Pookott Alanchery Amith Prasad

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Master Thesis

Structural Design of Sea Gate against Tsunami loads considering Ultimate Strength

Supervisor: Prof Maciej Taczala, Professor, West Pomeranian University of Technology, Poland

Internship tutors : Prof Kazuhiro Iijima, Associate Professor, Osaka University, Osaka

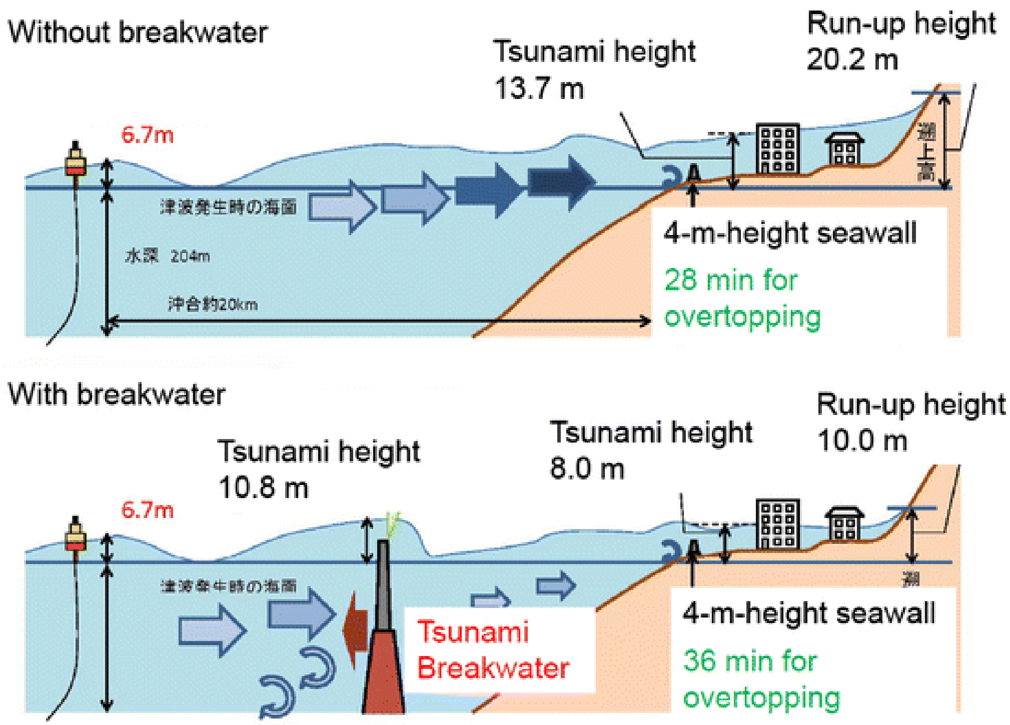
Prof Akira Tatsumi, Assistant Professor, Osaka University, Osaka

Reviewer: Prof Rigo Philippe, Professor, University of Liege, Belgium

Hamburg, February 2019

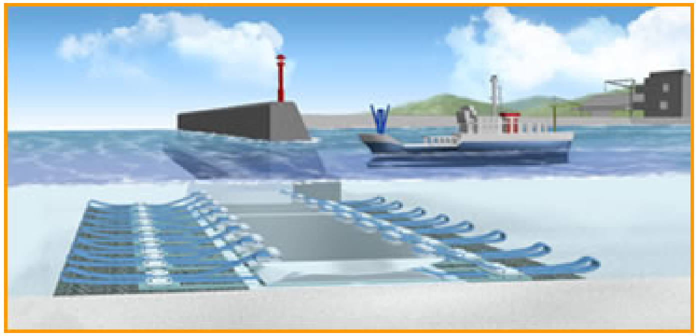
Introduction

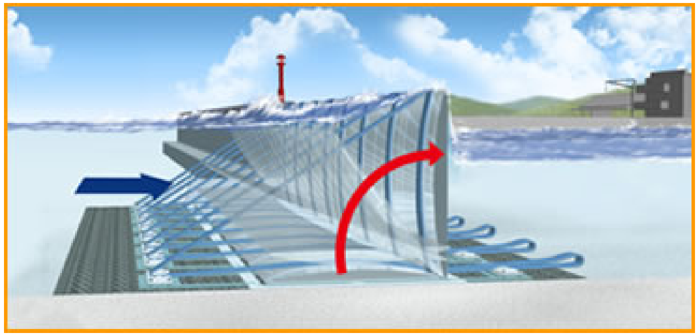
- Aftermath of Tohoku Tsunami - New ideas/concepts had to be implemented
- Understanding from drawbacks of the previous ideas

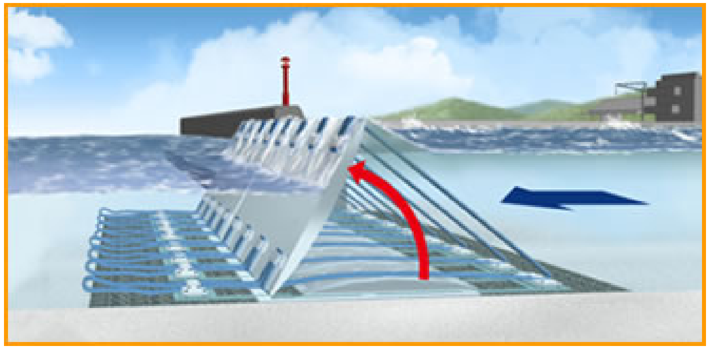


The Concept

- Concept of Seagate evolved
- The structure action – Tsunami hydrodynamic force



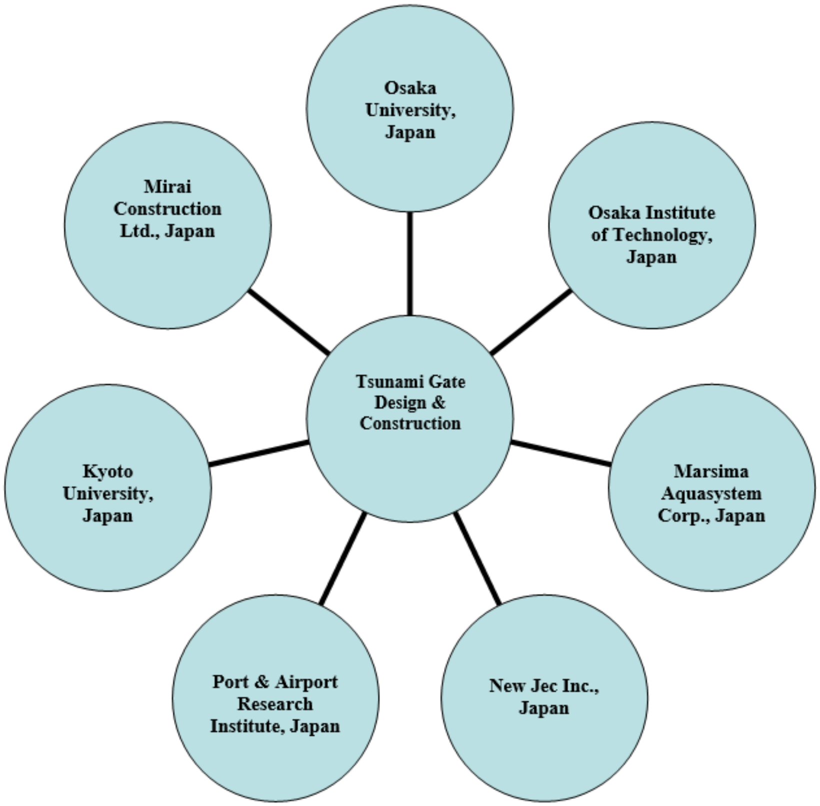




Design Philosophy

	Determination	Idea
Level-1 Tsunami	Frequent tsunami with return period of the order of 100 years.	・Protect human lives, cities and various things. ・Maintain the whole structure of the breakwater.
Level-2 Tsunami	Maximum possible tsunami and used to design evacuation plan. The return period of the order must be over 1000 years.	・Protect human lives. ・Minimize the destruction of cities and economy. ・Maintain partial structure of the breakwater as possible.

Organizations Involved



Functionality Test at Kyoto University(Model height-43cm)

- Different scaled models were tested
- All the tested models pass the tests with no damage

Case	Wave Height(cm)	Max. water level variation(cm)		Max. velocity(cm/s)		Max. Tension(N)	Barrier erection
		Out	In	Out	In		
SW005	1.1	1.0	0.9	4.6	4.3	-	No
SW010	2.2	2.3	2.3	11.1	9.9	-	No
SW025	5.4	6.0	5.7	23.7	23.1	-	No
SW050	10.8	11.7	11.0	42.8	41.8	636.0	Yes
SW075	16.1	16.4	15.6	58.5	53.0	2261.0	Yes
SW100	21.5	21.8	19.4	76.1	63.9	3013.0	Yes

Table 2 Short Tsunami wave characteristics generated and after barrier influence

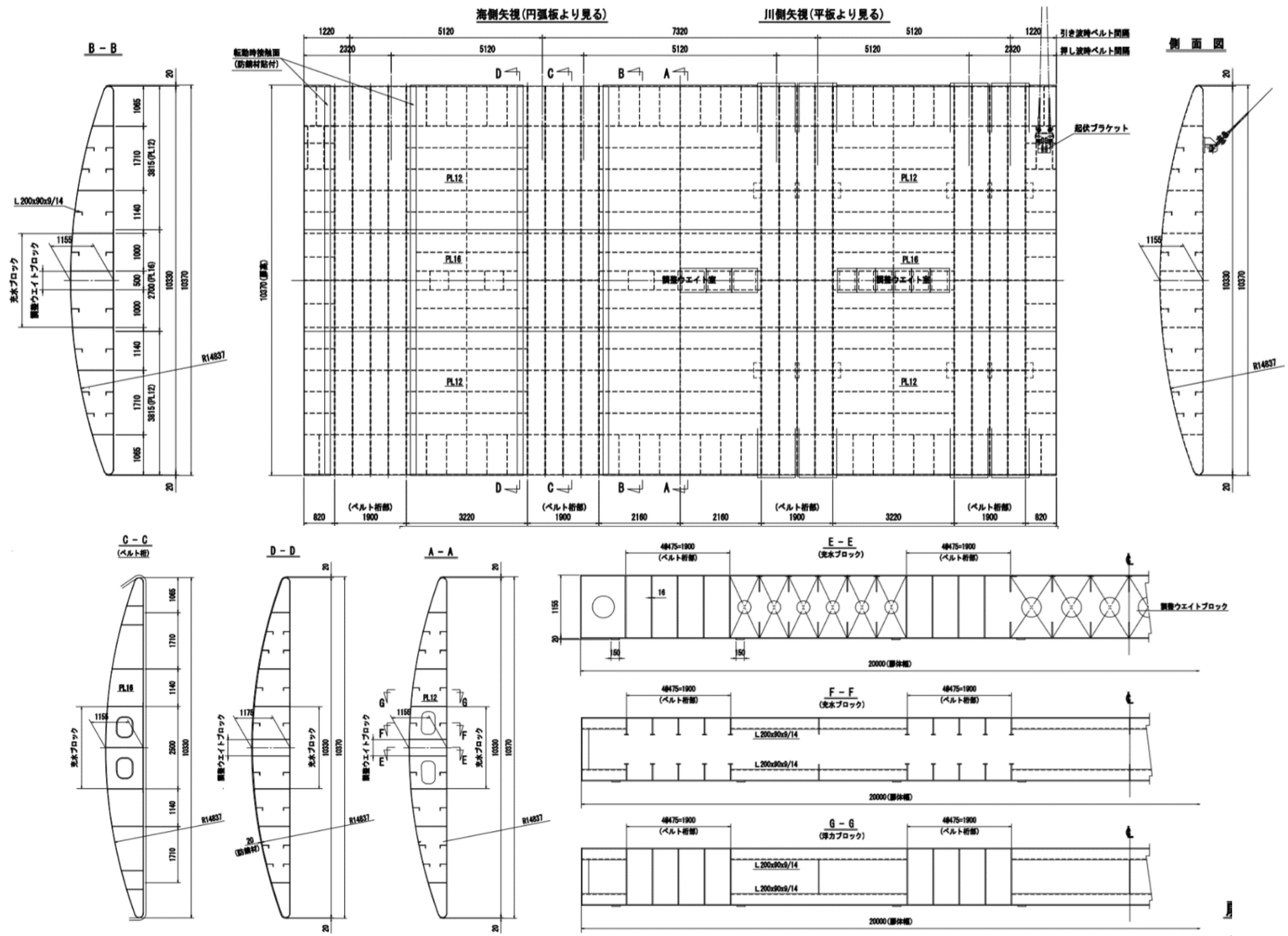
Case	Pump Discharge(m3/s)	Max. water level variation(cm)		Max. velocity(cm/s)		Max. Tension(N)	Barrier erection
		Out	In	Out	In		
FL005	0.05	0.5	0.4	5	2.5	-	No
FL010	0.1	1.3	1.3	5	2.9	-	No
FL030	0.3	7.9	4.3	16.3	14.5	177.0	Yes
FL050	0.5	14.2	5.2	27.2	21.5	360.0	Yes
FL070	0.7	20.0	7.2	37.7	27.5	683.0	Yes

Table 3 Long Tsunami wave characteristics generated and after barrier influence

Areas of Implementation

Prefecture	Port	No. Of locations
Hyogo	Nushima Island	2
	Fukura Harbour	
Mie Town		
Kochi		

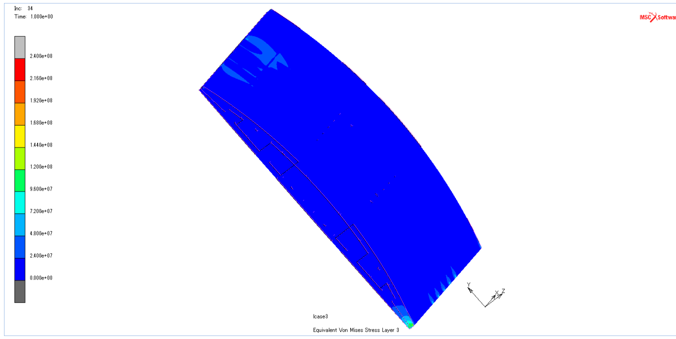
Structure under investigation

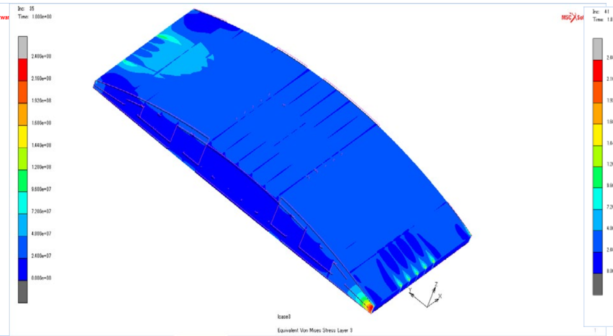


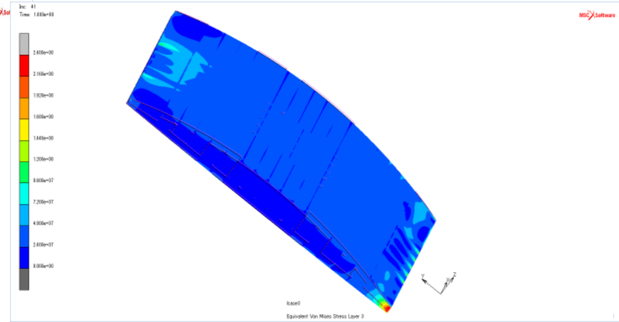
SM 400

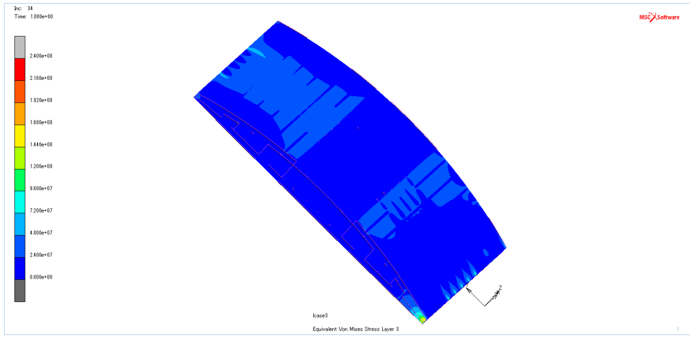
NN-450 S-S想定グラフ

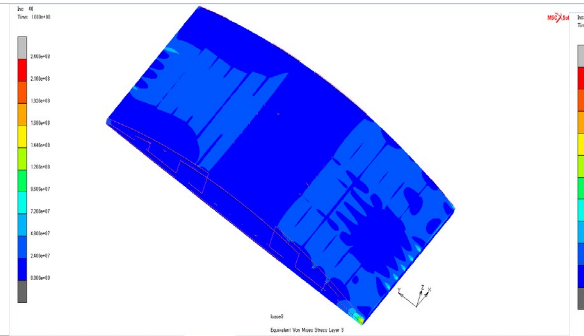
Results

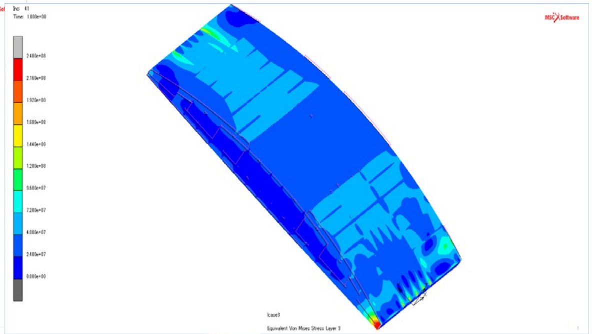

L1C1


L1C2

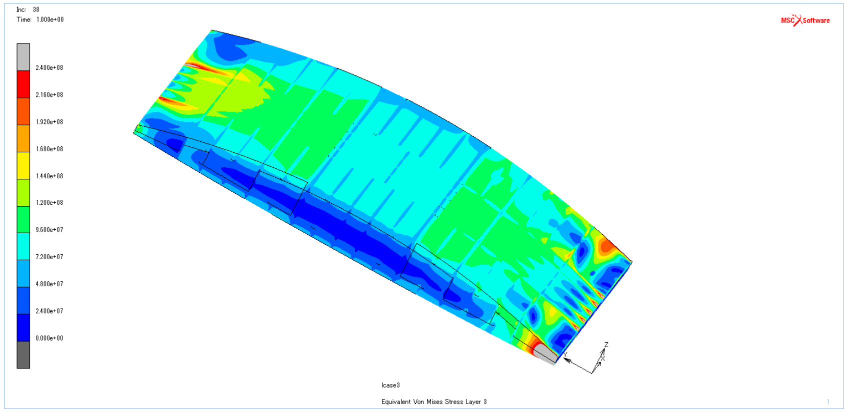

L1C3


L2C1

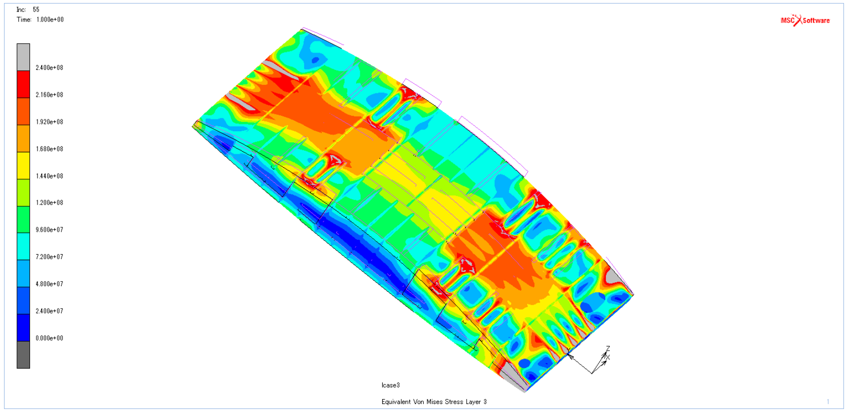

L2C2


L2C3

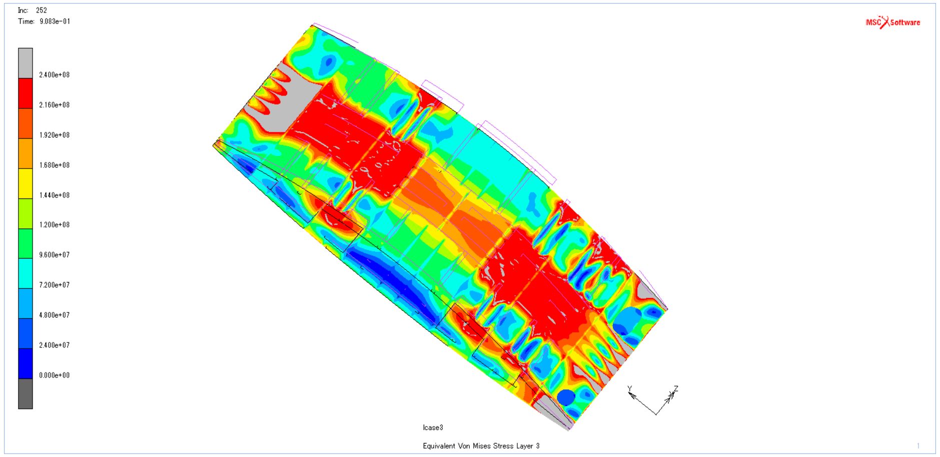
Increment of Loads in proportion to L2C3



2*L2C3

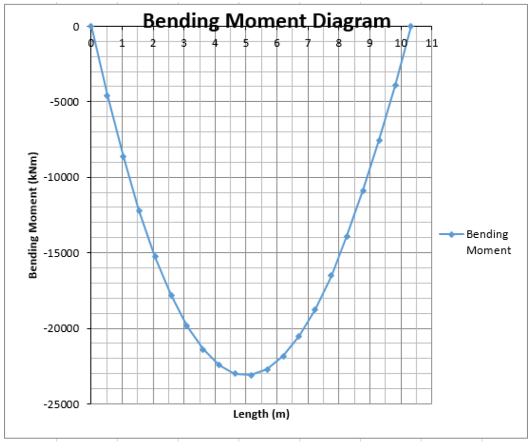


3*L2C3

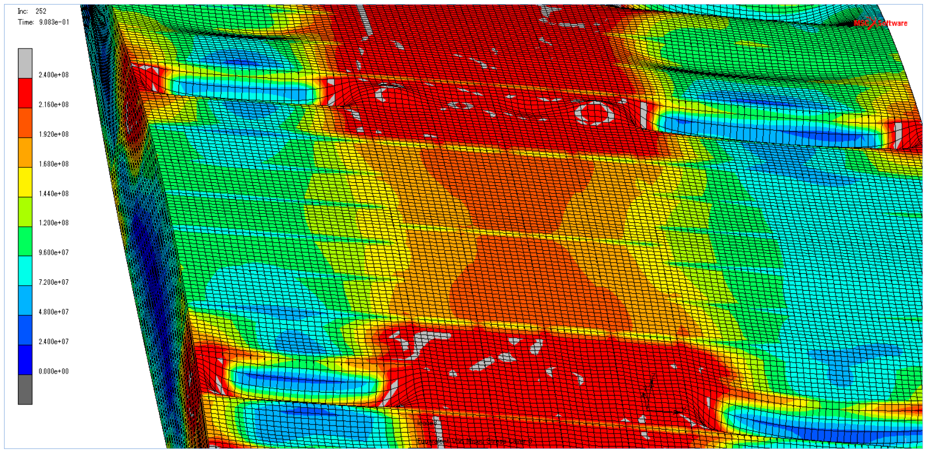


Collapse of Structure-90% of 4*L2C3

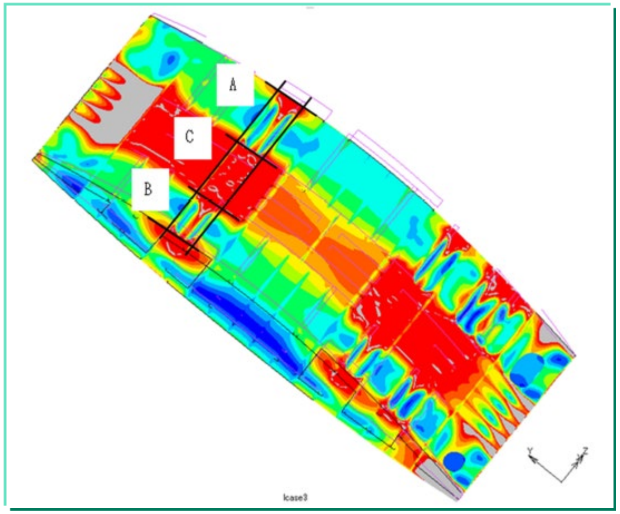
Why & How?



Moment Distribution



Closer look at the critical area



Collapse sequence

Conclusions

- The structure is safe against the L1/L2 loads
- The Collapse of the structure happens at 90% of 4*L2C3 case

Future work

- Belt could be modeled along with structure for analysis
- To study the collapse area in detail
- To verify and implement the design formula