结构防灾减灾技术
structural disaster prevention and mitigation technology（earthquake, fire, explosion and wind）

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参考文献：References

- 江见鲸，《防灾减灾工程学》，机械工业出版社，2005
- 周云，《防灾减灾工程学》，中国建筑工业出版社，2007
- 陈龙珠等，《混凝土结构防灾技术》，化学工业出版社，2006
- 李宏男等，《结构防灾、监测与控制》，中国建筑工业出版社，2008
- 周福霖，《工程结构减震控制》，地震出版社，1997年
- 张相庭关于抗风方面的书籍，如《工程抗风设计计算手册》

Chapter 1 Introduction to the disasters

- Types of disaster
- Influence of Disasters on Human
- Measures and Strategy of Disaster Prevention and Mitigation
- Disasters Prevention and Mitigation in Civil Engineering

Chapter 1 Introduction

- **Types of disaster**
  - **Definition of disaster**

    由于自然的、人为的或人与自然综合的原因，发生的对人类生存和社会发展造成损害的现象

    Disaster is a natural or anthropogenic phenomena which negatively effect human survival and society development

Chapter 1 Introduction

- **Types of disaster**

自然灾害 Natural Disaster

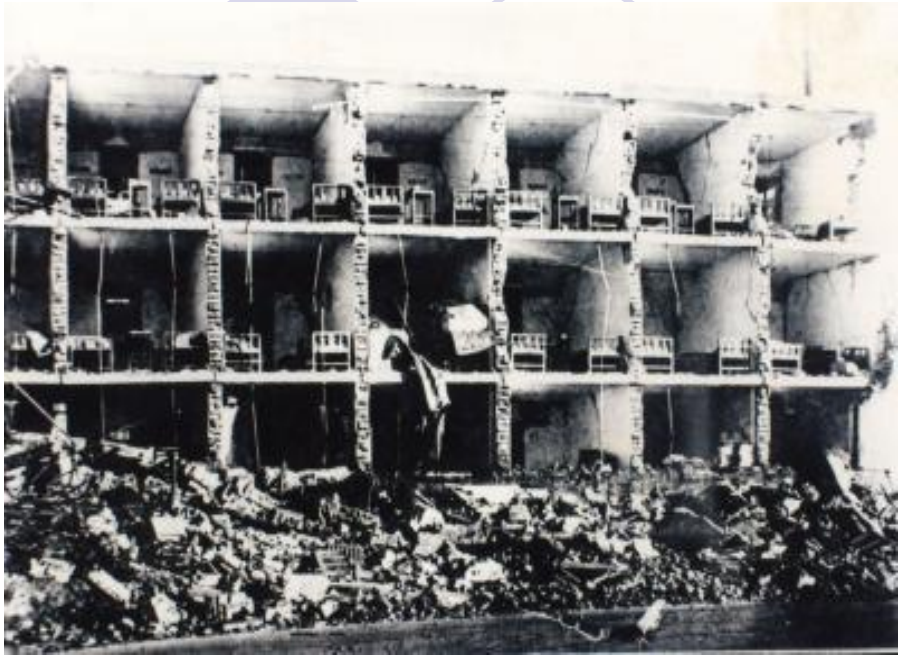
给人类生存和发展带来损害的自然现象

The natural phenomenon that threats survival and development of human

社会灾害 Social Disaster

人类社会内部由于**人的主观因素和社会行为失调或失控**产生的危害人类自身利益的社会现象

The social phenomenon which endangers the human self-interest because of subjective reasons, disorder or out of control of social behaviors.



1976年我国唐山发生里氏7.8级的地震不仅大量的房屋建筑倒塌毁坏而且造成24.2万人丧生

The M7.8 earthquake in Tangshan in 1976, caused 242 thousand death and the destruction of numerous buildings

1970年孟加拉国热带旋风造成30~50万人死亡

300 to 500 thousand people lost their lives because of tropical cyclone happened in 1970 , Bangladesh

1982年3月28日墨西哥埃尔奇琼火山喷发使得1700人遇难
The eruption of El Chichón Volcano in Mexico, 1982, caused 1700 casualties

1985年哥伦比亚火山爆发导致2.2万人遇难
The eruption of Nevado del Ruiz Volcano in Colombia in 1985 killed 22 thousand people

2008年汶川地震
2008 Wenchuan earthquake

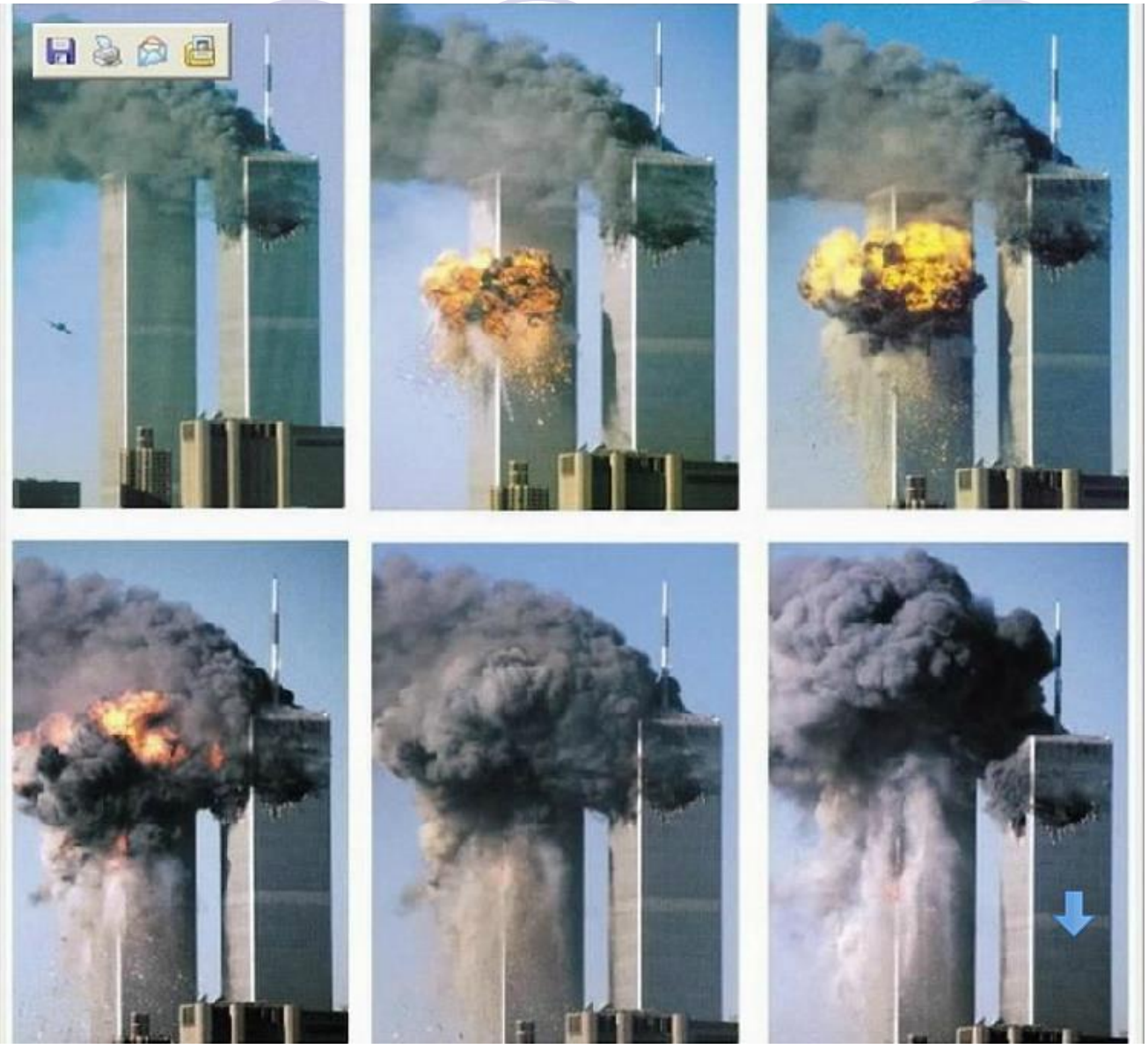
2010年玉树地震
2010 Yushu earthquake

2011年11月1日 贵州福泉爆炸，8死300多伤。附近公路的往来车辆，周围的检修厂，加油站，粮库，民居受到严重影响。

The explosion in Fuquan on 1st November, 2011 casued 8 deaths, over 300 injuries, and heavy impact on nearby vehicles, repair factury, gas station and granary, which severely hampered the life of residents.

天津滨海区爆炸
the explosion in Binhai District, Tianjin in 2015

- 死亡人数161人，失联者12人,住院治疗者268人.
- 161 deaths including 23 fire policemen, 73 Tianjin Harbor firemen, 11 policemen, and 54 others. 12 people were reported missing and 268 were in hospital.



9.11事件
September 11 attacks in 2001 at the world trade center

2010.11.15，上海静安区余姚路胶州路 一高层住宅发生火灾，58人遇难

Nov 15th 2010, Yuyai Road, Jingan District Shanghai，A High rise building caught in fire causing 58 deaths

- 2011.11.4，河南义马矿难，冲击地压事故。冲击地压，又称岩爆，这是一种岩体中聚积的弹性变形势能在一定条件下的突然猛烈释放，导致岩石爆裂并弹射出来的现象.
- On November 4th 2011, a pressure bump accident occurred Thursday at the Henan Yima Coal Mine Group's Qianqiu facility. Pressure bump is a natural phenomenon that the elastic deformation energy in rock mass is accumulated to extent and bursts.

- 2011.11.10，云南师宗县私庄煤矿发生一起**煤与瓦斯突出**事故，致34人遇难 (煤与瓦斯突出是指在压力作用下，破碎的煤与瓦斯由煤体内突然向采掘空间大量喷出，是另一种类型的瓦斯特殊涌出的现象)。
- The mine in the southwestern province of Yunnan was hit by a "coal and gas outburst" — a sudden and violent ejection of coal, gas and rock from a coal face. 34 workers were killed.

灾害类型 Types of Disaster

- 灾害形成机制：自然灾害和人为灾害
  - By the causes of disaster: natural disaster and human-instigated disaster(man-made disasters)

- 灾害发生过程：原生灾害和次生灾害
  - By the sequence of occurrence of disaster: primary disaster and secondary disaster

灾害类型 Types of Disaster

- 过程特征：
  - By the process characteristics
  - 突变型　地震，火山爆发，泥石流
  - Rapid-onset disasters: earthquake, volcanic eruption, debris flow
  - 发展型　暴雨，台风
  - Developing disasters: rainstorm, hurricane
  - 持续型　旱灾，涝灾，传染病
  - Slow-onset disasters: drought, flood, plague
  - 环境演变型　沙漠化，水土流失，气候变暖
  - Environment evolution: desertification, soil erosion, global warming

灾害的分级 the classification of Disasters

- 巨灾：死亡1万人以上；经济损失1亿人民币
- Huge disaster: over 10,000 death and economic losses over 100 million yuan
- 大灾：死亡1000-10000人；经济损失1000万-1亿
- Large disaster : 1000 to 10000 deaths, and economic losses 10 million to 100 million yuan
- 中灾：死亡100-1000人；经济损失100万-1000万
- Medium disaster : 100 to 1000 deaths, and economic losses 1 million to 10 million yuan
- 小灾：死亡10-100人；经济损失10万-100万
- Small disaster : 100 to 1000 deaths, and economic losses 10 thousand to 100 thousand yuan
- 微灾：死亡10人以内；经济损失10万
- Tiny disaster : below10 deaths and economic losses below 100 thousand yuan

Chapter 1 Introduction

- **灾害对人类的影响 Impact of disaster on human**
  - 危及人类生命，威胁人类正常生活
  - Endangers human lives, threaten human's normal life
  - 破坏基础设施，造成严重经济损失
  - Damage infrastructures, cause severe economy loss
  - 破坏资源和环境，威胁国民经济的可持续发展
  - Negatively impact on resources and environment, threaten the sustainable development of national economy

Chapter 1 Introduction

- 防灾减灾对策与措施 measures and strategy of Disaster prevention and mitigation
  - 防灾减灾系统工程(system engineering)
    - 1.灾害监测：监测与自然灾害有关的数据
    - Disaster monitoring: monitoring the relevant data on natural disaster
    - 2.灾害预报：根据灾害的周期性，重复性灾害间的相关性等对未来灾害发生的可能性进行估计判断。
    - Disaster forecasting: assessing the possibility of incoming disasters based on the periodicity of disaster and the connection between repetitive disasters

Chapter 1 Introduction

- 防灾减灾系统工程 (system engineering)
  - 3.防灾：在灾害发生前采取避难性措施
  - Disaster prevention: Taking refugee measures before disaster occurs
    - 规划性防灾、工程性防灾、技术性防灾、转移性防灾、非工程性防灾
    - Planning prevention, engineering prevention, technical prevention, transferring prevention and no-engineering prevention

Chapter 1 Introduction

- 防灾减灾系统工程 (system engineering)
  - 4. 抗灾：人类面对灾害的挑战作出的反应。disaster resistance: human reaction to disaster
  - 5. 救灾：灾害开始后采取的最紧迫的减灾措施。Disaster relief: the most imperative measures to be taken after a disaster happens
  - 6. 灾后重建和恢复生产 post-disaster rebuilding and resuming production
- 防灾减灾指导方针和原则 The principle for Disaster prevention and mitigation
  - “以防为主，防抗救相结合”
  - Disaster prevention is the primary measure combining with resistance and relief.

Chapter 1 Introduction

- **土木工程防灾减灾 Disaster prevention and mitigation in civil engineering**
  - 灾害造成了人员伤亡和财产损失，主要是土木工程基础设施破坏以及由此引起的次生灾害所致。The loss of life and property is mainly caused by the destruction of infrastructures and the corresponding secondary disaster
  - 土木工程在防灾减灾工程中起着至关重要的作用，具有不可替代性。 Civil Engineering plays a critical role in disaster prevention and mitigation, which is indispensable.

土木工程抗灾减灾与各种灾害之间的关系 the contribution of civil engineering to mitigation of various disasters

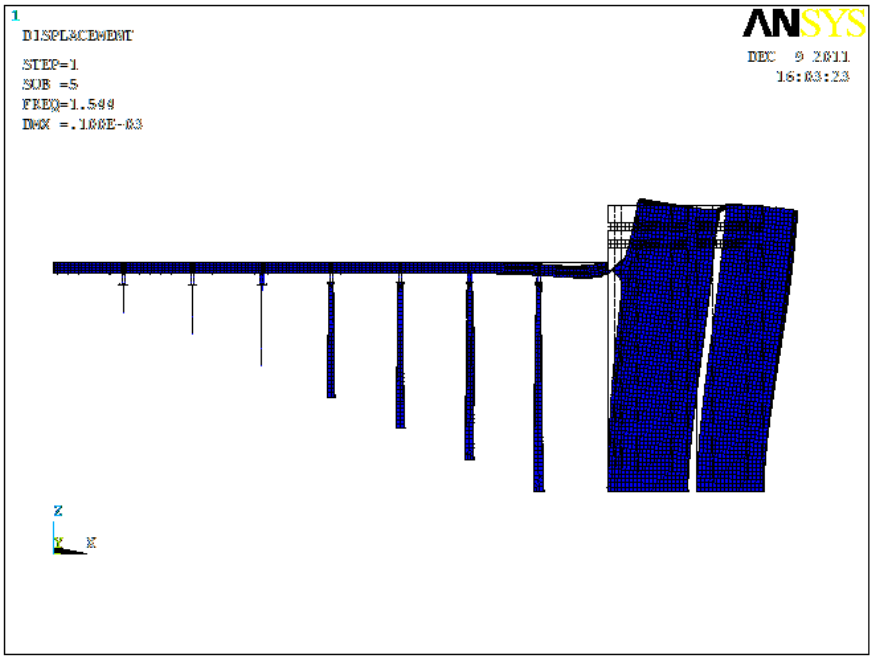
- 地震：提高烈度，工程抗震、隔震减震等措施
- Earthquake: increasing seismic intensity, taking some earthquake-resistant, vibration-isolation and energy-absorbing measures.
- 洪水：防洪，泄洪
- Flood: flood protection and discharge
- 滑坡，泥石流：锚索加固，挡土结构
- Landslide and debris flow: anchor reinforcement, retaining structures
- 核泄露：安全壳
- Nuclear Leakage: safe bunkers

土木工程抗灾减灾与各种灾害之间的关系 the contribution of civil engineering to mitigation when facing various disasters

- 战争：人防工程
- Warfare: civil defense projects
- 火灾，爆炸：建筑结构防火，防爆墙
- Fire and explosion: fire-proof structures, blast wall
- 旱灾：渠灌引水（南水北调，东水西调工程，渡槽，渠道等）
- Drought: South–North Water Transfer Project, East–West Water Transfer Project, aqueduct, channel,
- 海啸飓风：防波坝等，结构抗风
- Tsunami and hurricane: breakwaters, hurricane-proof building

土木工程防灾减灾的主要内容 Main content of disaster prevention and mitigation in civil engineering

- 土建工程防灾规划
  Disaster prevention planning for civil engineering
- 土木工程结构抗灾理论
  structural anti-disaster theory
- 土木工程结构防灾，抗灾技术理论及其应用
  the theories and applications of disaster prevention and mitigation
- 土木工程减灾技术
  disaster mitigation technology in civil engineering
- 结构灾后检测与加固
  post-disaster structural testing and strengthening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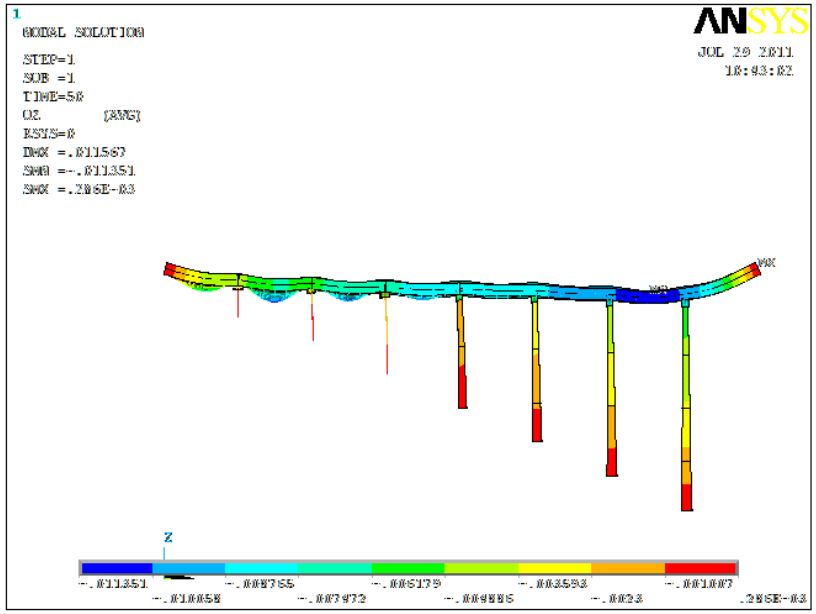
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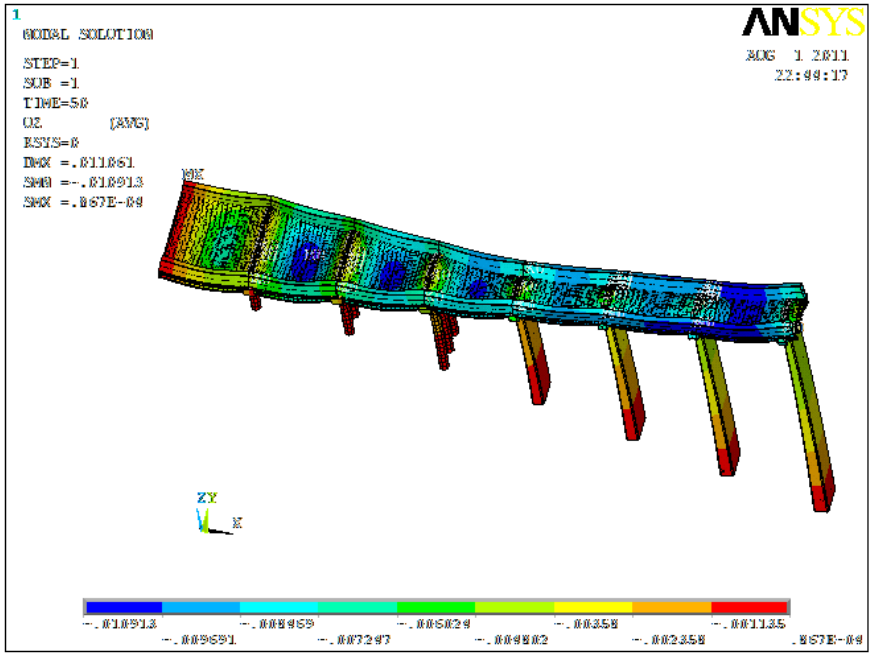
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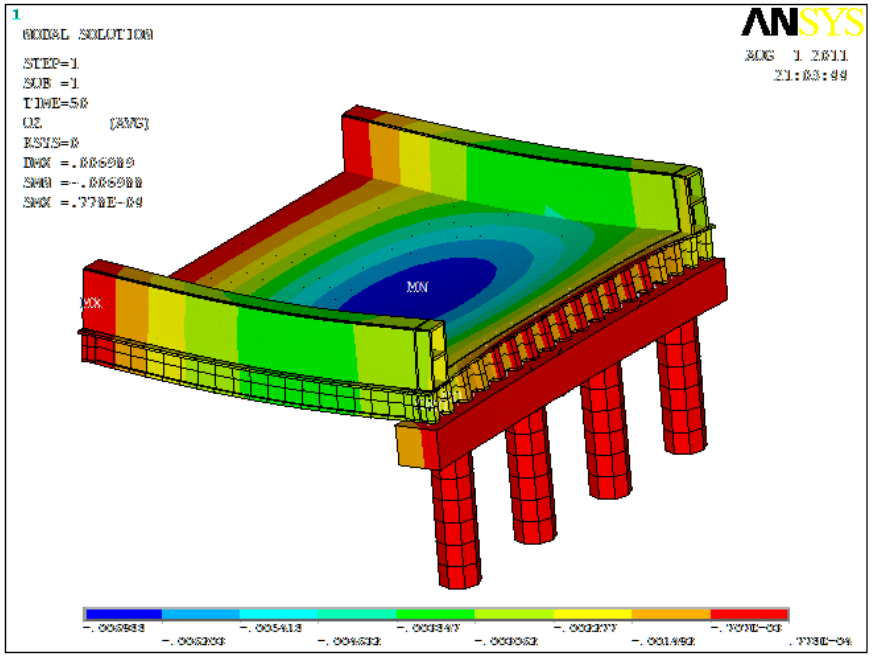
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