Manufacturing and Application of Anti-Vibration and Seismic Products in the Engineering Field

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Zhuzhou Times New Material Technology Co.,Ltd.,

China

The first seismic isolation building in china, in 1993

China map with the distribution of high-speed rail

Research and Application of Anti-Seismic Device in the Engineering Field

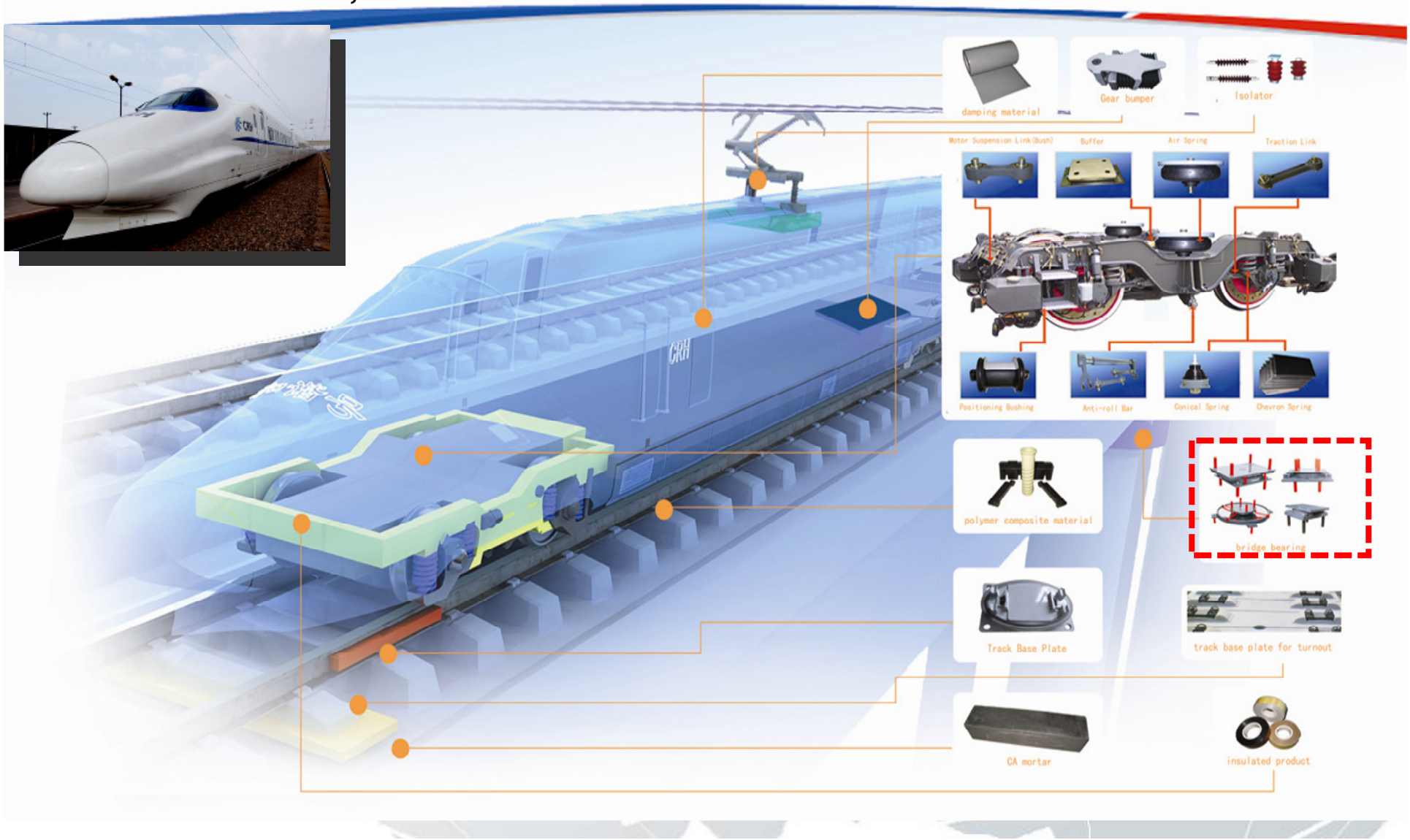
Xiangliang Ning

24 April 2013, Budapest

Contents

Part 1 General information of TMT

“Top 50 of the World Non-Tire Rubber Product Industry”.
In2012, the sales volume of TMT is about 4 billion RMB.



Part 1 General information of TMT

BUSINESS SCOPES

Rail Vehicle

- RTM part for primary and secondary suspension
- Plastic and polyurethane product
- Sealing part
- Insulator and insulation material
- Damping & deadening material

Wind Energy

- RTM for gear box & generator
- Plastic and polyurethane part
- Blade for wind turbine
- Insulation
- Damping & deadening materia

Infrastructure

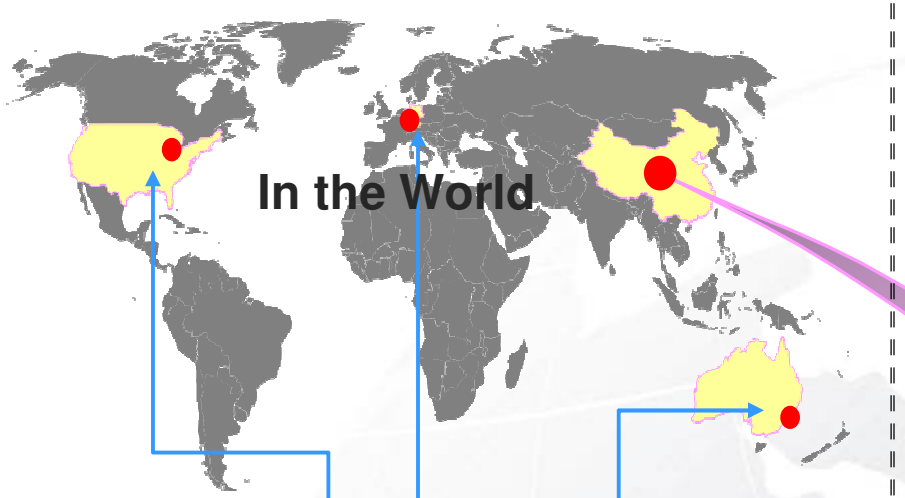
- Base plate for railway track
- Bearing/damper for bridge and building
- RTM for civil construction

Truck & Non-rail Vehicle

- RTM part for automotive, heav truck and engineering machinery
- Plastic and polyurethane product
- Sealing part

Part 1 General information of TMT

WOELDWIDE NETWORK



Chicago USA (planning)
N.A. Office

Munich Germany
E.U. Office

Sydney Australia
Delkor Ltd
Australia Office

Hunan
TMT Headquarter
New Material Testing Center
R & D Center
Production Center
(Elastomeric Components,
Bridge Bearings,
Wind Blades,
Engineering Plastic and
Insulating Products)

Heilongjiang
Qiqihar JV
(RTM for Wagon)

Inter-Mongolia
Inter-Mongolia Factory
(Wind Blade)

Shanxi
Xianyang JV
(Sealing part)`

Hubei
Xiangfan Factory
(Bridge Products)

Shandong
Qingdao JV
(Water Treatment)

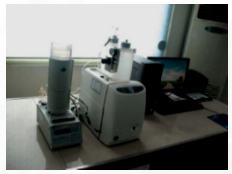
Tianjin
Tianjin Factory
(Wind Blade)

Part 1 General information of TMT

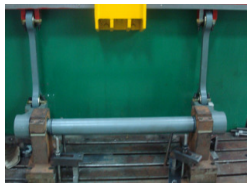
Test Center

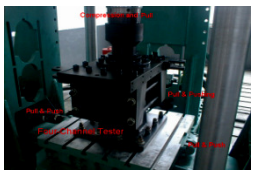
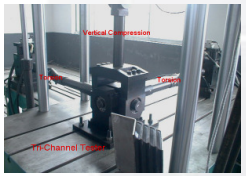
owns a unique national test center for elastomeric components in china

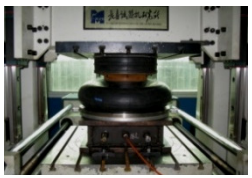










性能参数 Parameters:
垂直载荷Vertical load:5200t
水平载荷Horizontal load:1200t
测试项目Test Item:
垂直荷重测试Vertical load test
水平荷重测试Horizontal load test
转角测试rotate test
磨擦系数测试Friction Coefficient test
垂直剪力测试Vertical shear test
拉力测试Pull test
动态测试Dynamic test

Max. Vertical static load：2500T
Max. Vertical stroke：200mm
Max. Vertical speed：400mm/min
Max. Horizontal dynamic load：±200T
Max. Horizontal stroke：±500mm
Max. Horizontal speed：600mm/min

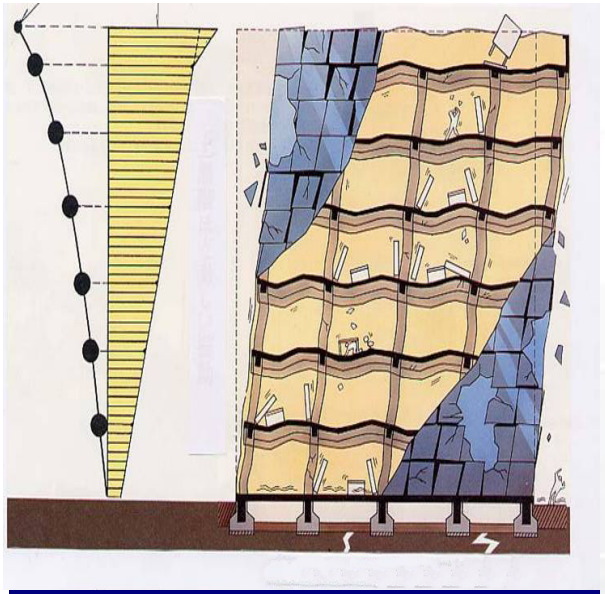
Max. static load：±450 T
Max. dynamic load：±350 T
Max. Horizontal stroke：±600 mm
Max. Horizontal speed：0.9m/s（300T）

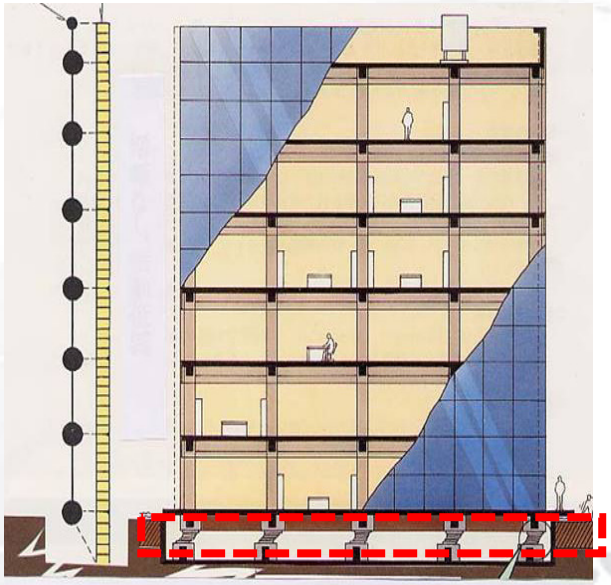
➢ Classification of Anti-Vibration and Seismic Device

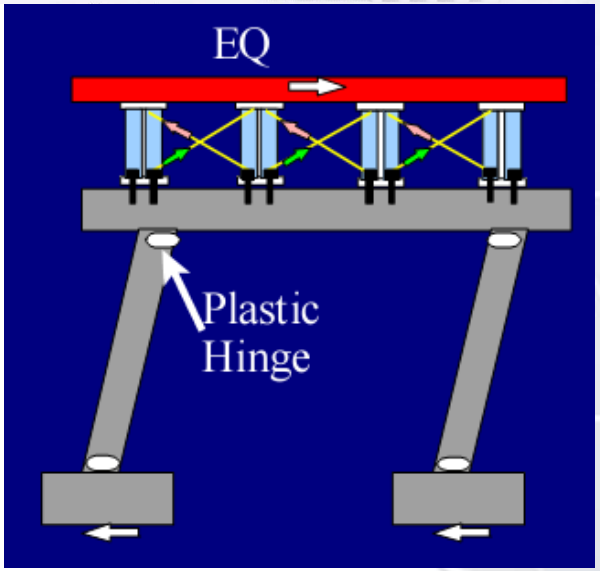
- **Isolation**
  - (1) LNR; (2) LRB;
  - (3) HDR; (4) FPB;
- **P- Control**
  - (1) Viscous Damper; (2) VED
  - (3) Friction Damper; (4) Steel Damper
  - (5) TMD和TLD
- **A- Control**
  - (1) AMD; (2) HMD
- **SA-Control**
  - (1) AVD (2) AVS
- **I-Control**
  - (1) MRFD; (2) SMA; (3) PZT

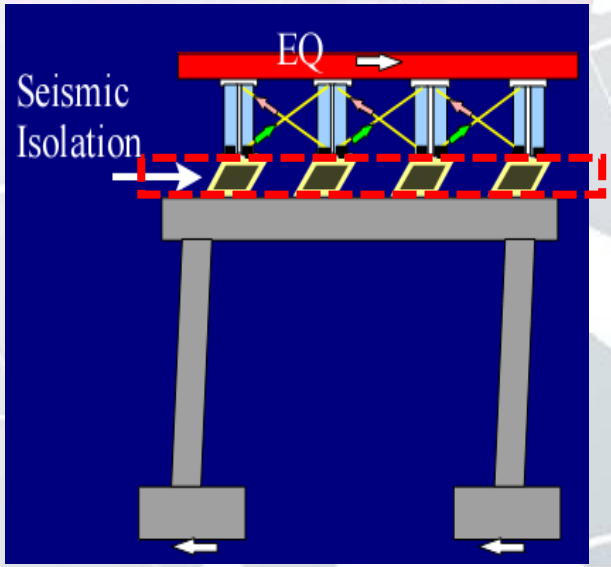
Related code: EN1337, EN15129, ISO 22762 & Chinese code

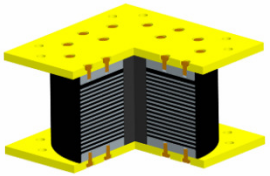
➢ Seismic Isolation



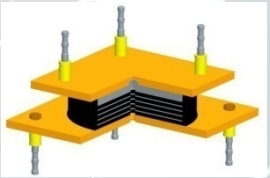




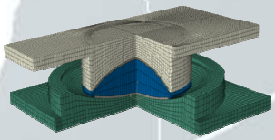




LRB/LNR

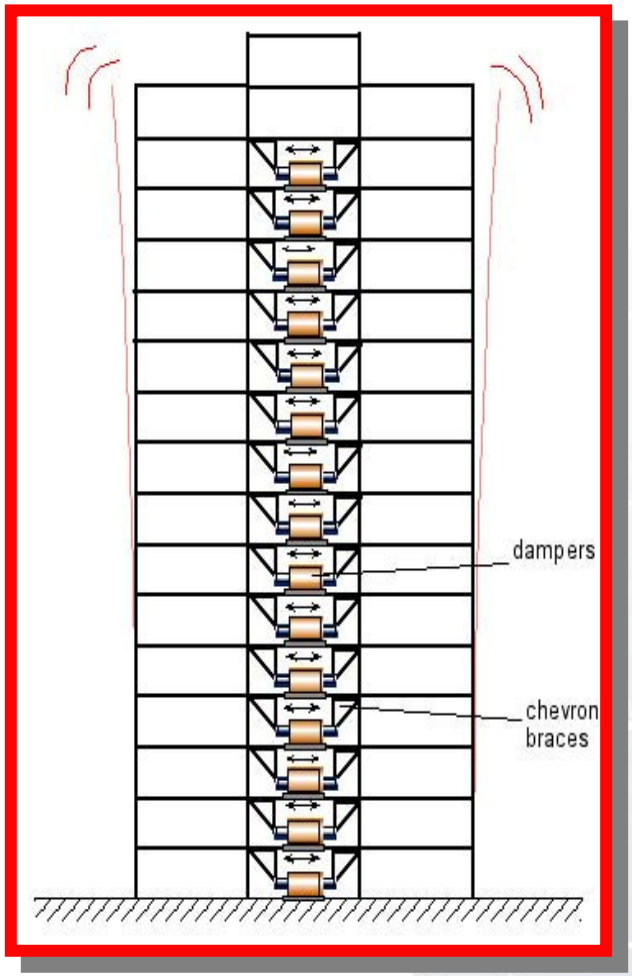


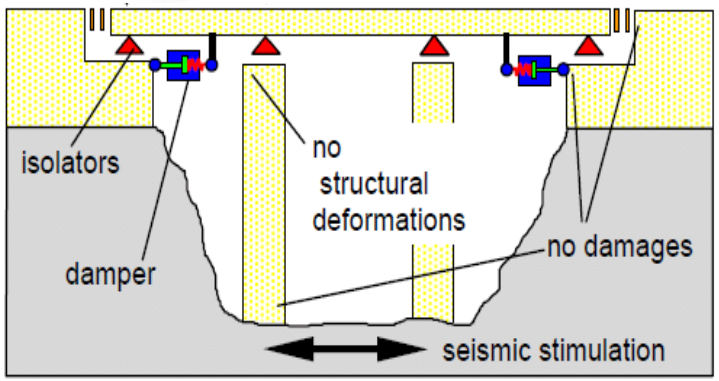
HDR

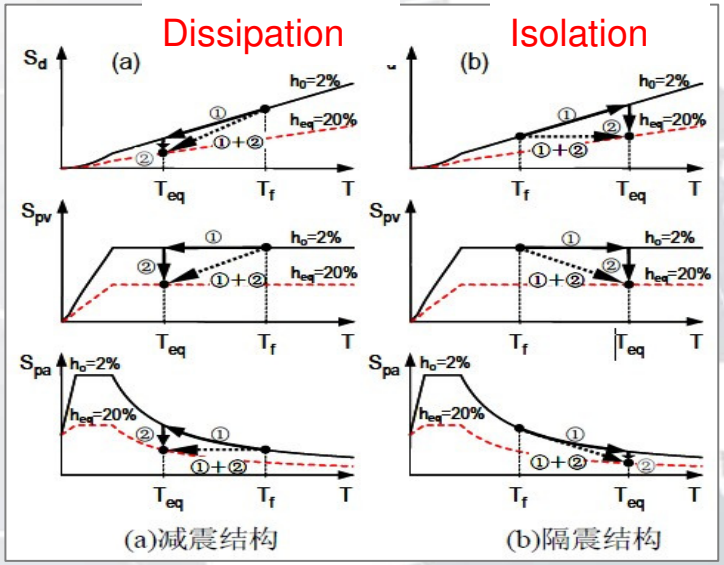


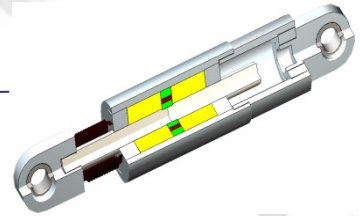
FPB

➢ Energy Dissipation

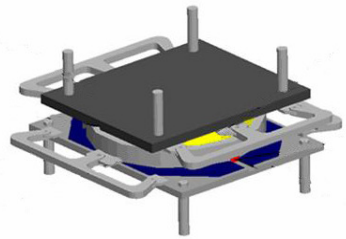


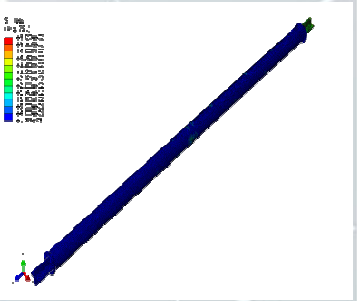






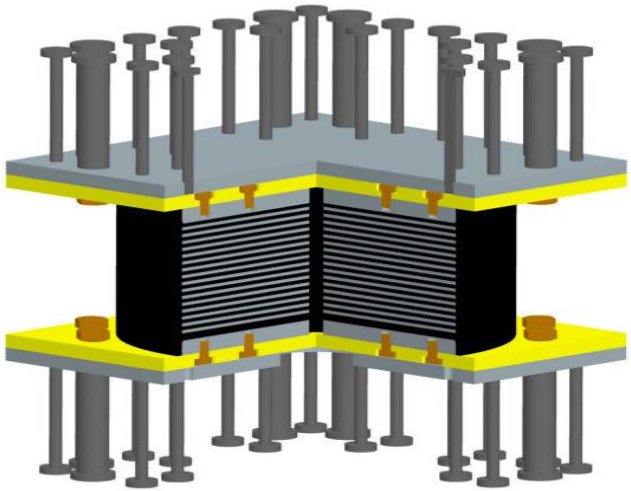
FVD

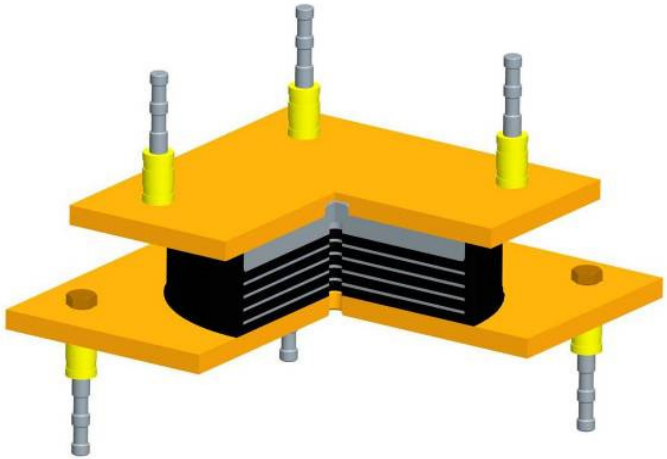




Steel Damper

➢ Rubber bearing- structure and design





Main part

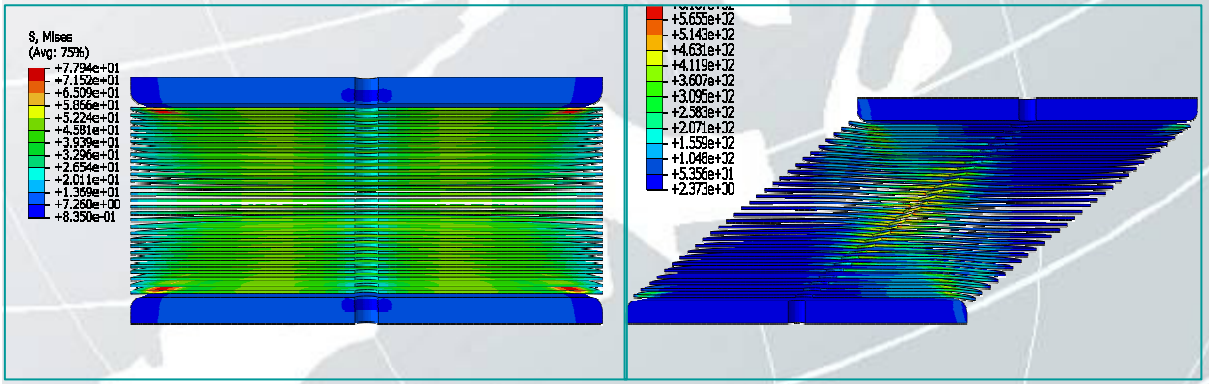
- Load &Def.
- Stiffness &Damping
- Material & size of rubber and steel plate
- Lead core

Connection

- Material & size of the bolt and sleeve
- Mounting & connecting flange

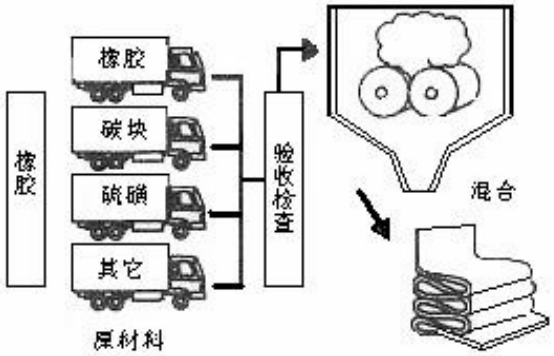
FEM

- Verification
- optimization

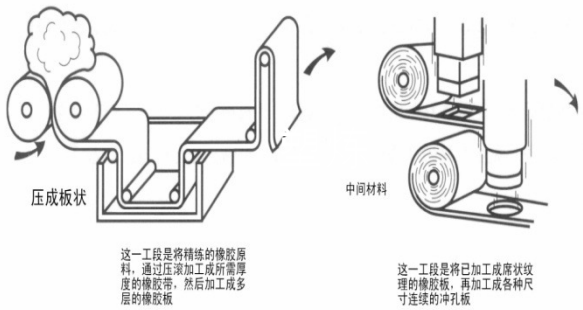


➢ Rubber bearing- manufacture

Plastication and mixing



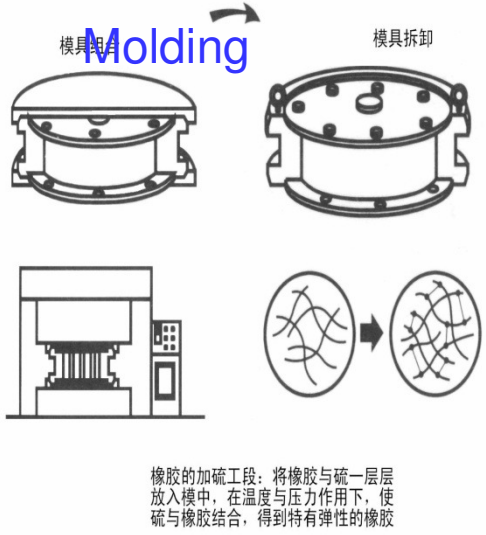
Calendering

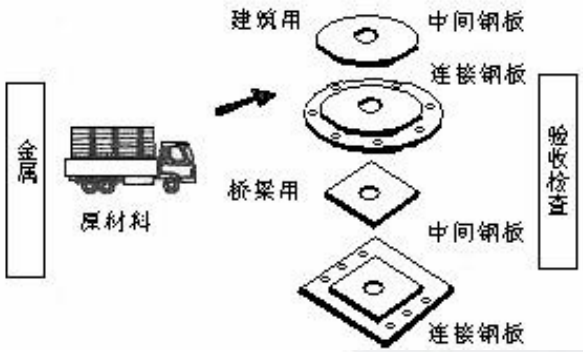


Composite

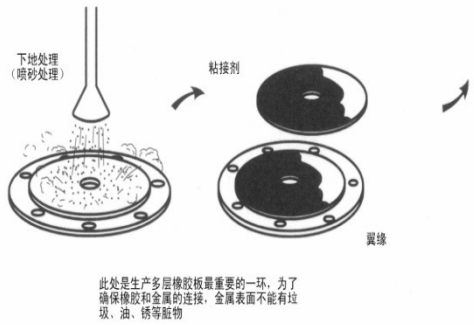
Vulcanization

Molding





Sandblasting



Spraying

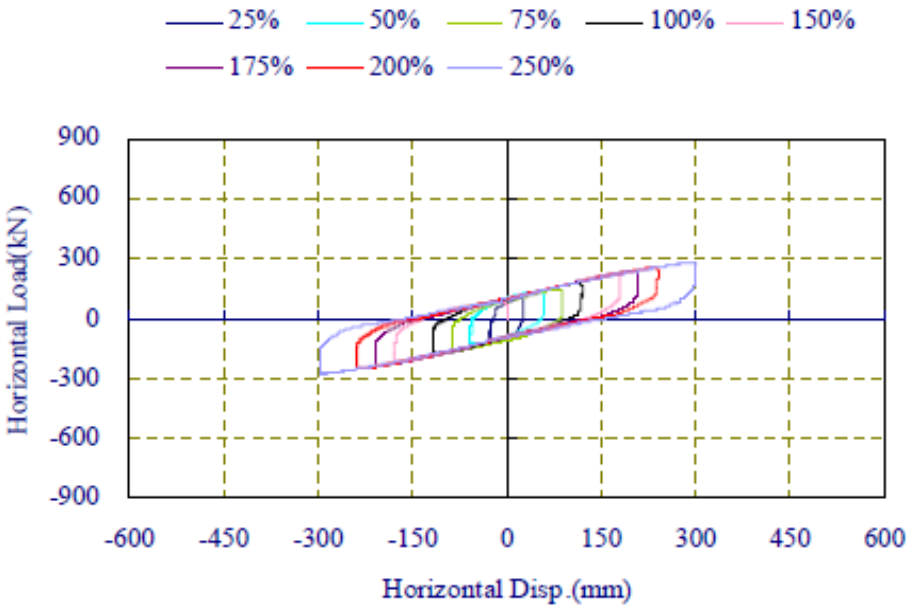
➢ Rubber bearing- Testing

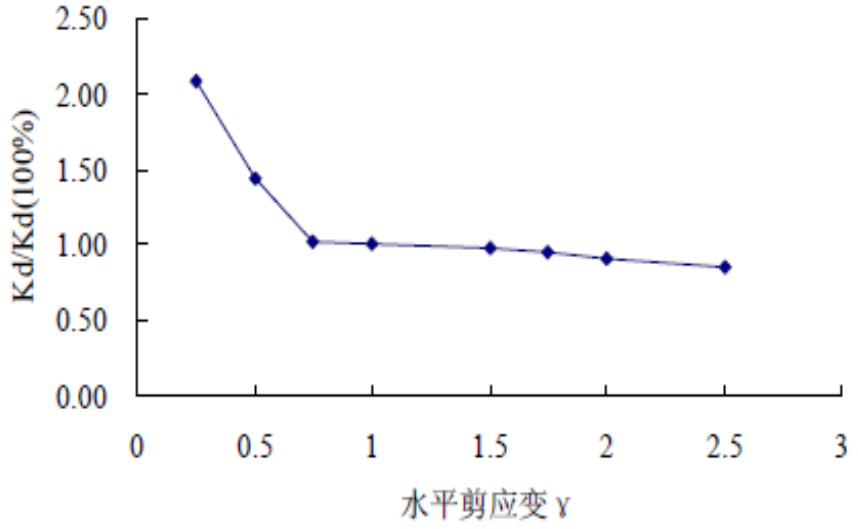
ISO 22762-1, 2005

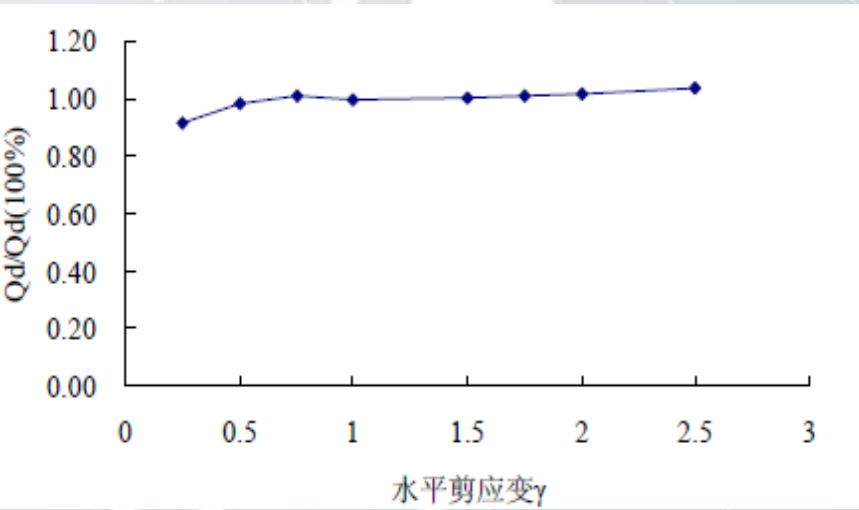
Properties	Test items
Compression properties	Compression stiffness
	Compression displacement
Shear properties	Shear stiffness
	Equivalent damping ratio
	Post-yield stiffness
	Characteristic strength
Dependency of shear properties	Shear strain dependency
	Compressive stress dependency
	Frequency dependency
	Repeated loading dependency
	Temperature dependency
Dependency of compressive properties	Shear strain dependency
	Compressive stress dependency
Ultimate shear properties	Breaking displacement (strain), force
	Buckling displacement (strain), force
	Roll-out displacement (strain), force
Tensile properties	Tensile breaking force
	Tensile yielding force
	Shear strain
Durability	Property change by ageing
	Creep
	Property change by fatigue
Force of reaction against low-rate deformation	Shear modulus at low-rate deformation

➢ Rubber bearing- Testing

shear strain stress dependency

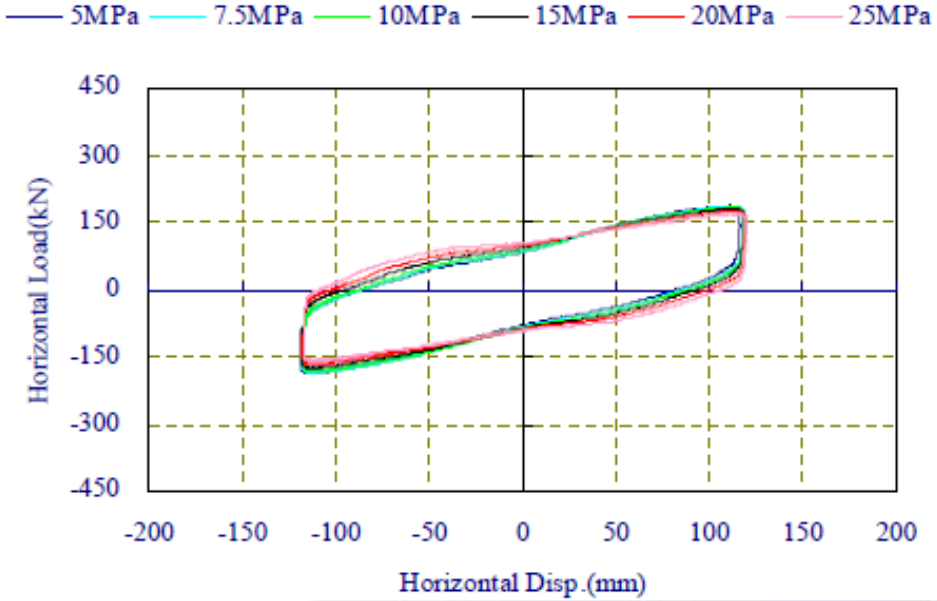


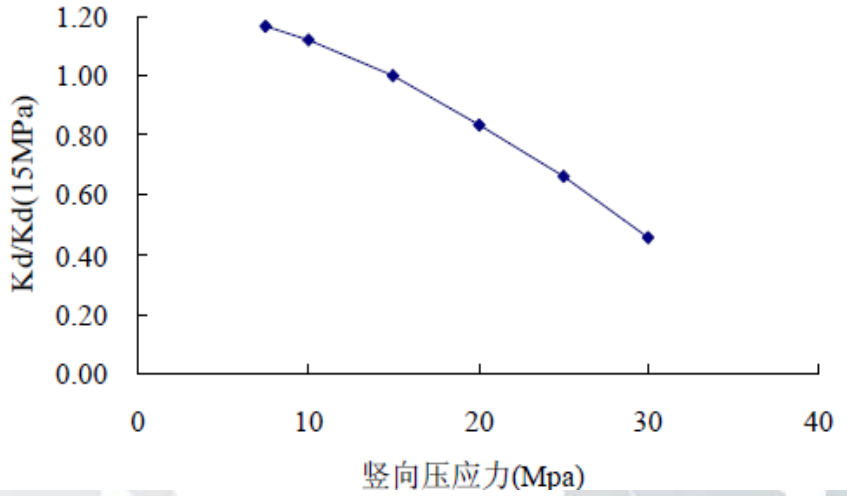


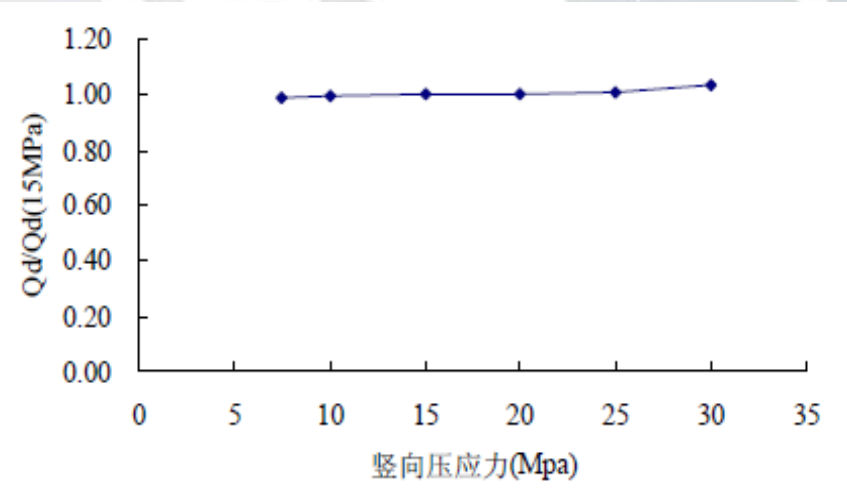


➢ Rubber bearing- Testing

Compressive dependency

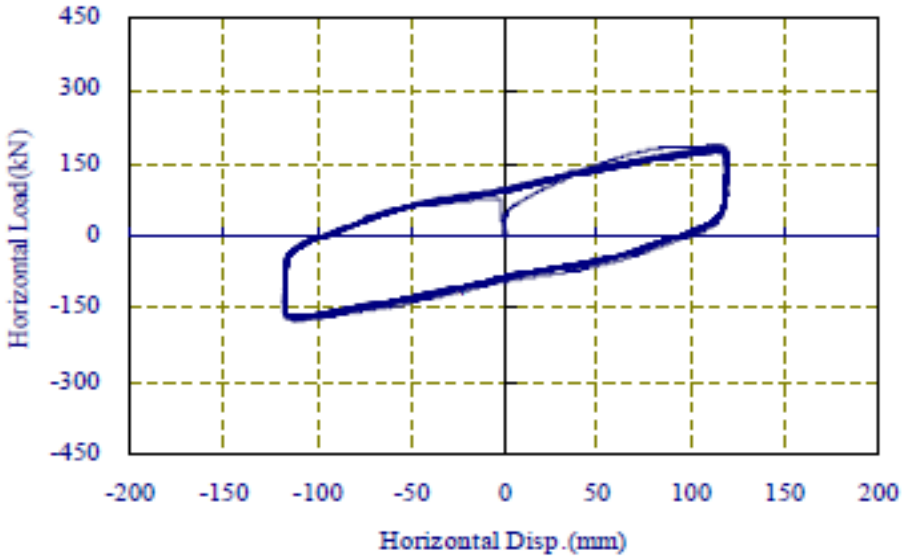


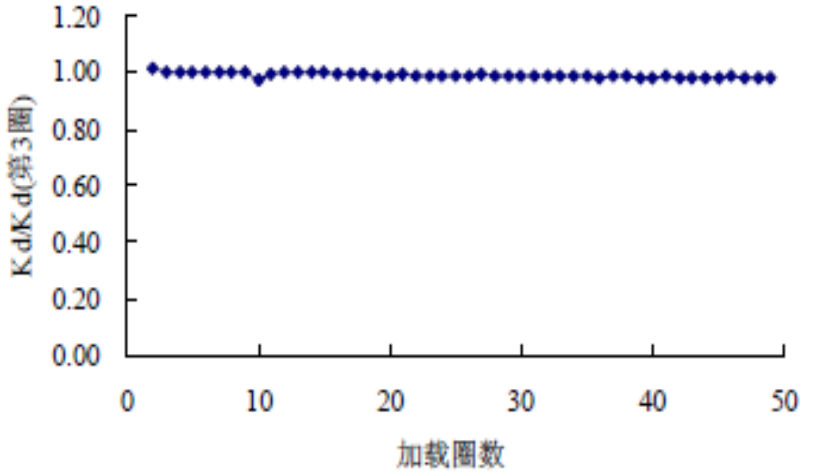


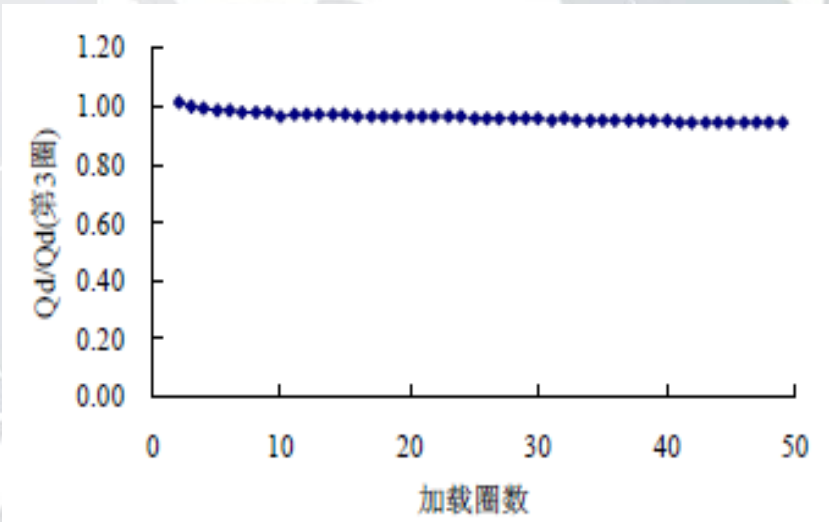


➢ Rubber bearing- Testing

Repeated loading dependency

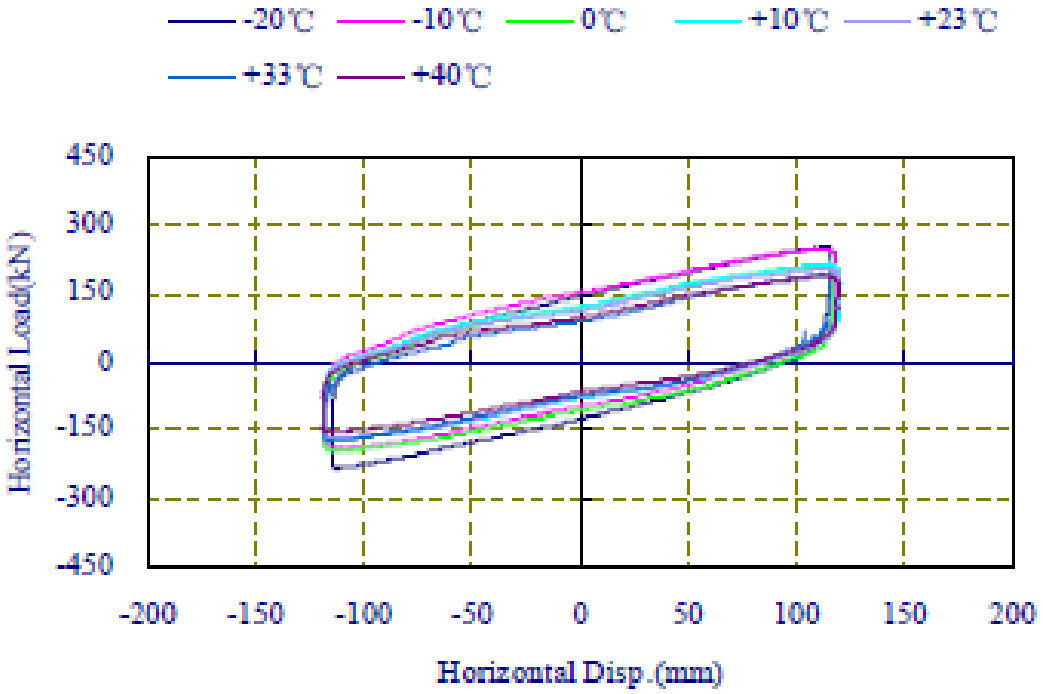




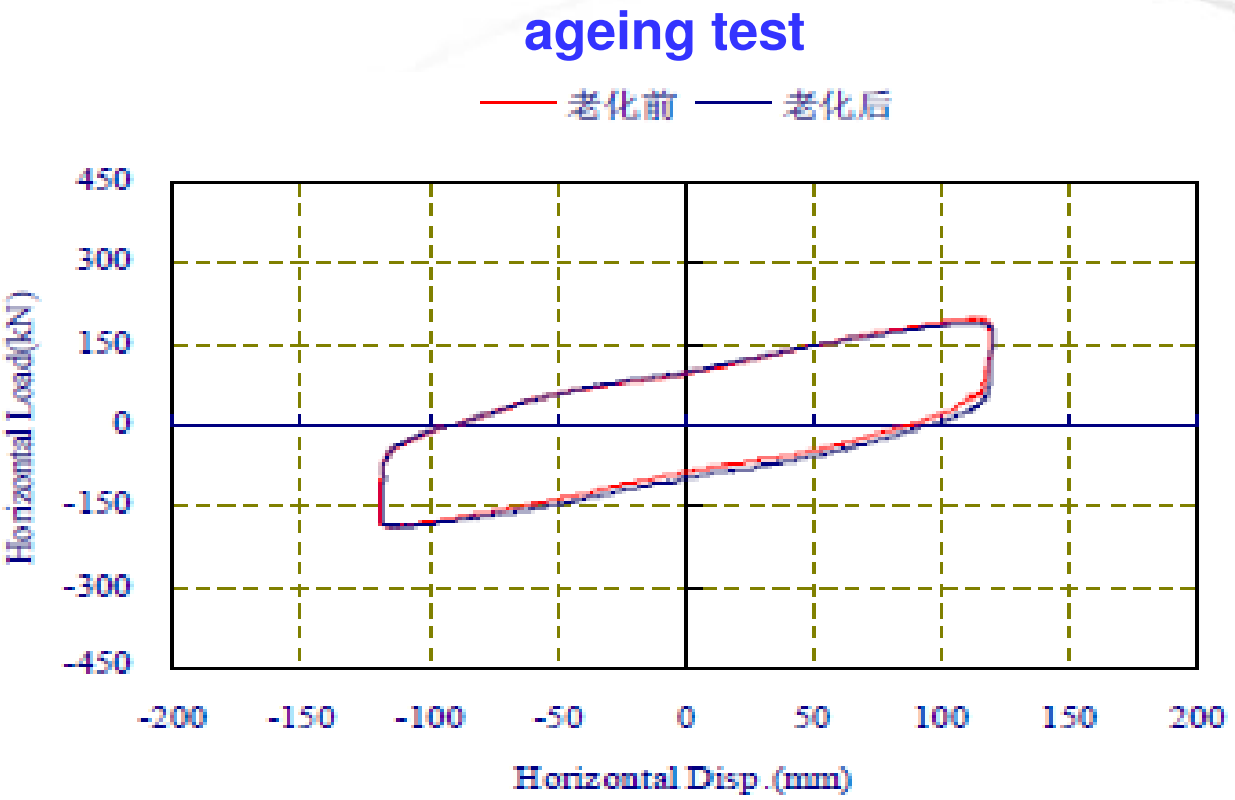


➢ Rubber bearing- Testing

temperature **dependency**

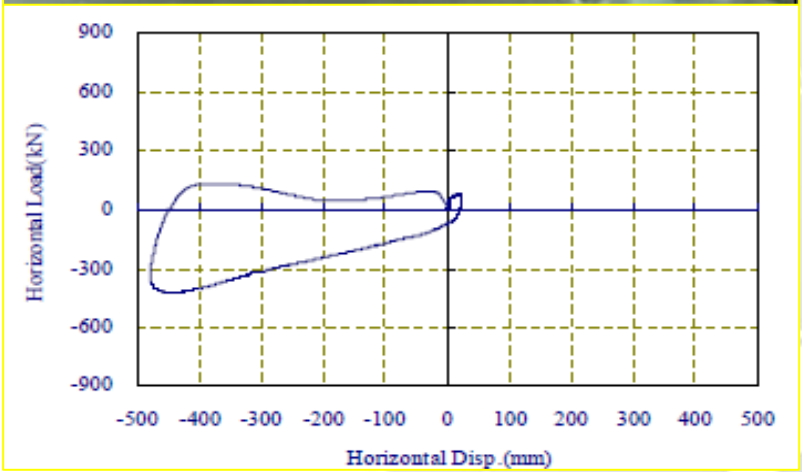


➢ Rubber bearing- Testing



➢ Rubber bearing- Testing

Ultimate shear property

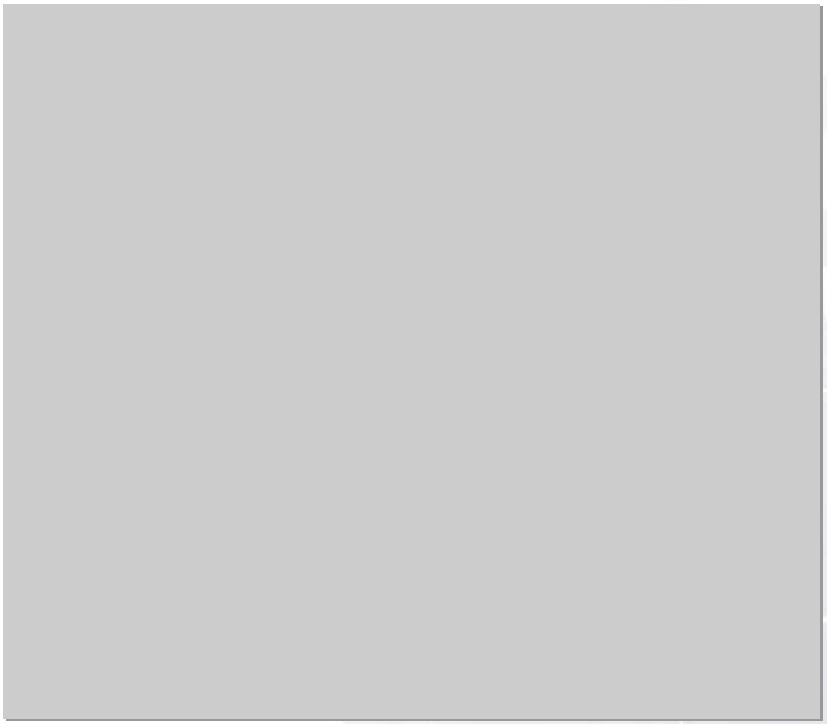


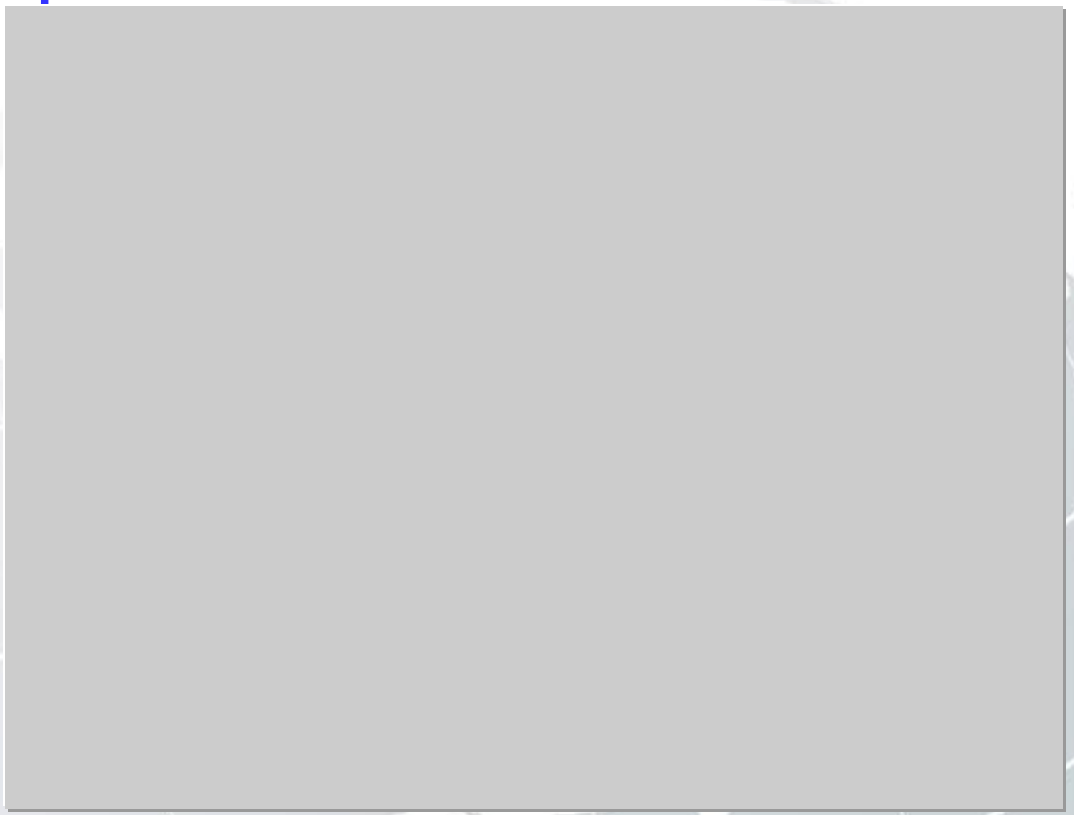
15Mpa，r> 400%

15MPa极限试验PC190084.MOV

➢ Rubber bearing- Testing

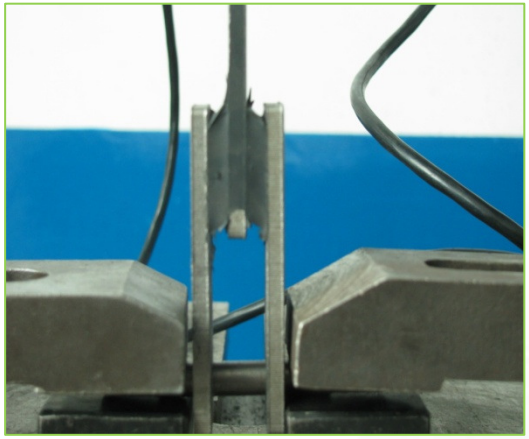
Creep test

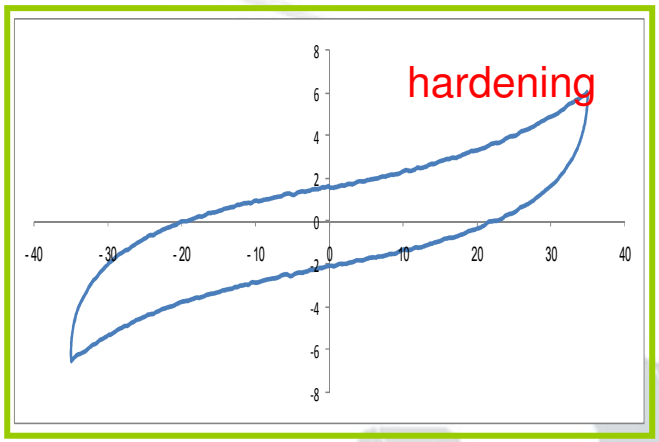




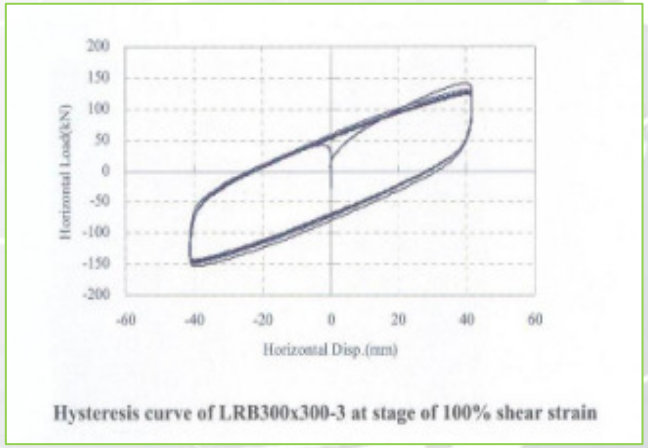
All test results show that the performance of this kind of rubber bearing is very stable and with excellent durability.

➢ Rubber bearing- Testing

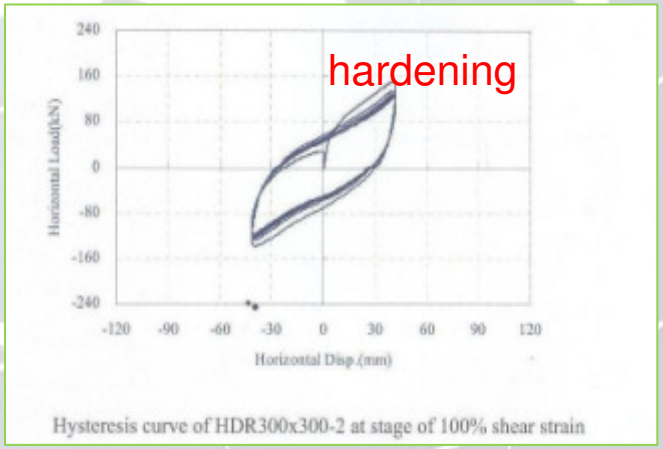




HDR VS NR



Hysteresis curve of LRB300x300-3 at stage of 100% shear strain

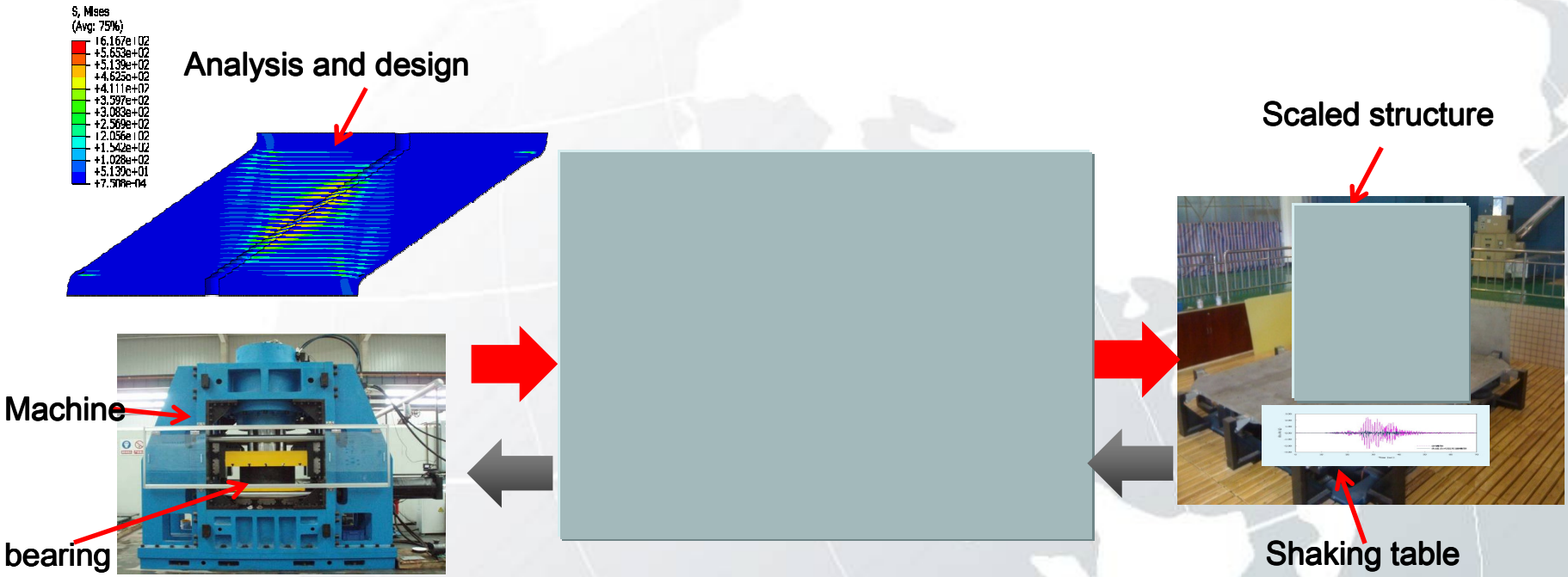


Hysteresis curve of HDR300x300-2 at stage of 100% shear strain

HDR VS LRB

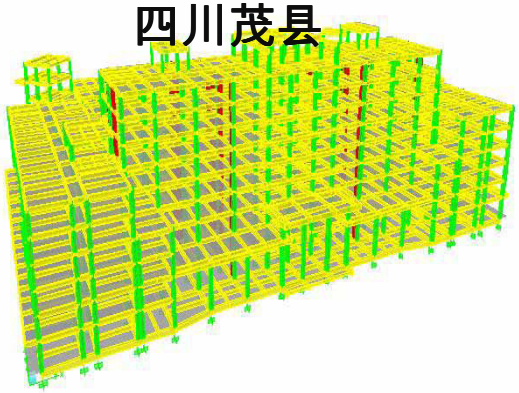
Part 2 R&A of Anti-seismic Device

From product design, test and performance evaluation, to design the seismic isolation buildings and modeling experiments, China have establish a complete design methods and processes.



- Rubber bearing- Some applications of TMT

四川茂县



The highest isolated building in china

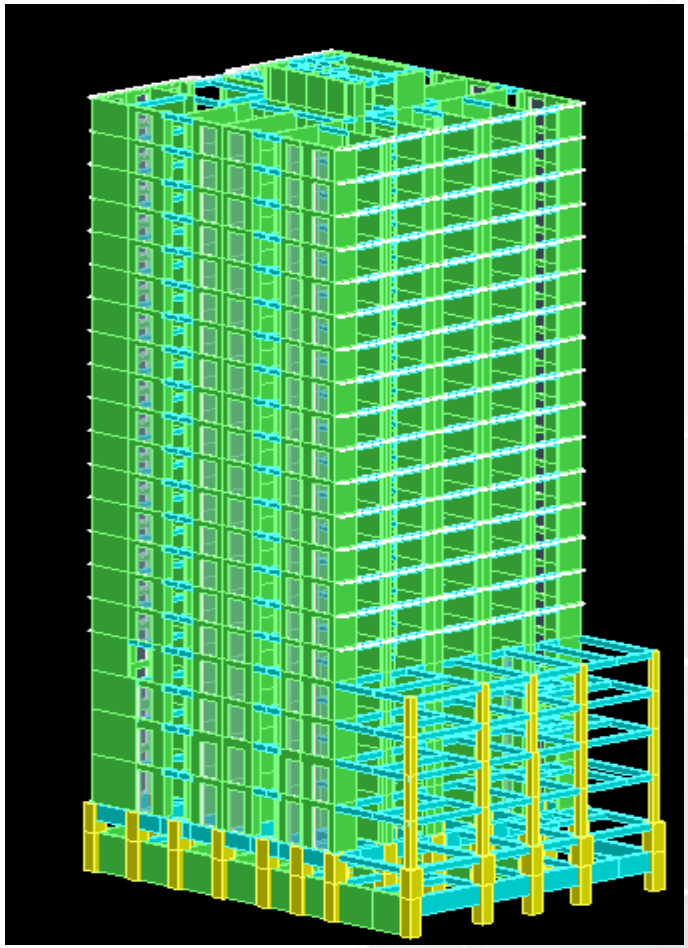
港珠澳大桥

The super project-HZM

Part 2 R&A of Anti-seismic Device

- Rubber bearing- Some applications of TMT

In 2011, designed by Prof.Zhou's team



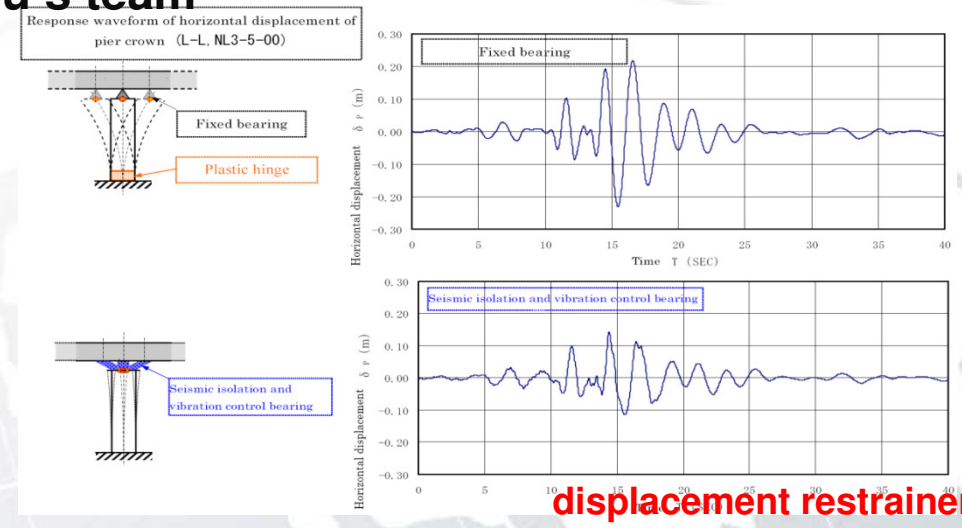
振型	非隔震结构			隔震结构		
	周期	质量参与系数（%）		周期	质量参与系数（%）	
		X 向	Y 向		X 向	Y 向
1	1.68	55	0	3.22	88	0
2	1.51	55	56	3.16	88	88
3	1.17	56	56	2.70	88	88
4	0.44	72	56	0.78	89	88
5	0.37	72	72	0.74	89	89
6	0.35	72	72	0.02	90	89
7	0.22	79	72	0.02	90	89
8	0.19	80	72	0.01	91	90
9	0.17	80	80	0.01	91	90

Height= 65m, Diam. of LRB=1.2m

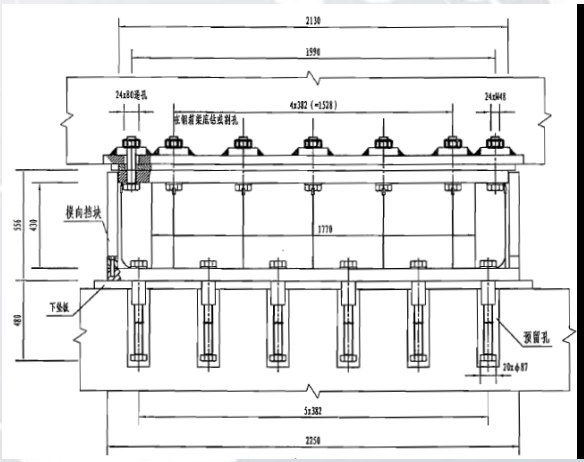
Part 2 R&A of Anti-seismic Device

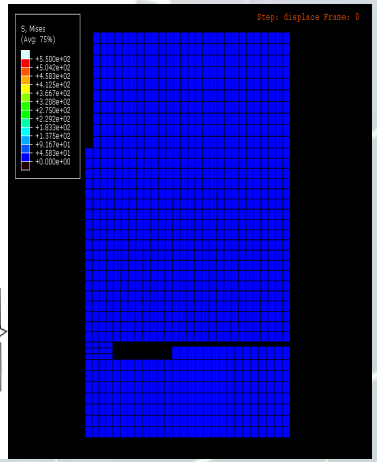
- Rubber bearing- Some applications of TMT

In 2010-2012, designed by Prof.Zhou's team



displacement restrainer

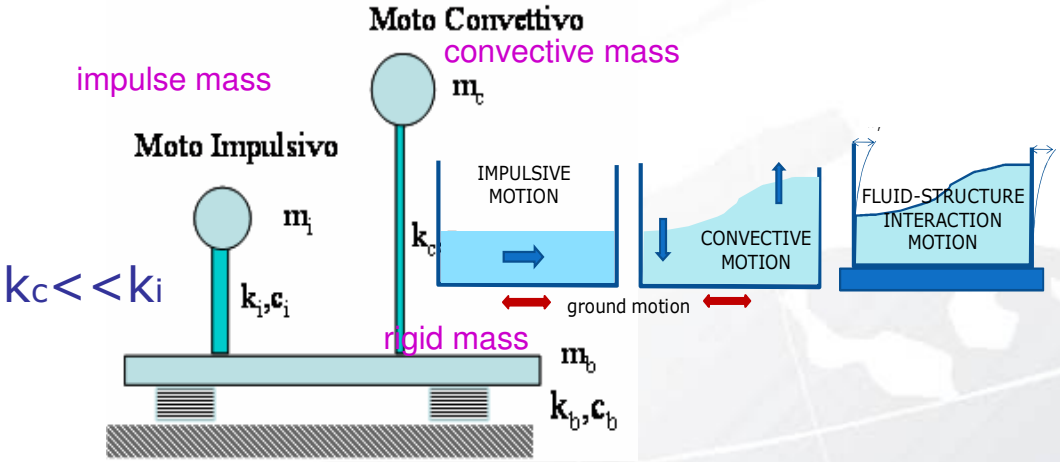




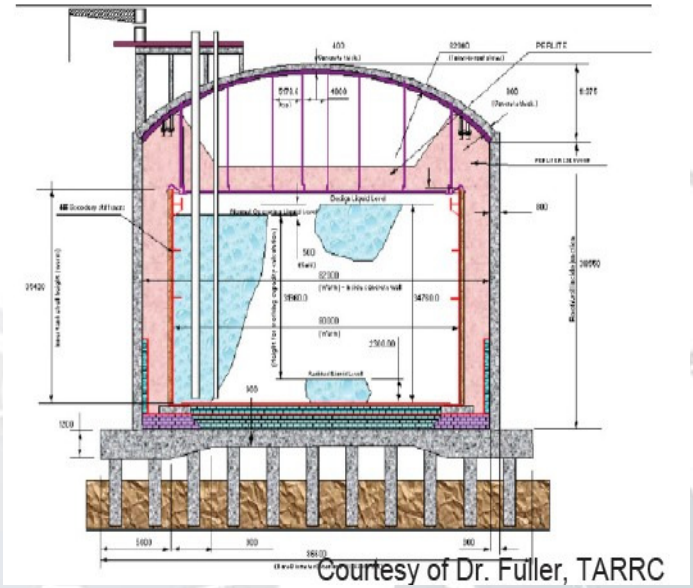
HongKong-Zhuhai-Macau Viaduct Bridges **Vert. Load=2750t, Diam. of HDR=1.77*1.77m**

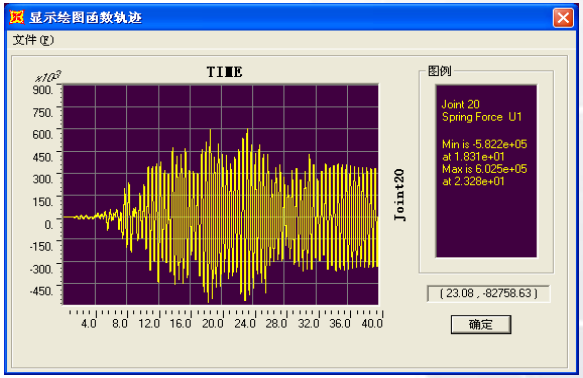
Part 2 R&A of Anti-seismic Device

➢ Rubber bearing- Some application of TMT

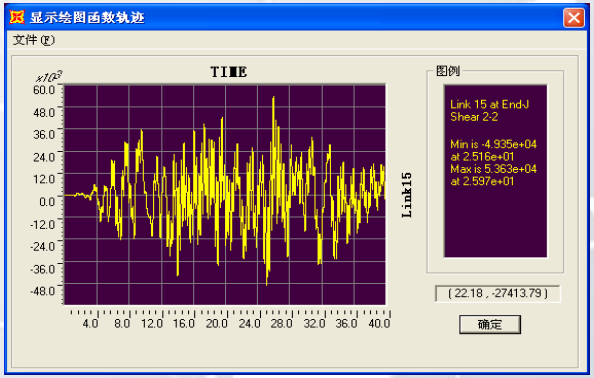


Model of LNG isolation system

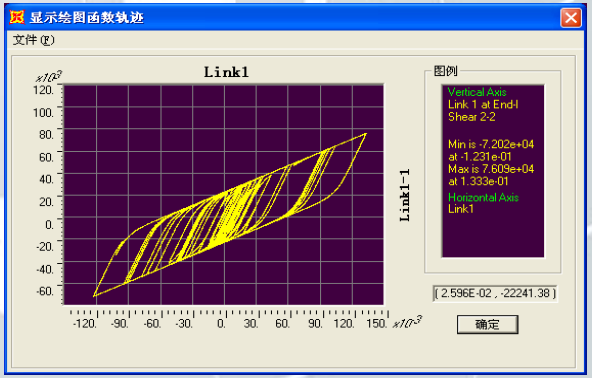




without isolation



isolation

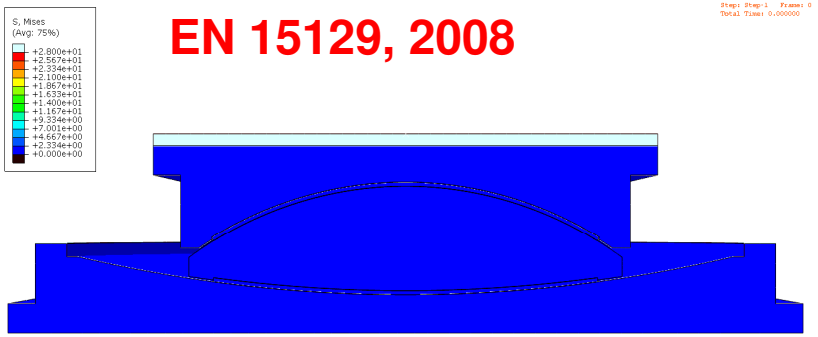


F-D curve

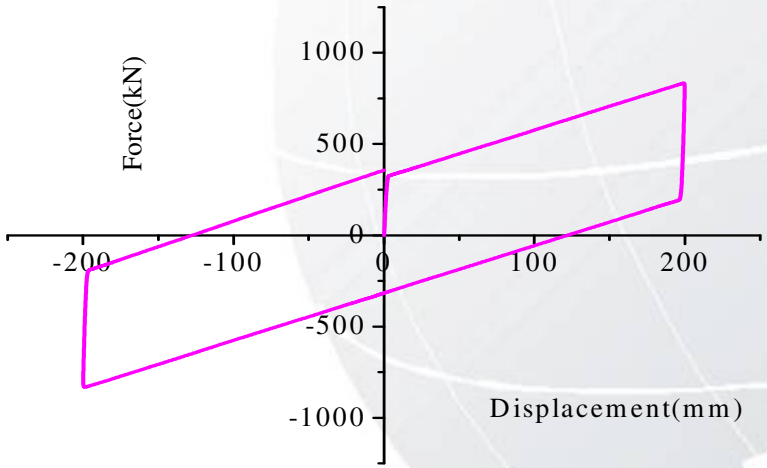
Base shear in SSE

➢ Friction pendulum bearing- structure and design

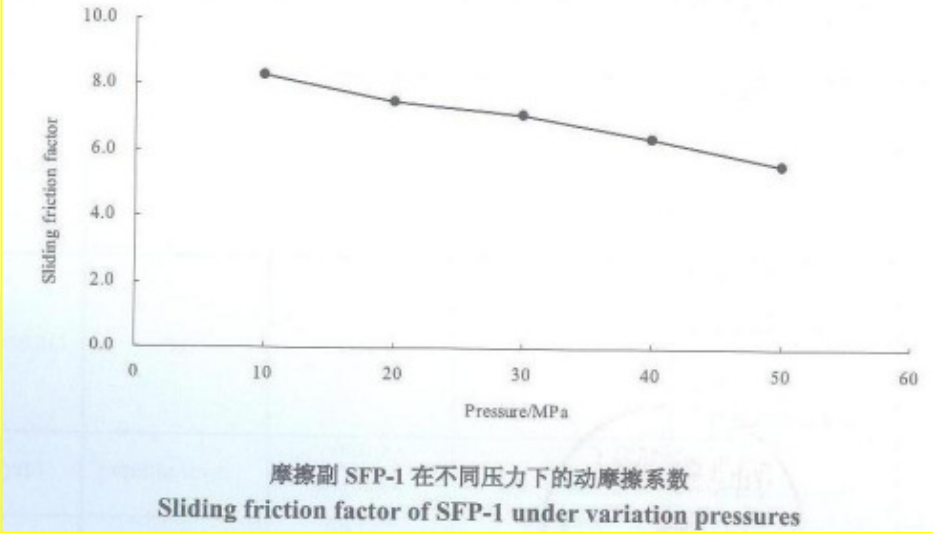
EN 15129, 2008



FPB支座运动过程应力云图2010-07-29.avi

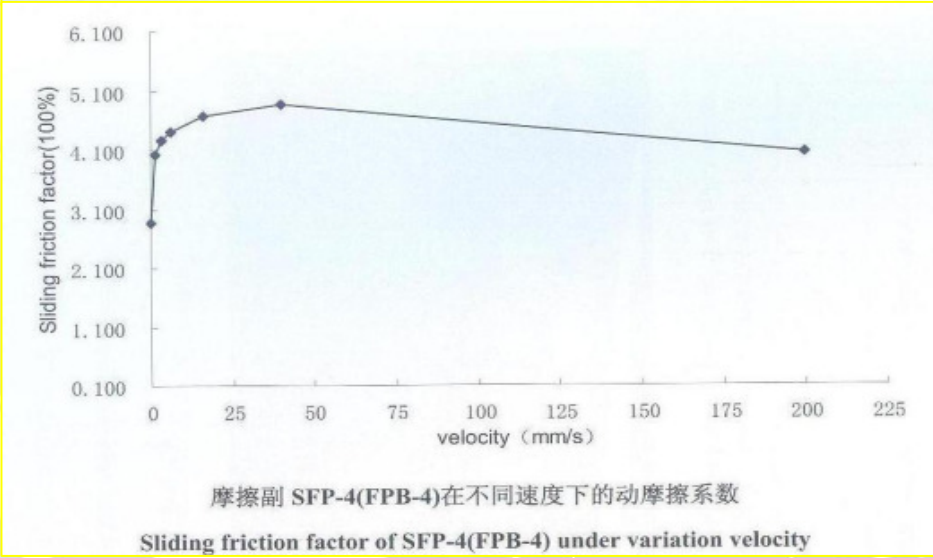


Fy=W*μ, K=W/(r1+r2-h)



摩擦副 SFP-1 在不同压力下的动摩擦系数

Sliding friction factor of SFP-1 under variation pressures



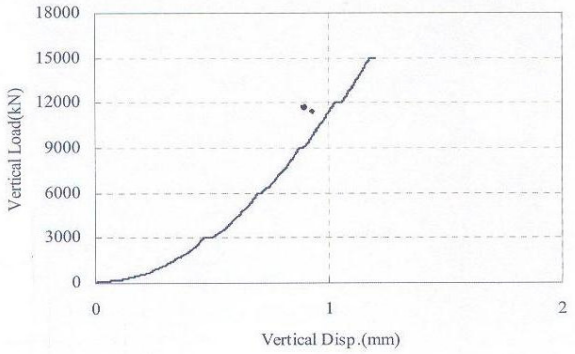
摩擦副 SFP-4(FPB-4)在不同速度下的动摩擦系数

Sliding friction factor of SFP-4(FPB-4) under variation velocity

➢ Friction pendulum bearing- testing

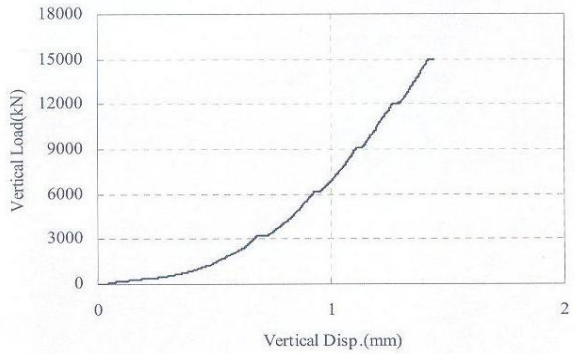
逐级加载试验照片

Testing photo about vertical load by steps (Date: 2012013



第 2 次试验力－变形关系曲线

Second time – the vertical load-displacement curve

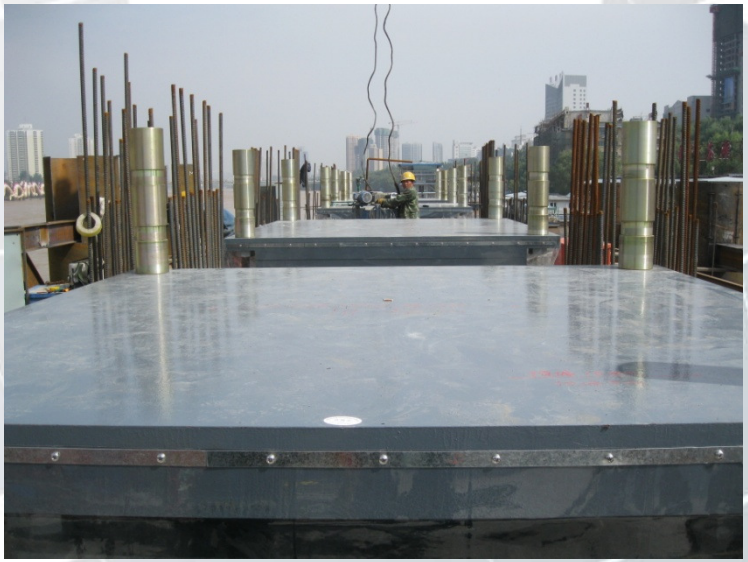


第 3 次试验力－变形关系曲线

Third time – the vertical load-displacement curve

- Friction pendulum bearing- Some applications of TMT

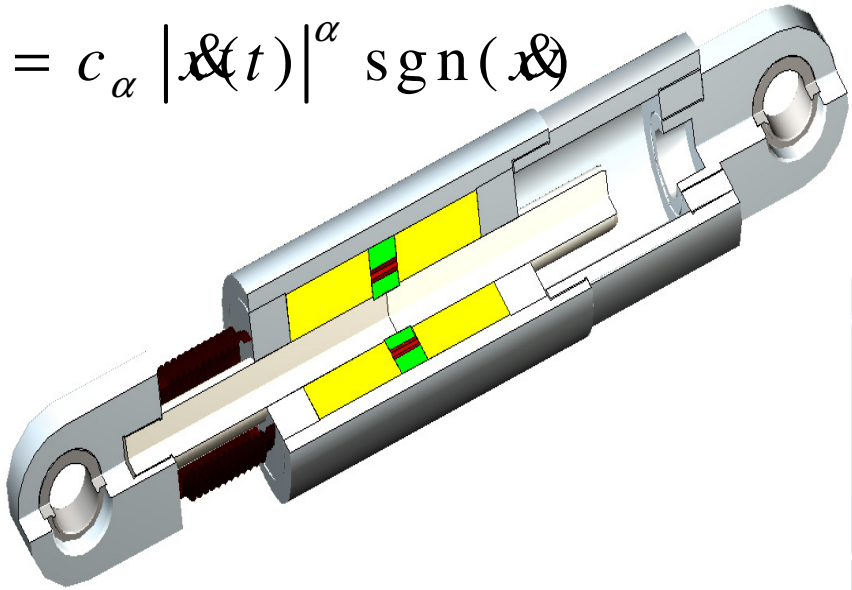
Vertical Load = 5500t

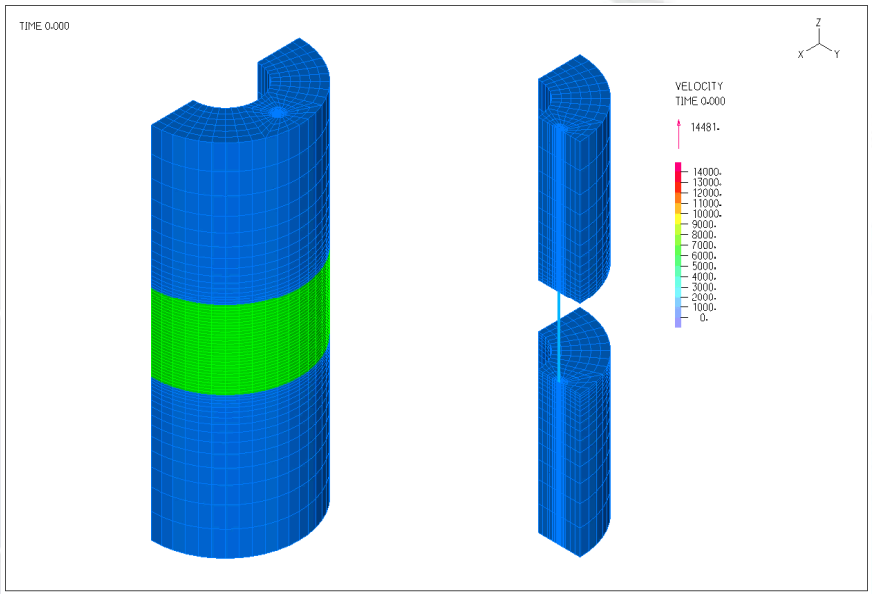


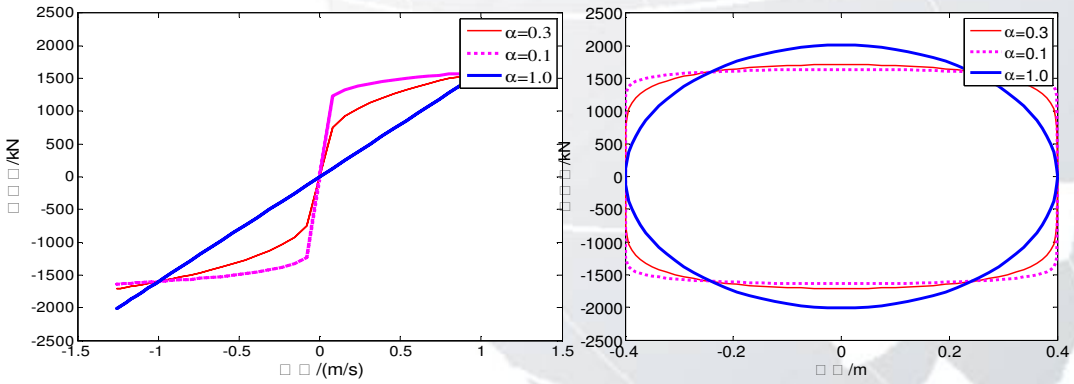
➢ Fluid Viscous Damper- structure and design

EN 15129, 2008

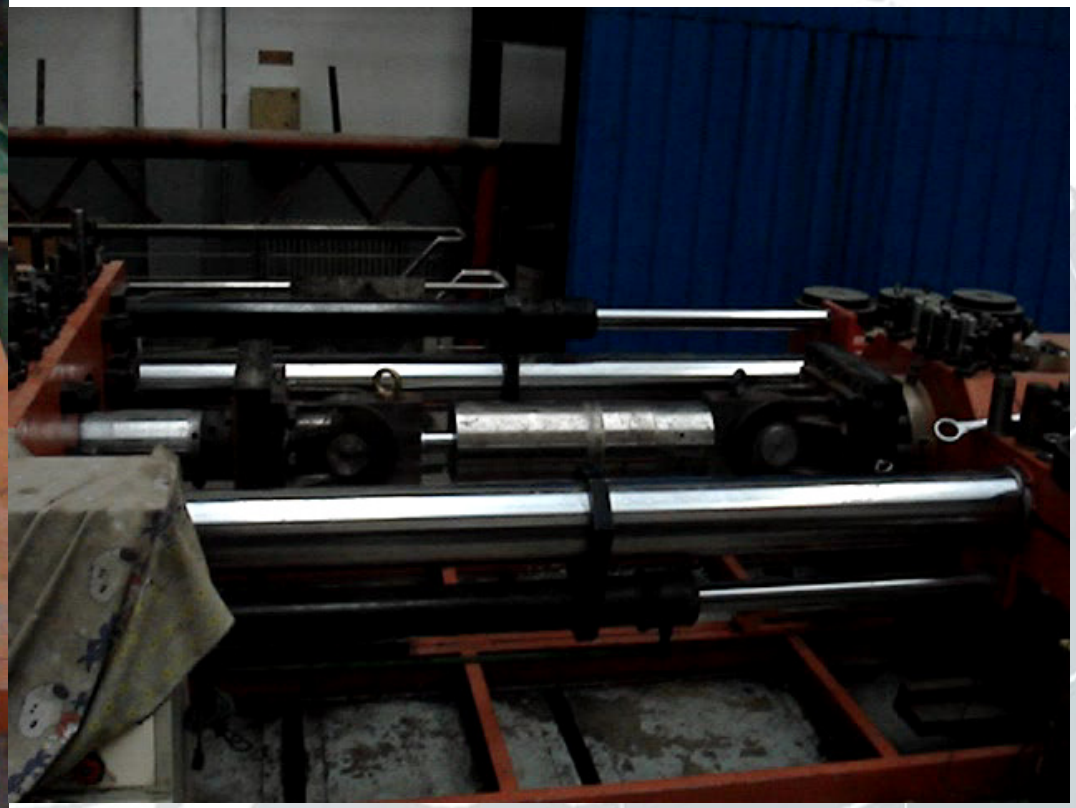
$$f(t) = c_\alpha \left|\dot{x}(t)\right|^\alpha \operatorname{sgn}(\dot{x})$$







➢ Fluid Viscous Damper- testing



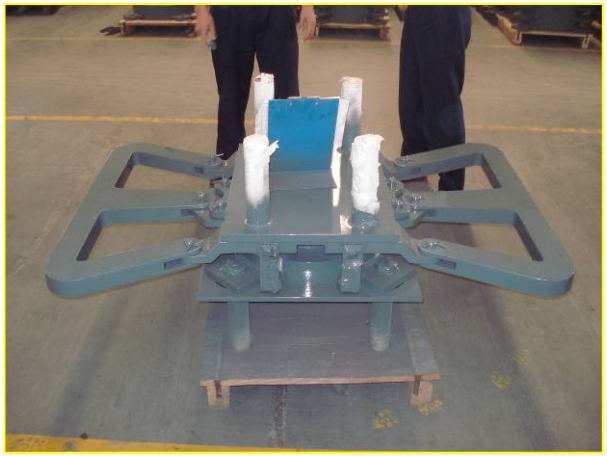
➢ Fluid Viscous Damper- Some applications of TMT

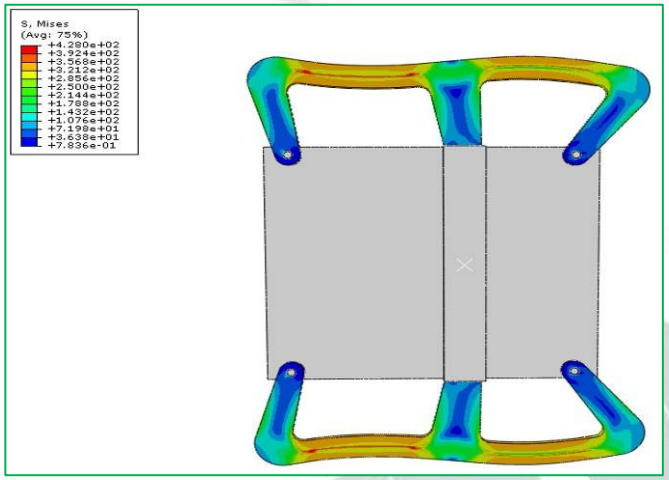
- 湘西矮寨大桥(S = ± 680mm)
- 宁波象山港公路大桥
- 郁江双线特大桥
- 北京密云高速
- 澧水大桥
- 凤凰三桥（F=350t）
- 钦江大桥
- 六冲河大桥

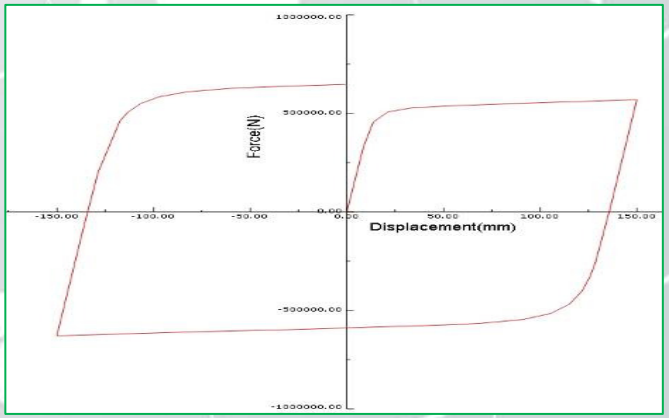
Maximum Force= 350t, Maximum Stroke = 680mm

Part 2 R&A of Anti-seismic Device

➢ Steel Damper- structure and design







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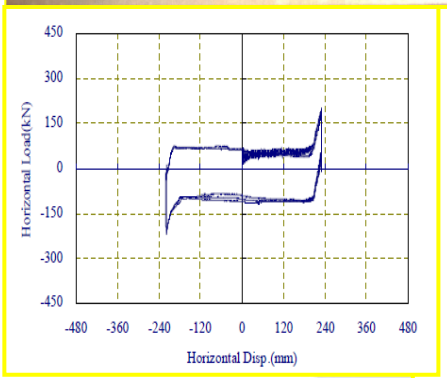
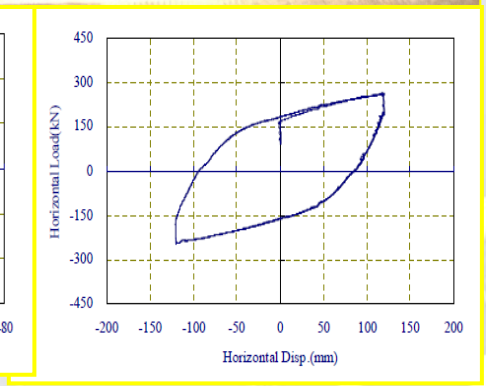
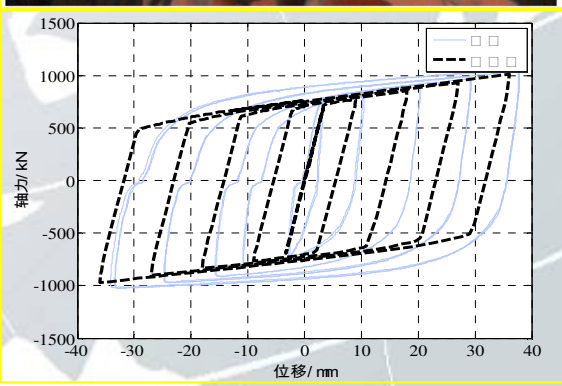
➢ Steel Damper- testing

Steel damper + bearing





BRB

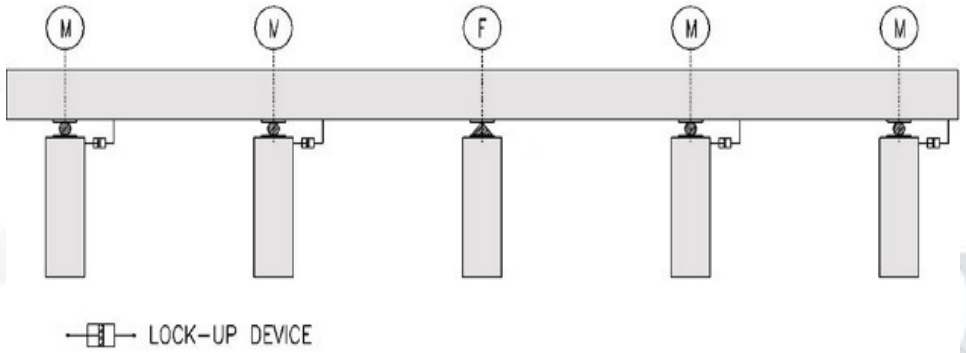


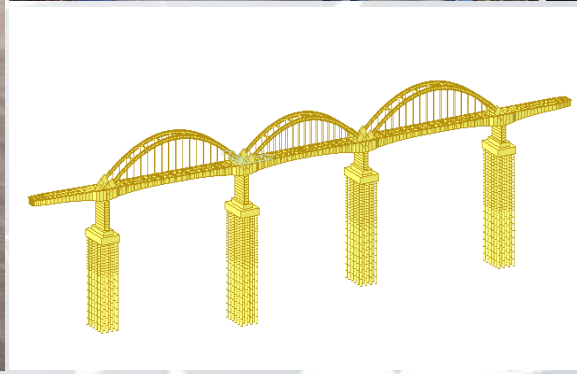
➢ Steel Damper- Some applications of TMT

- 内蒙古黄河大桥
- 鄂尔多斯罕台川大桥
- 南京夹江大桥
- 九龙江特大桥
- ….

Part 2 R&A of Anti-seismic Device

➢ Locked up devices

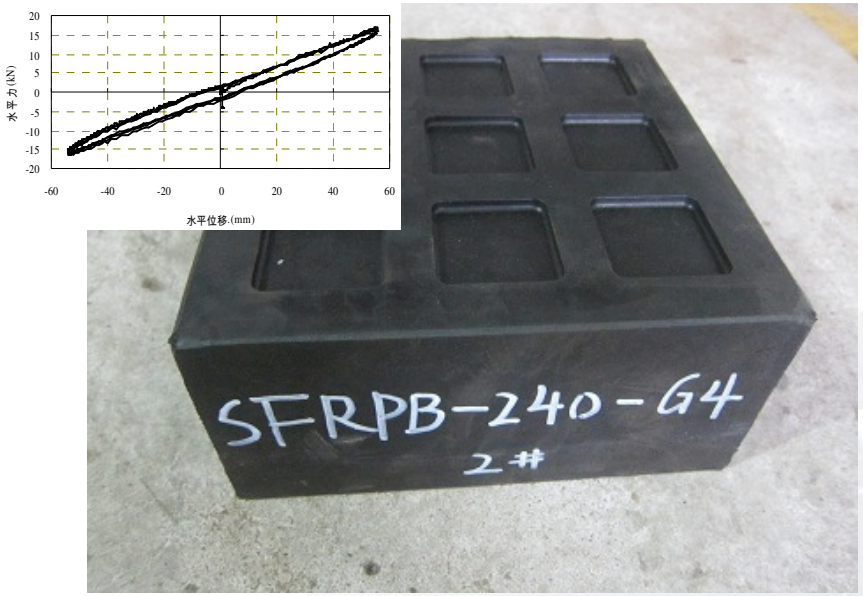




Maximum Force= 800t

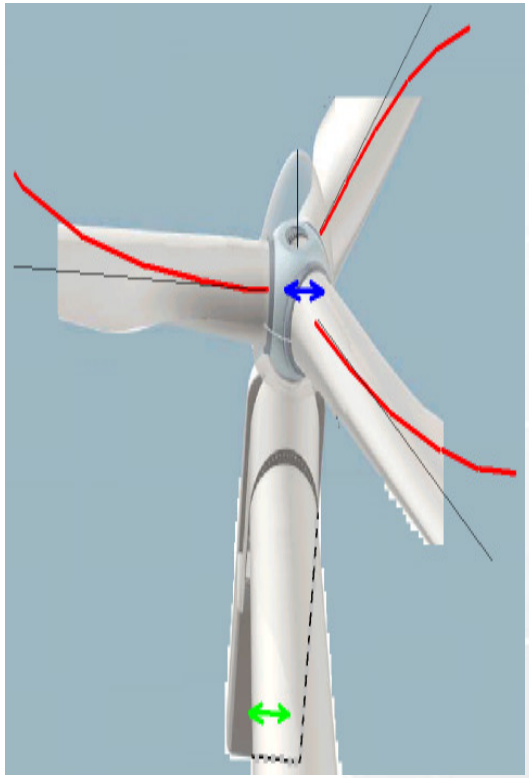
Part 3 Some other studies

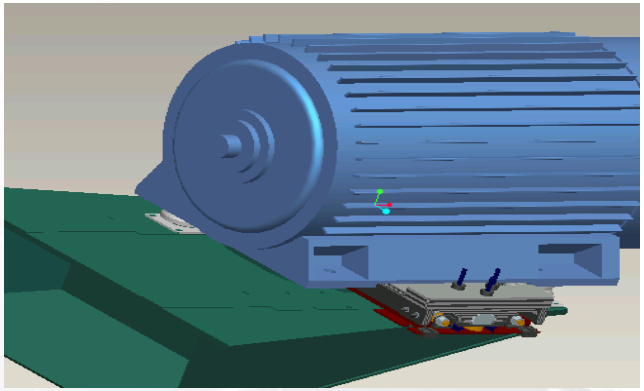
➢ FRP bearing

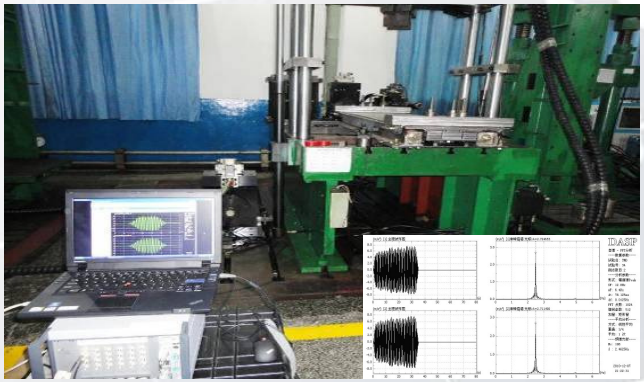


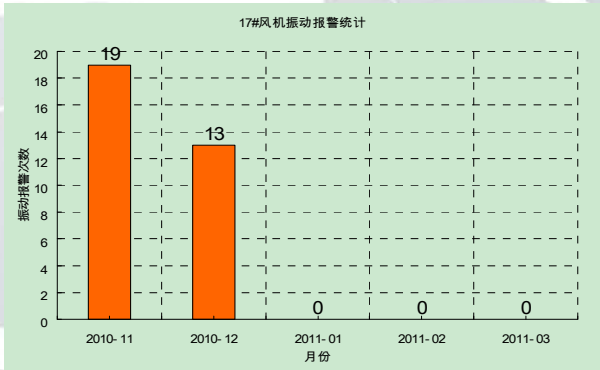
Part 3 Some other studies

➢ Tuned Mass damper



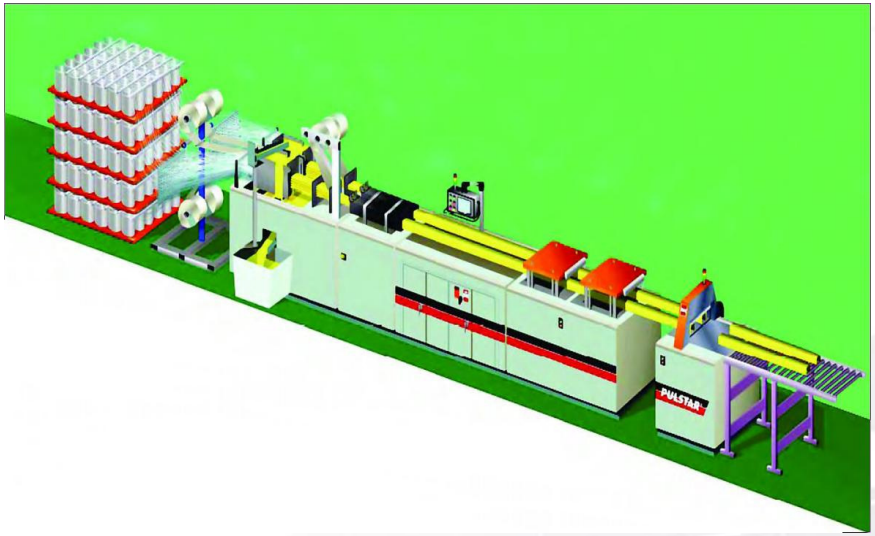


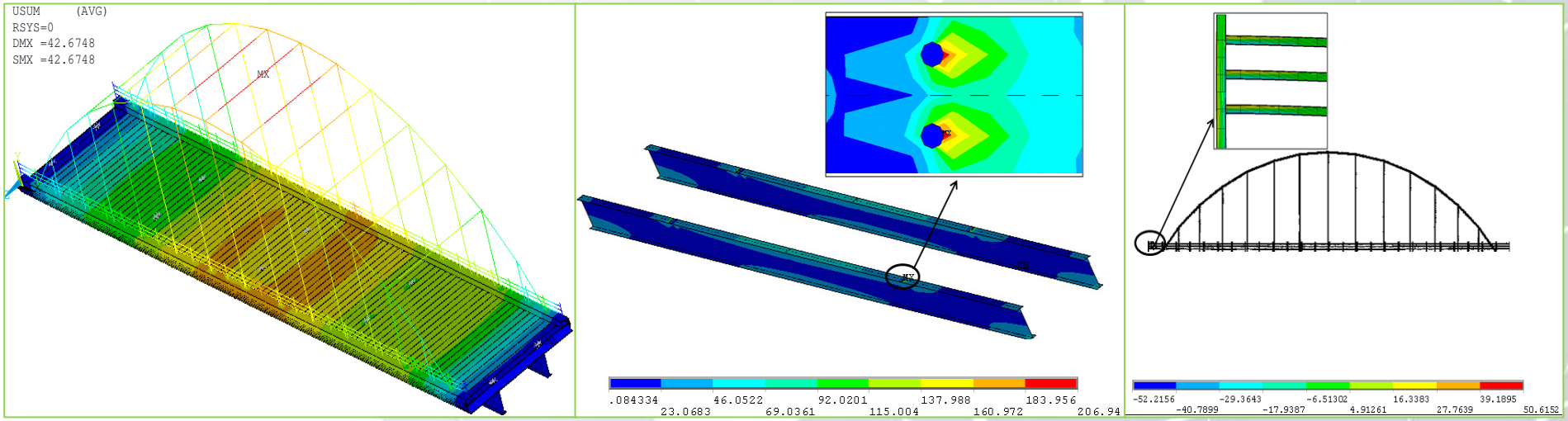




Part 3 Some other studies

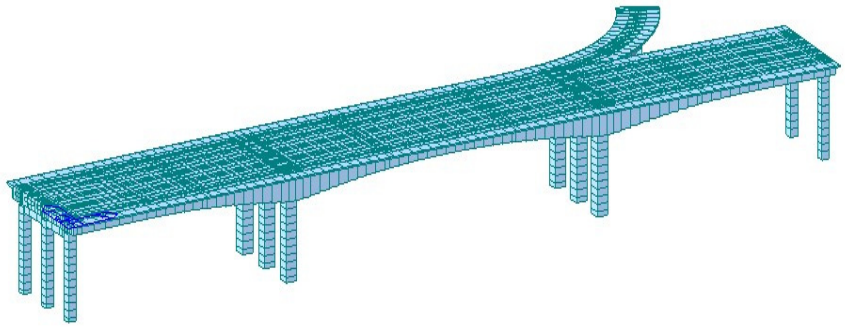
➢ FRP Bridge

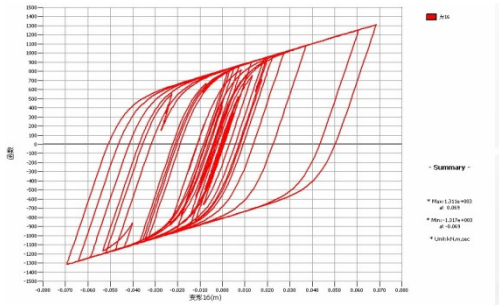


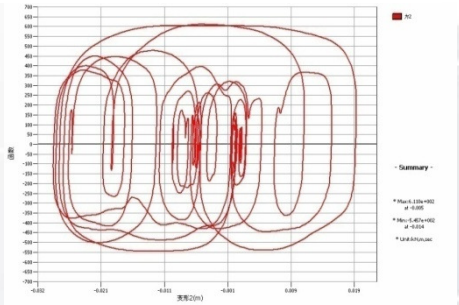


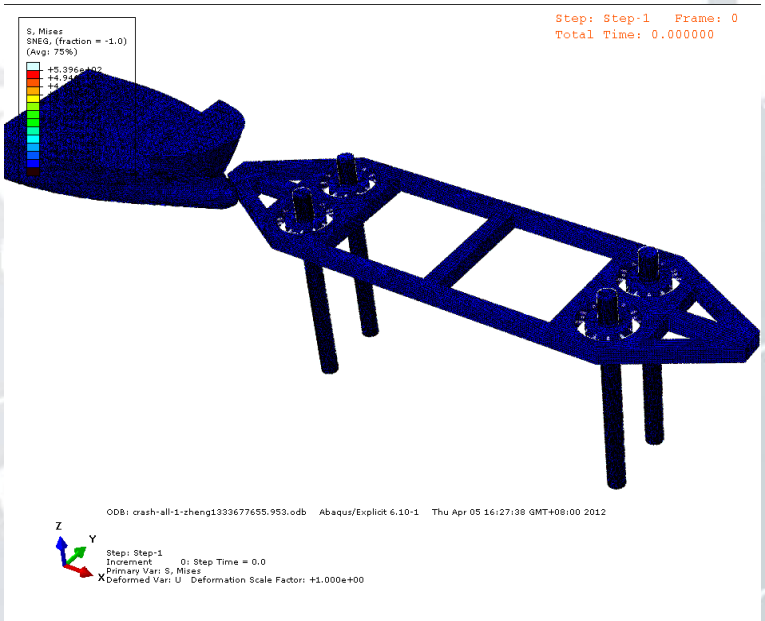
Part 3 Some other studies

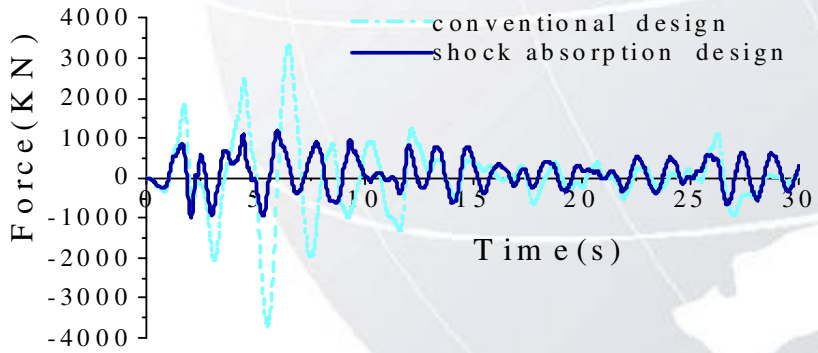
➢ Analysis and design











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