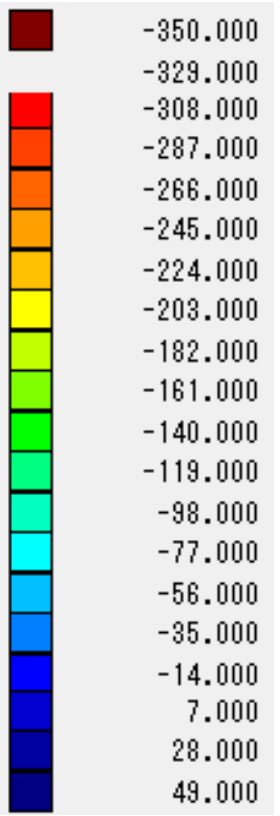
[Pa]

3 m



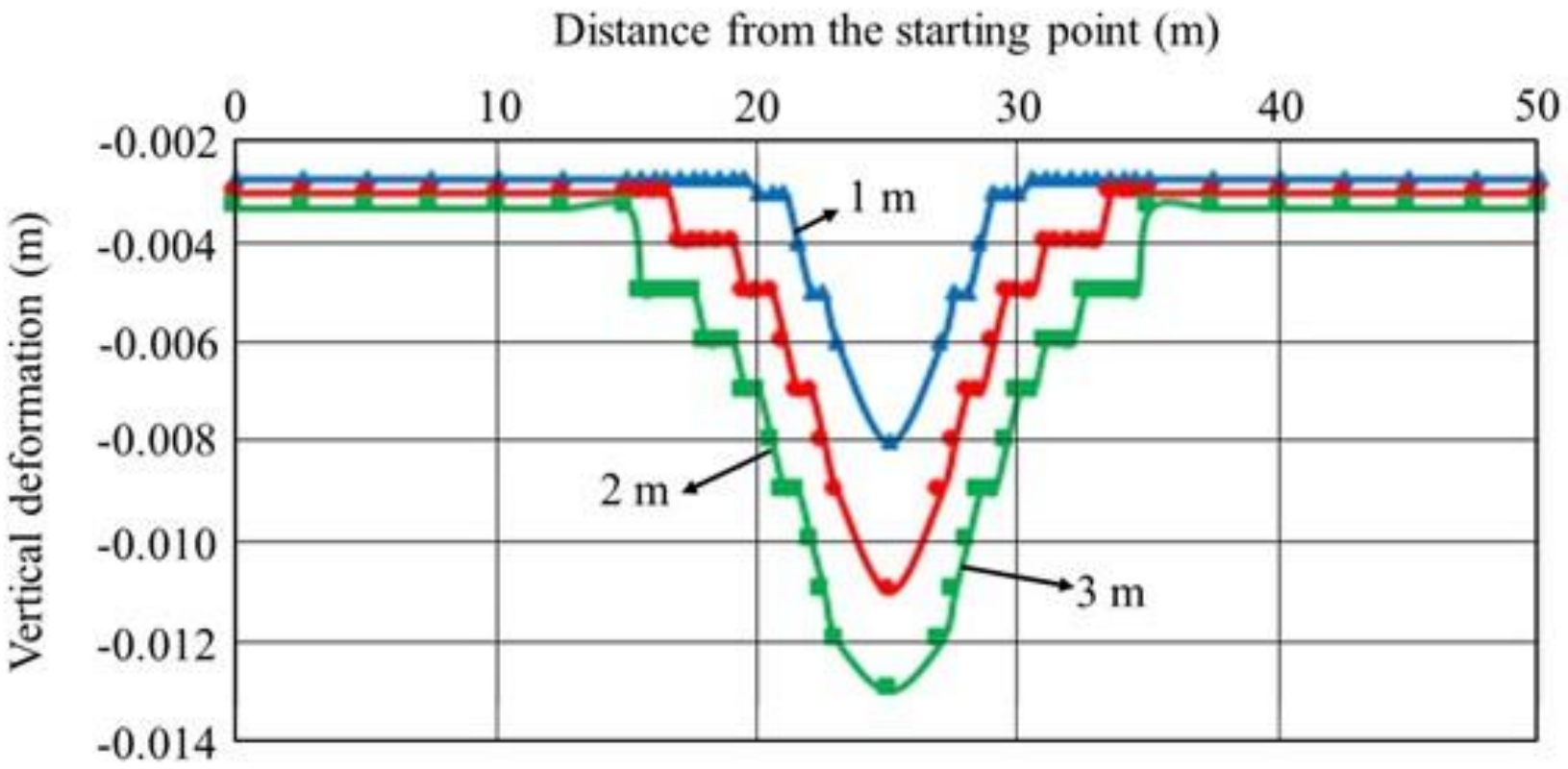
1 m



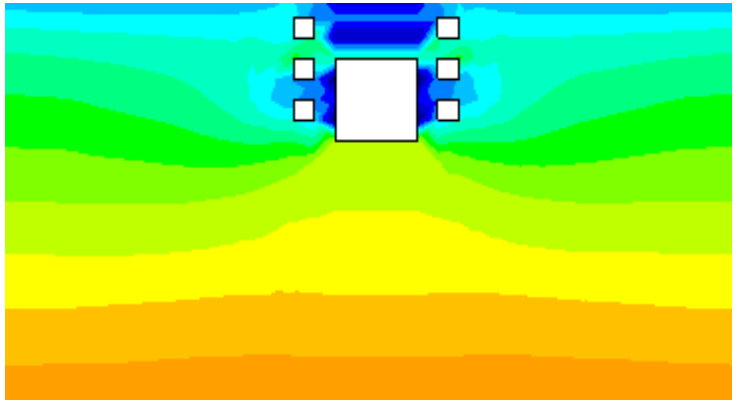


Tension below the floor of existing structure decreases (which indicates suppression of the deformation) with decreasing the distance.

INFLUENCE OF DIFFERENT DISTANCE BETWEEN PIPE AND EXISTING STRUCTURE
Ground Movement



Distance: 1 m



Existing structure's floor settlement and trough width decreases with decreasing the distance.

CONCLUSION

(1) The application of the under-pinning method using the pipe jacking method can reduce the deformation of the bottom part of the existing structure.

(2) The differences of pipe shape and distance between the pipe and the new structure or existing structure are important parameter to mitigate the deformation of surrounding ground.

The suppression effect on existing structures by using under-pinning method in adjacent construction was confirmed.

THANK YOU FOR YOUR KIND ATTENTION!