Design of Large-sized Accelerator Tunnel

Speaker

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J-PARC

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Introduction

Accelerator Facilities / Civil Engineering

- Key points for the design of underground accelerator tunnel
- Overview of the structural analysis concerning with necessity of Expansion Joints

Based on the experience in J-PARC

2 key-points for the design of underground accelerator tunnels

① Transformation of the accelerator tunnel should be minimal

② Level of integrity and durability of the tunnel structure should be high

→ **◆stable operation of the accelerator**

→ **◆very few cracks in the cover concrete**

①Transformation of the tunnel is controlled by following factors

- Geological features, Situation of groundwater
- Change of live load to the tunnel
- Temperature change inside the tunnel, Influence from earthquake
- Structure of the tunnel itself

  (Foundation, ***Expansion joint***, etc.)

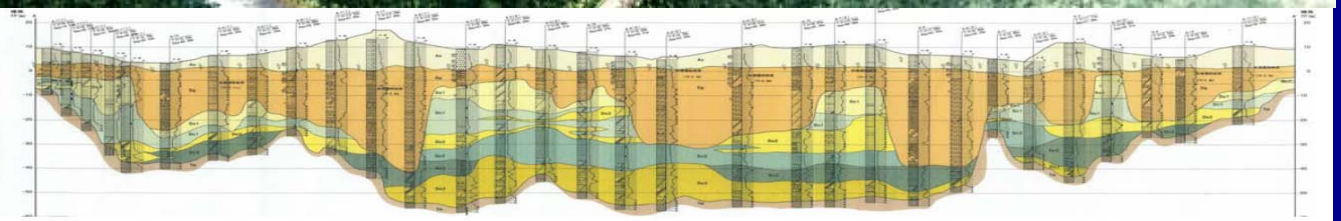
② Integrity and durability of the tunnel is controlled by following factors

＝To realize very few cracks in tunnel concrete

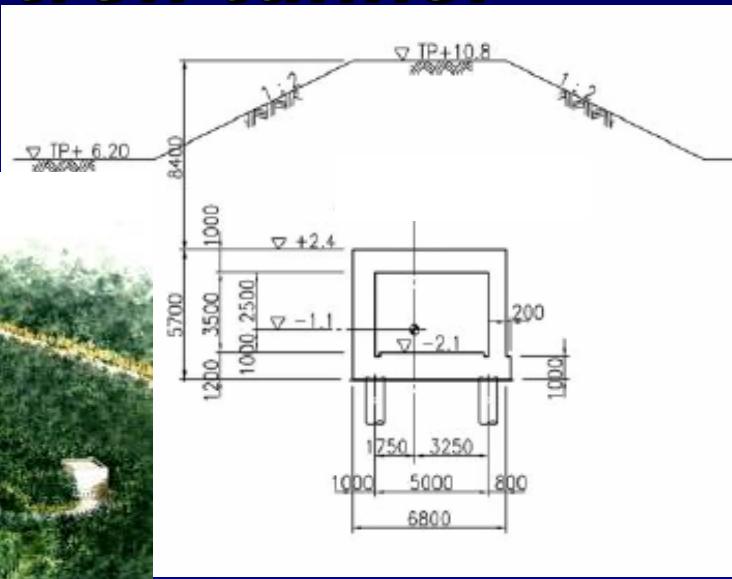
- To use watertight mass concrete
- To place indispensable quantity of reinforcement accurately in position
- To perform proper waterproofing work
- To take appropriate measures against shrinkage of concrete
- Structure of the tunnel itself (Foundation, ***Expansion joint***, etc.)

J-PARC 50GeV synchrotron tunnel

Bird's-eye view of J-PARC 50GeV

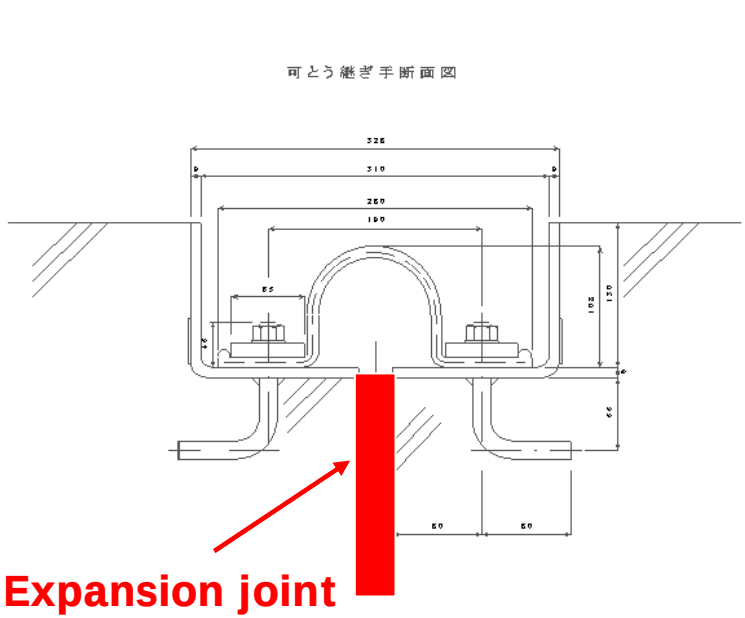


Complicated layer

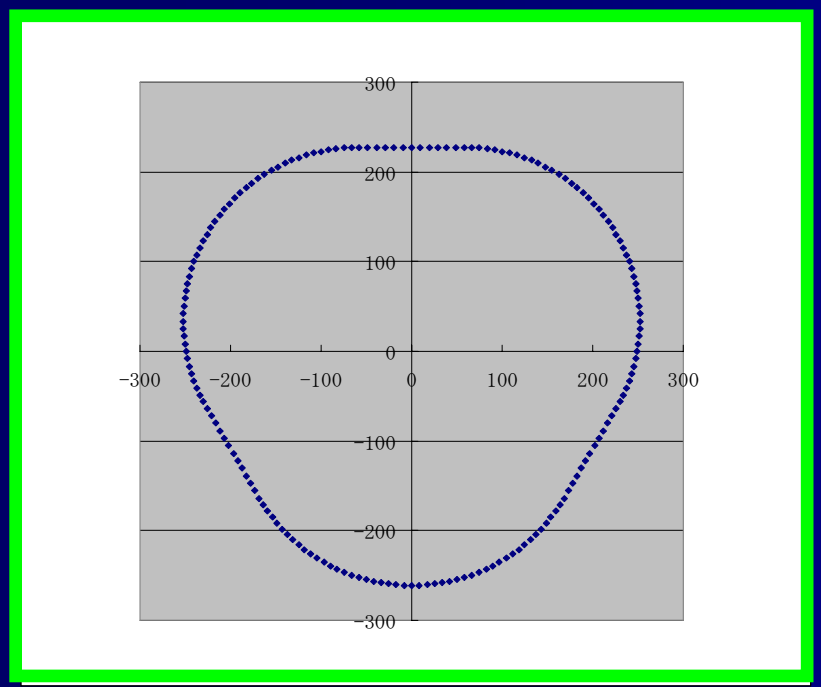


Cross-section
of J-PARC 50GeV tunnel

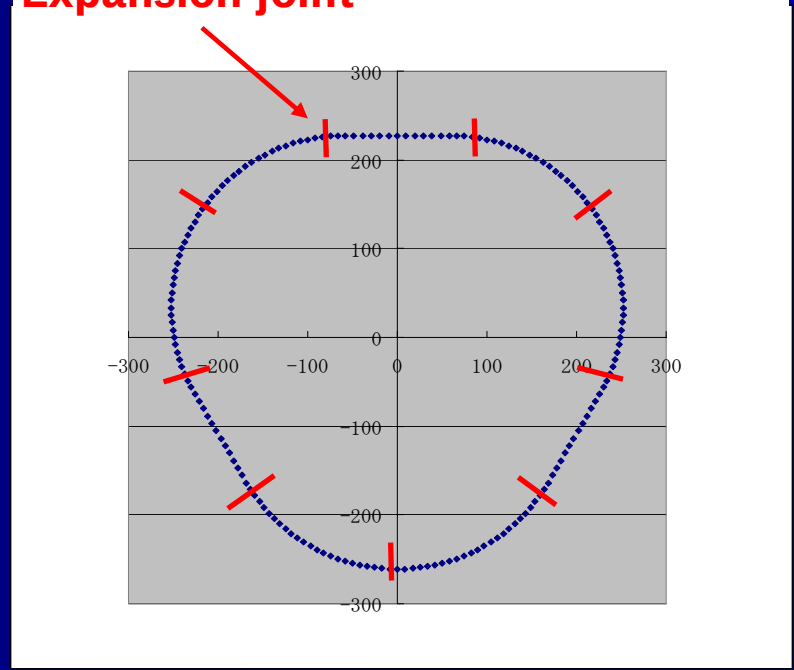
Expansion Joints



Analysis model



Without Expansion joint

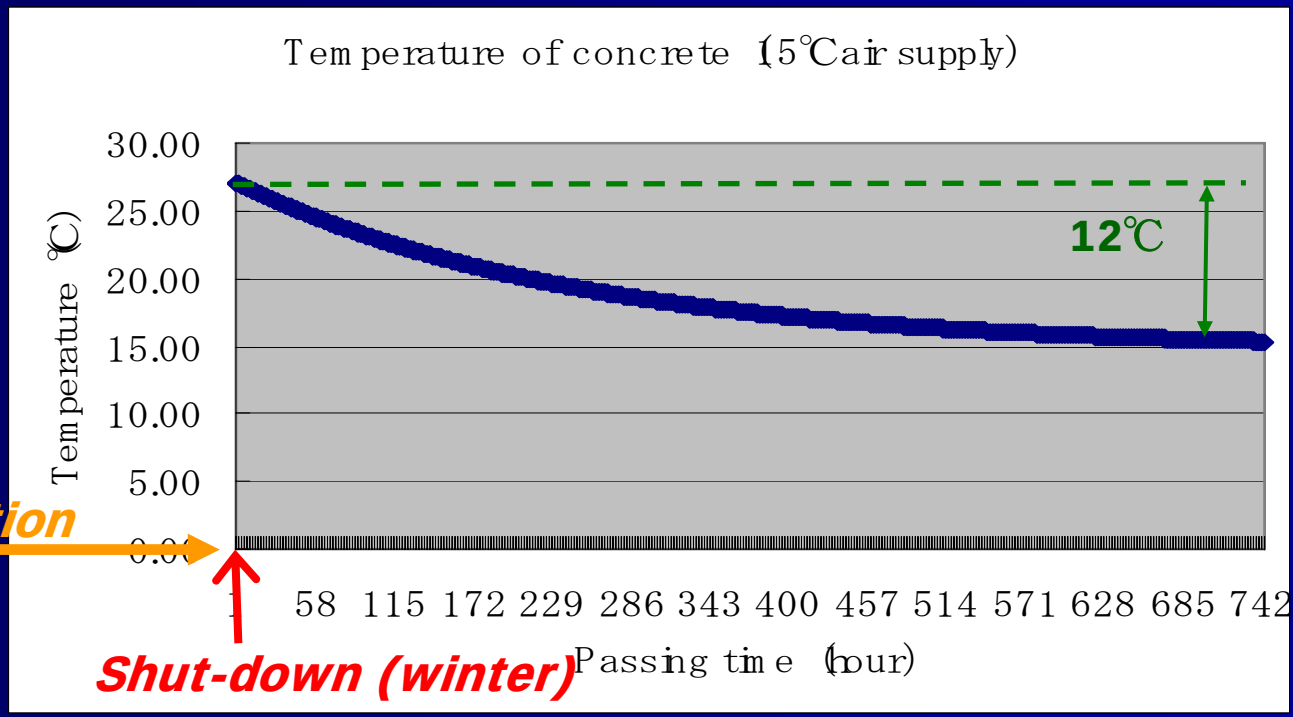


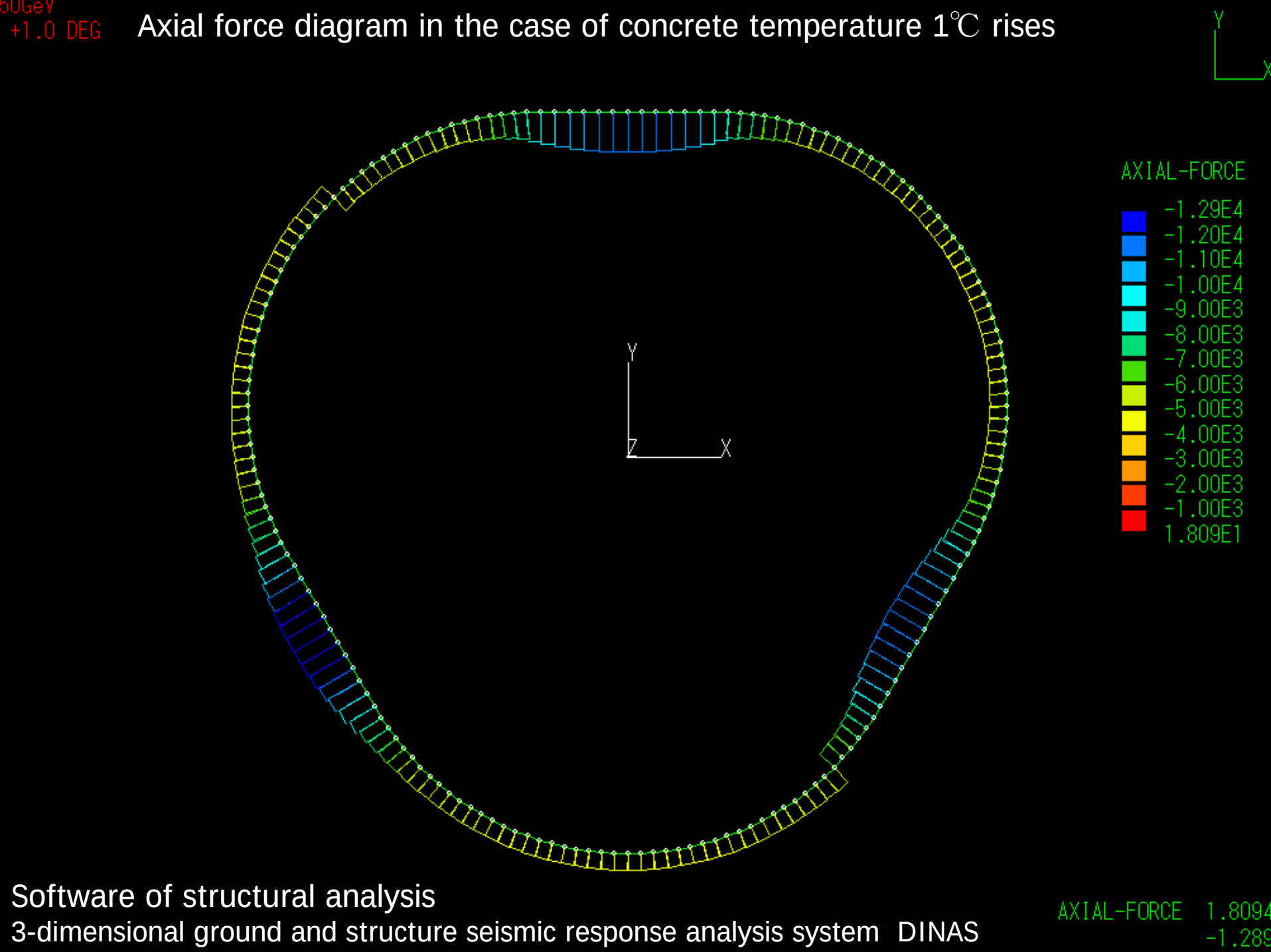
If provided Expansion Joints

Condition of structural analysis

(Temperature change of tunnel concrete)

- Structural analysis was performed based on the assumption of safe side that the temperature of tunnel concrete change 12℃




50GeV
+1.0 DEG
Axial force diagram in the case of concrete temperature 1℃ rises
Y
X
AXIAL-FORCE
-1.29E4
-1.20E4
-1.10E4
-1.00E4
-9.00E3
-8.00E3
-7.00E3
-6.00E3
-5.00E3
-4.00E3
-3.00E3
-2.00E3
-1.00E3
1.809E1
Y
Z
X
Software of structural analysis
3-dimensional ground and structure seismic response analysis system DINAS
AXIAL-FORCE 1.8094
-1.289

+1.0 DEG

Bending Moment diagram in the case of concrete temperature 1℃ rises

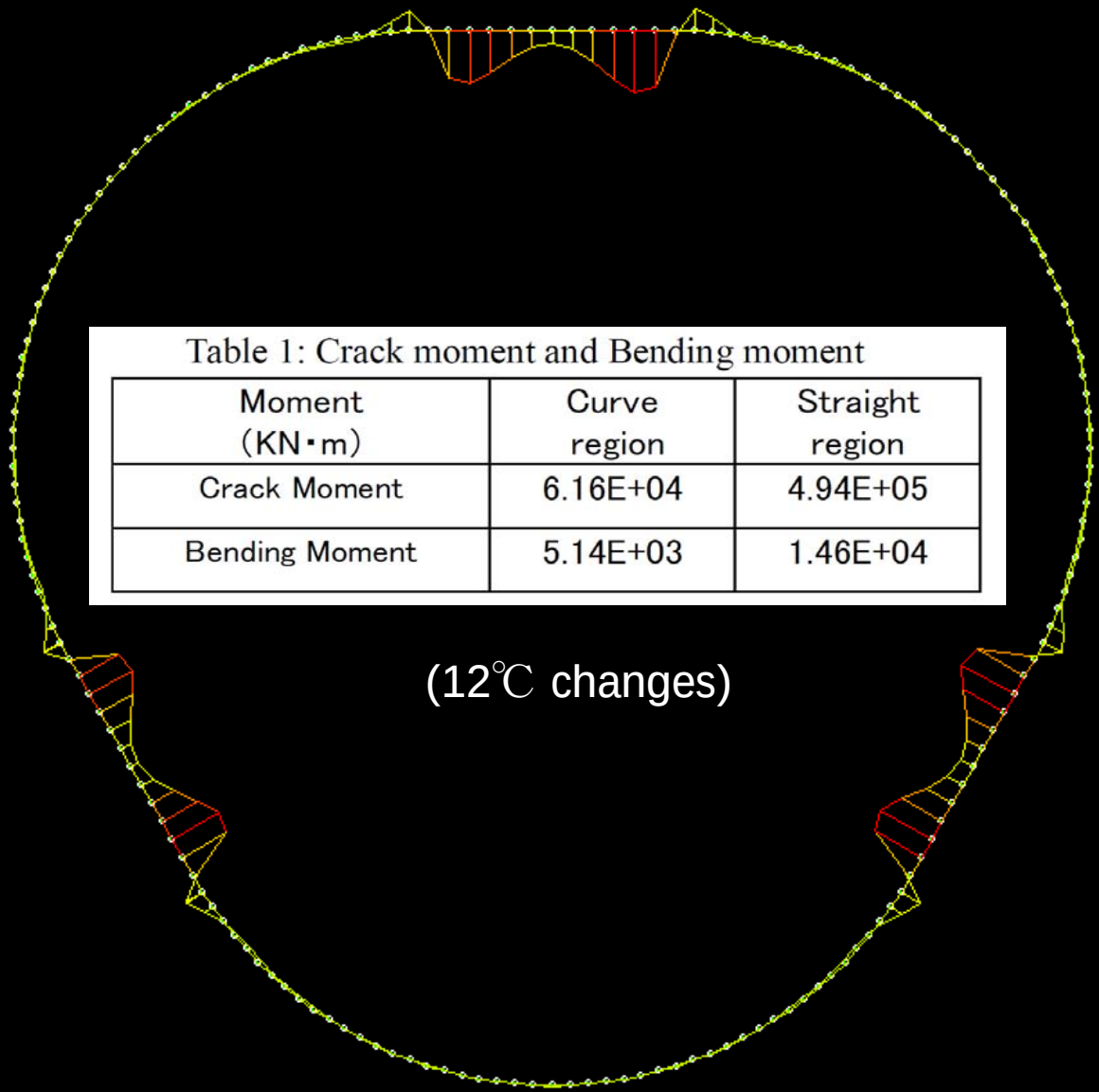


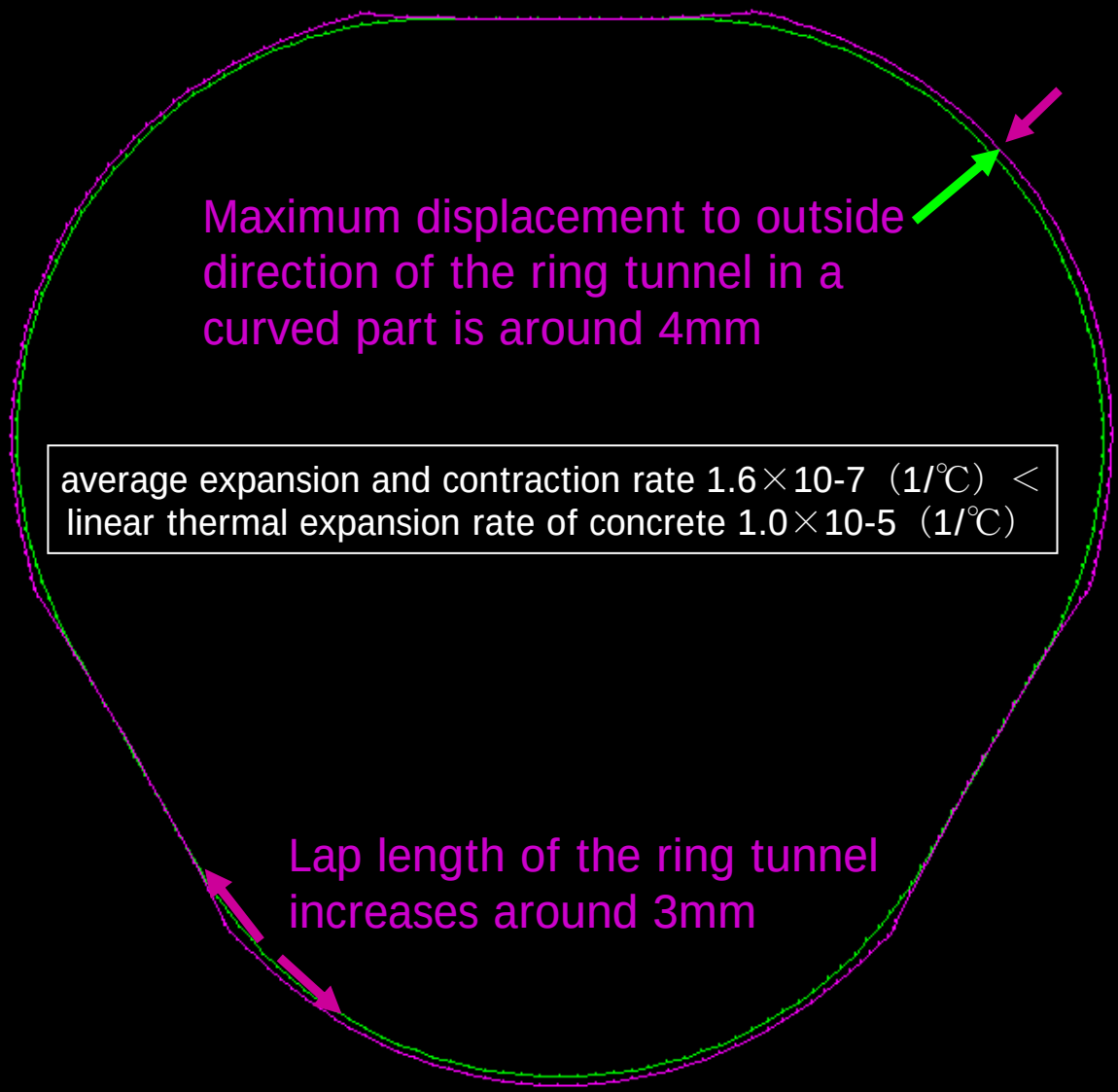
Table 1: Crack moment and Bending moment

Moment (KN・m)	Curve region	Straight region
Crack Moment	6.16E+04	4.94E+05
Bending Moment	5.14E+03	1.46E+04

(12℃ changes)

50GeV
+1.0 DEG

Transformation diagram in the case of concrete temperature 1℃ rises



MAX OF DISP 3.345E-4
CASE 1

Summary

- Key points for the design of the underground accelerator tunnel

→ Transformation should be minimal and level of integrity and durability of the tunnel structure should be high

- Structural analysis concerning with necessity of Expansion Joints

→ There will be no incidence of displacement and cracks in the tunnel concrete without expansion joints

Thank you very much for your attention