IABSE

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Risk Assessment and Management for A Cable-Stayed Bridge in Japan

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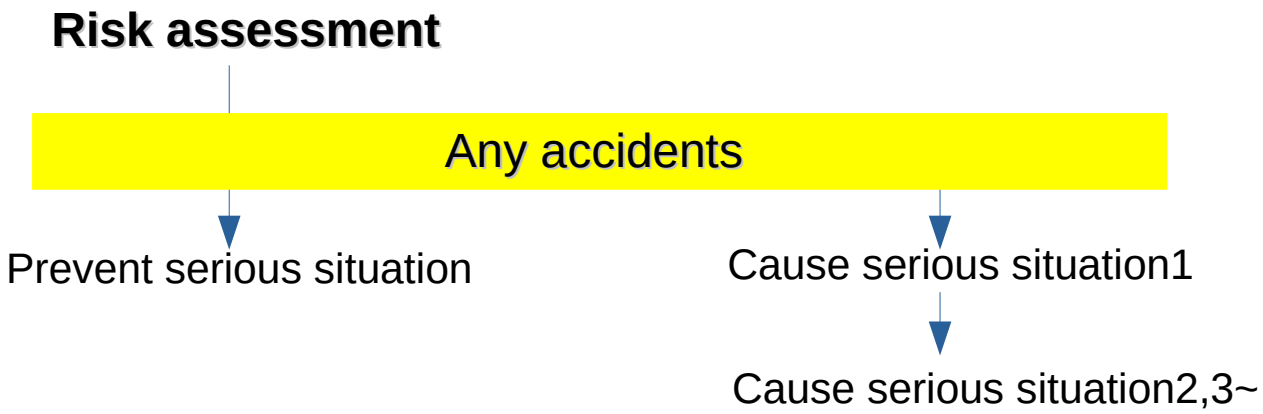
Purpose of Research

To propose a risk assessment in Japan by using a cable-stayed bridge.
Risk assessment is to consider how many risks for targeted bridge before construction and determine quantitatively risks.
Risk assessment is often used abroad, but not famous in Japan.
So as an introduction, I studied the any results of risk assessment on actual bridge in Akita prefecture.

Why is Risk assessment important ?

Thinking about risks in advance can prevent serious accidents from occurring.
As a result, we can prevent probability of risks too.



My research step

1st, To research about actual bridge's risks.

2nd,To determine quantitatively risks and consider its for actual one.

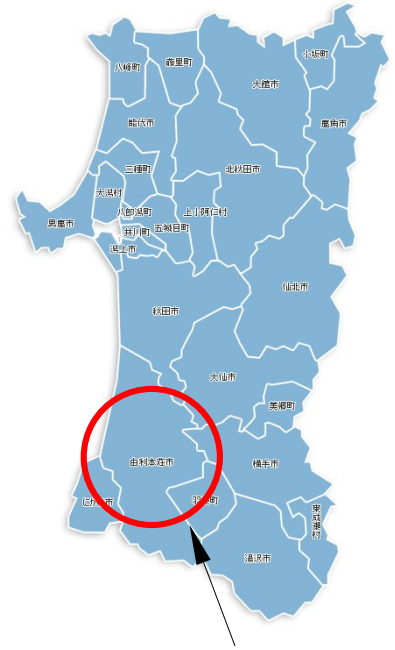
3rd, To propose a importance of risk assessment for bridge in Japan by using results.

About Akita and Targeted bridge

Area : 11,610 km^2 (no.6 in Japan)
Population : 896,225 people (smallest in Japan)
※ In Tokyo, 14,187,176 people
Total rode length : approximately 24,700 km
Specific feature : rural area / snowing area /
aging population is no.1 /
rice-producing is famous

Targeted bridge is **YURI bridge**.

Akita



YURI bridge is built in Yurihonjo city in Akita.
There are prefectural roads around YURI bridge,
so not too much traffic.

For example, about traffic volume of prefectural roads.

Prefectural Road 32 : approximately 8000 vehicles / day
Prefectural Road 57 : approximately 6500 vehicles / day
Prefectural Road 241 : approximately 4200 vehicles / day

Proposal of Risk assessment

How to calculate risks

Probability of risks depending on the situation × Bridge's span

→ Possible risks per year for that bridge (/ year)

Risk of traffic accident

Traffic accident rate in Akita : **0.38%**
Accident rate on prefectural roads : **0.27 / km × year**
Akita's prefectural roads rate in Japan : **0.2%**
Traffic accident rate on a straight road : **88.4%**
Correction factor for a straight road : **0.1**
Traffic accident fatality rate : **0.0036%**
Accident rate on bridges : **15.0%**

×

Risk of vehicle fire

Vehicle fire rate in Akita : **7.9%**
Freight vehicle pass rate : **14.15%**

This rate is high despite low traffic volume.

Quantification of risk

1.09×10^{-14} / km × year

Multiplied by span

1.09×10^{-14} / km × year

× 0.19km (bridge span of YURI bridge)

Fire risks of YURI bridge

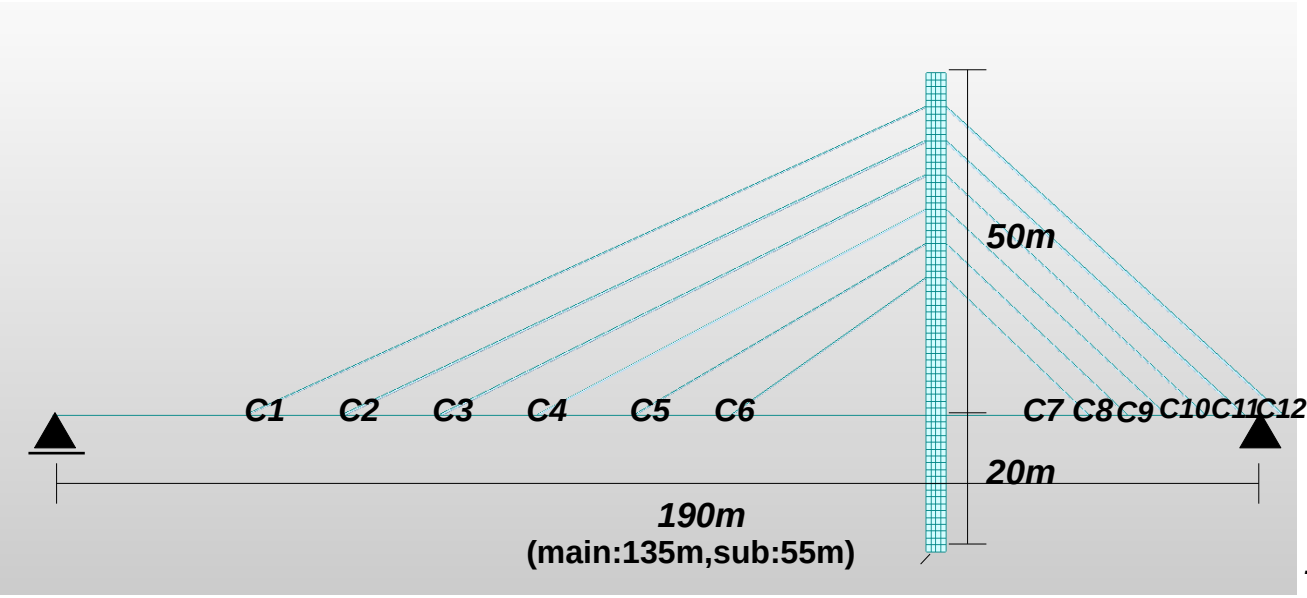
2.07×10^{-15} / year

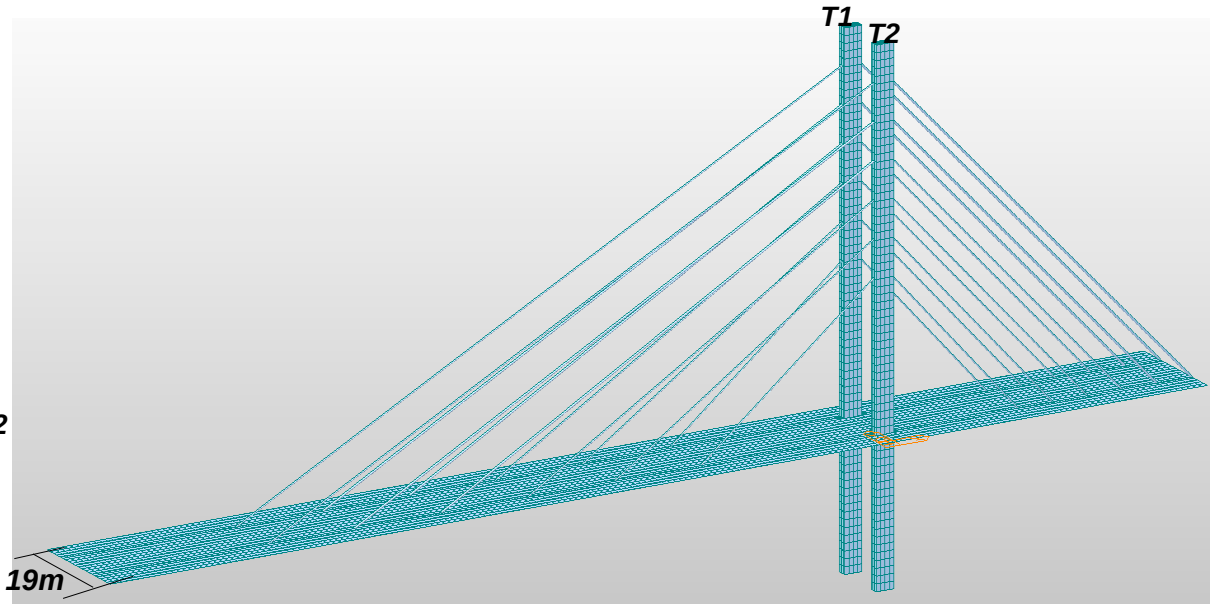
※ Supplementary information :
Risk of bridge (span : 1974m) in Romania is **1.14×10^{-6} / year**.

I try to confirm what would happen if bridge fire actually cause.

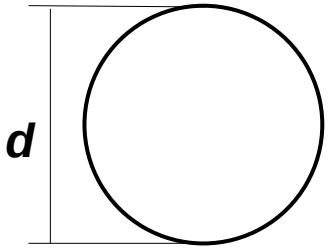
Analysis Model

Targeted bridge: YURI Bridge





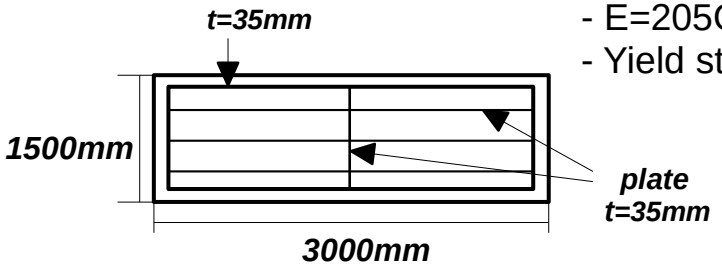
Cable diameter



C1,C4,C10 is d=225mm
C5~C9 is d=200mm
C2,C3,C11,C12 is d=315mm

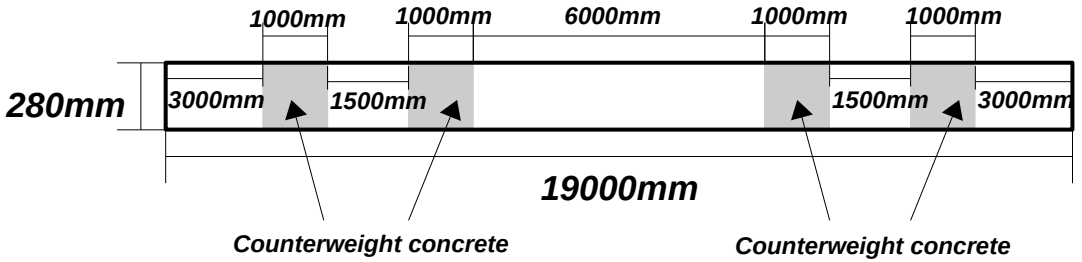
Cable material:ST1570
- E=195GPa
- Yield stress is 1570MPa

Main tower area



Steel material:SM490
- E=205GPa
- Yield stress is 335MPa

Girder area

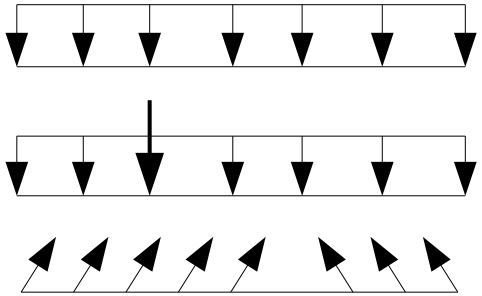


Design Load

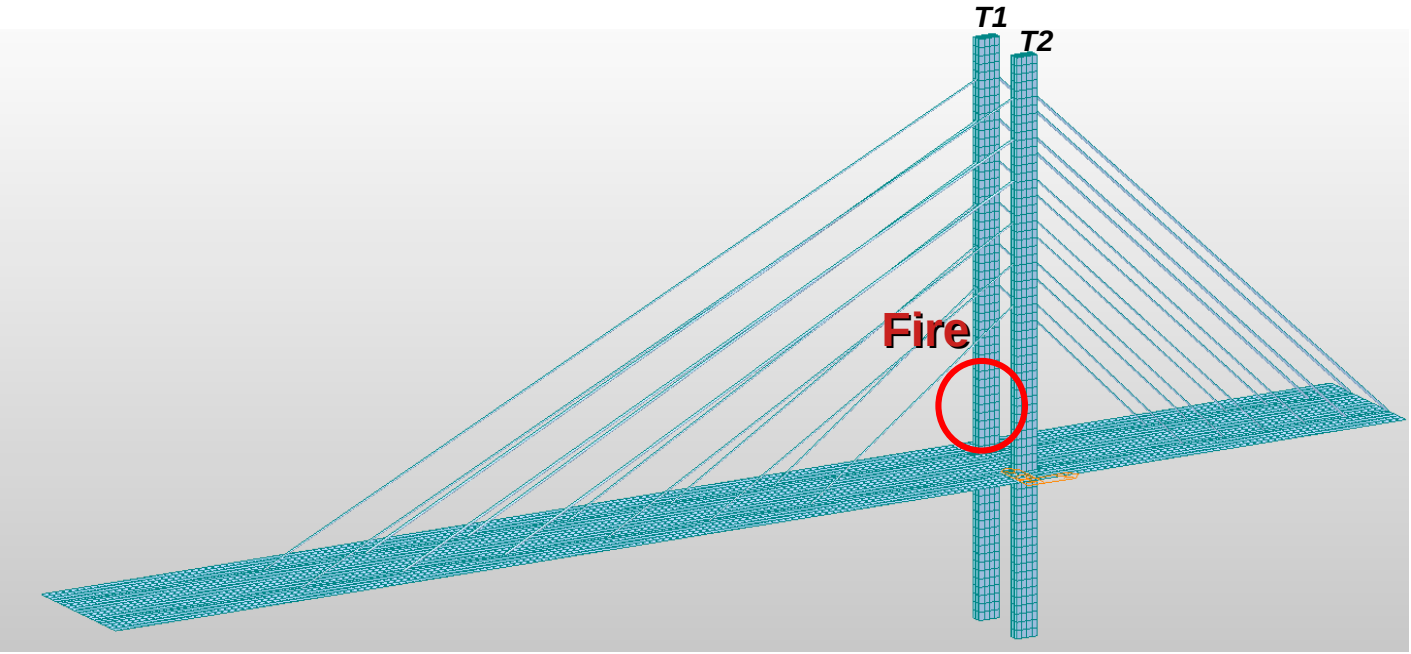
Dead load

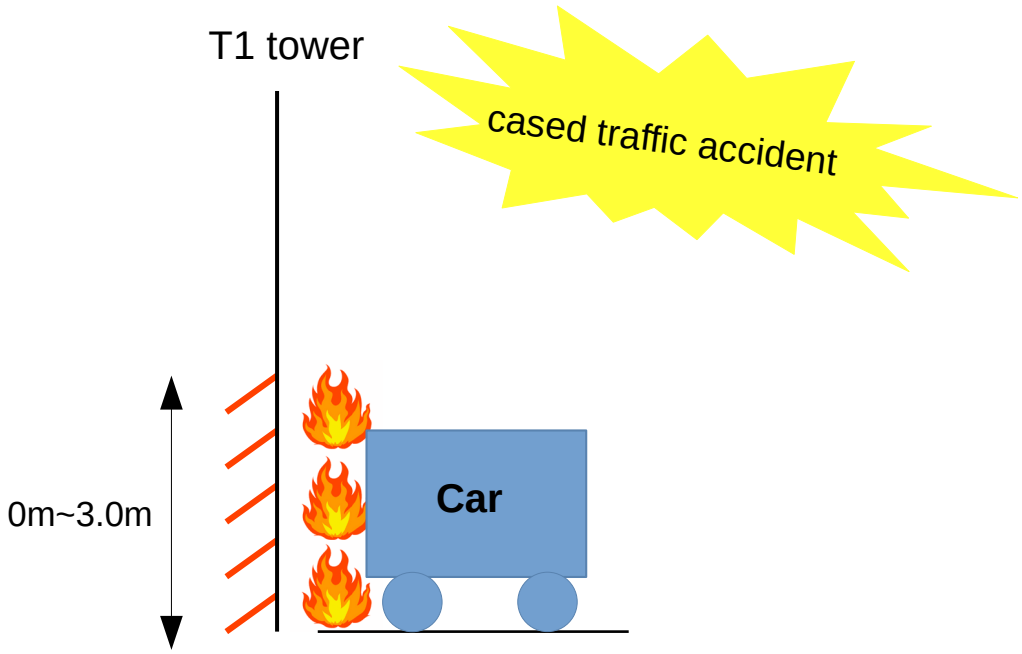
Live load

Pretension



Analysis Method





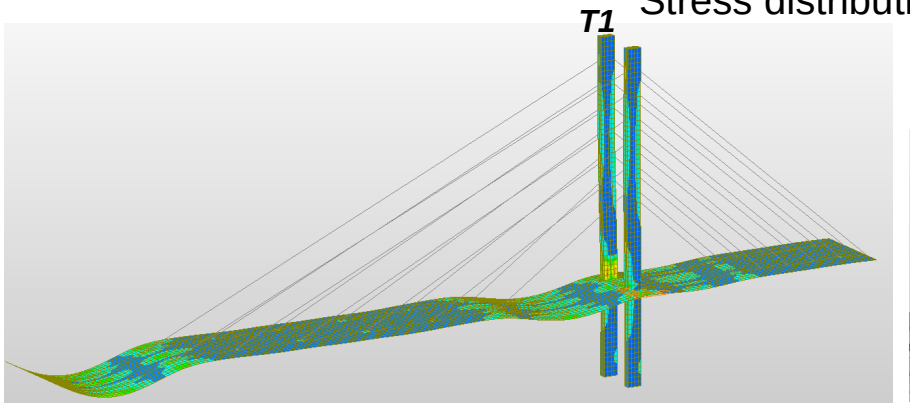
There is fire on the T1 main tower.
Temperature was applied at 0m~3m on the T1.
This position means “car height” .
The analyzed temperature are 250, 270, 300, 400 and 800 degrees.

In this case, assuming a collision between vehicles near the T1 main tower.
After that, it developed into a fire there.

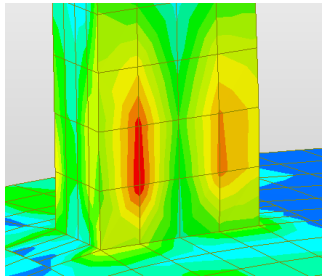
Look at the results of main tower stress and displacement at that temperature.

Analysis Results

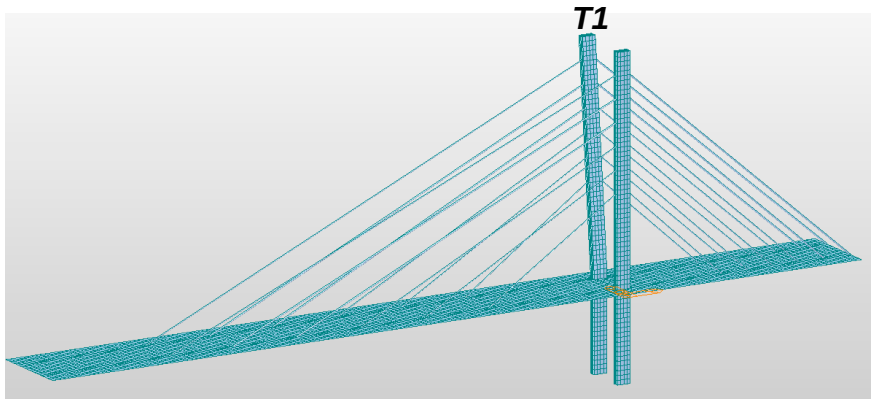
Stress distribution

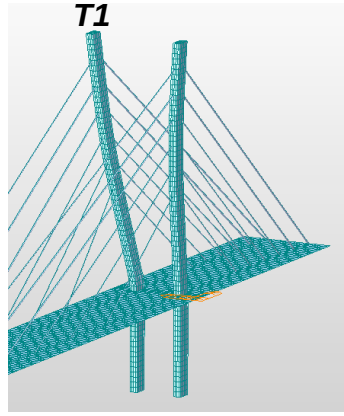


Enlarged view : T1

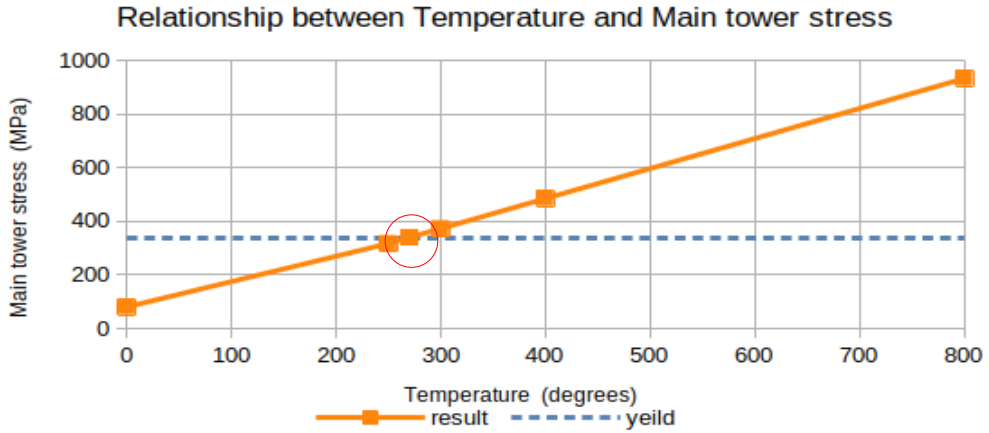


Deformation diagram





Stress concentrated in the heated area.

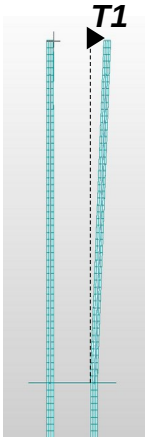


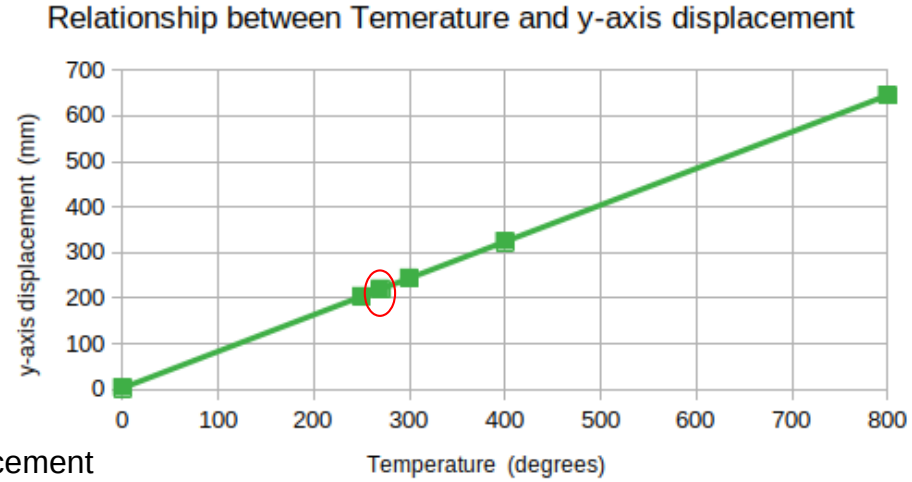
- Main tower yielded at 270 degrees.

Stress at 270 degrees is 340 MPa over than yielded.

- All cables stress didn't change much.

T1 main tower downed on outside the girder.





→ : y-axis displacement

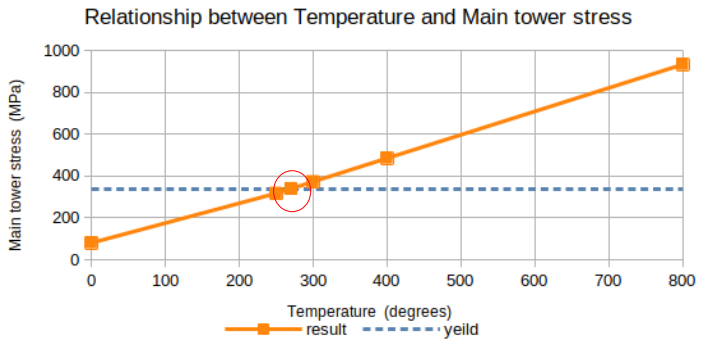
- Before bridge fire, displacement is 0mm.
- When 270 degrees, displacement is 220mm
- Significant affect wasn't seen on the cables.

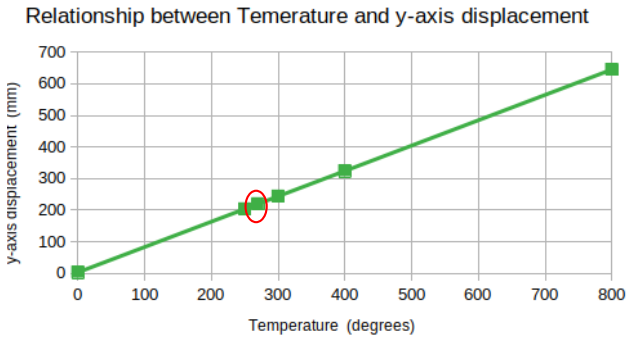
Conclusion

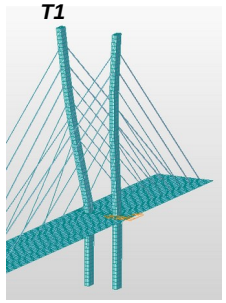
Risk assessment is to consider any risks and calculate possible one.
Risks of YURI bridge : **2.07×10^{-15} / year**

This risk level can not to be ignore.

if bridge fire cause･･･







Main tower yielded at 270 degrees and downed on outside.

New risks may be created
- To establish blockade period
- To increase travel time around people
- Traffic jam in another road
- To need repair costs

These will inconvenience to the around people and the city.

Regardless of high or low risk,
It is important to consider risk assessment for bridges.

Future tasks
- To study what happens when there is fire on the cable.
- To consider more kind of risks in the future.

Thank you for your attention