SAFETY IN CONSTRUCTION OF MAJOR PROJECTS

"If there is *no* risk there is *no* opportunity"

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2 Themes

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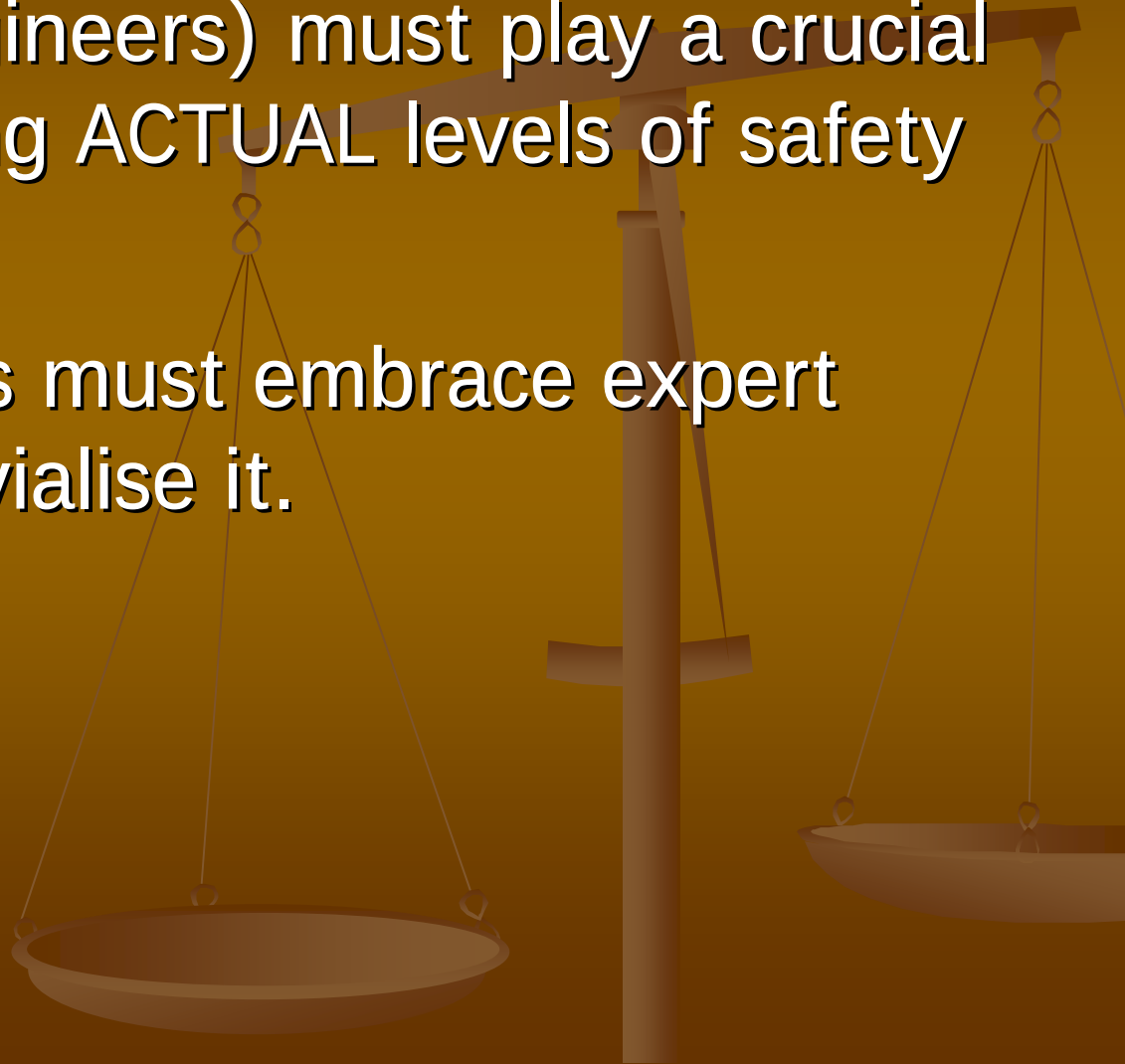
- Experts (eg Engineers) must play a crucial role in optimising ACTUAL levels of safety
- Decision makers must embrace expert advice – not trivialise it.



5 Propositions

- Underground Construction has high levels of construction risk
- Engineers and other actual risk “experts” can play a key role in managing risks to maximise opportunities.
- Clever contracts usually apportion liability – do not change *actual* risks
- Sophisticated risk management practices are no substitute for including professional technical advice from engineers and other experts.
- If things go “wrong” an inquiry will be conducted to identify those organizations and engineers whom have not acted professionally.

Example : Underground Construction?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oost

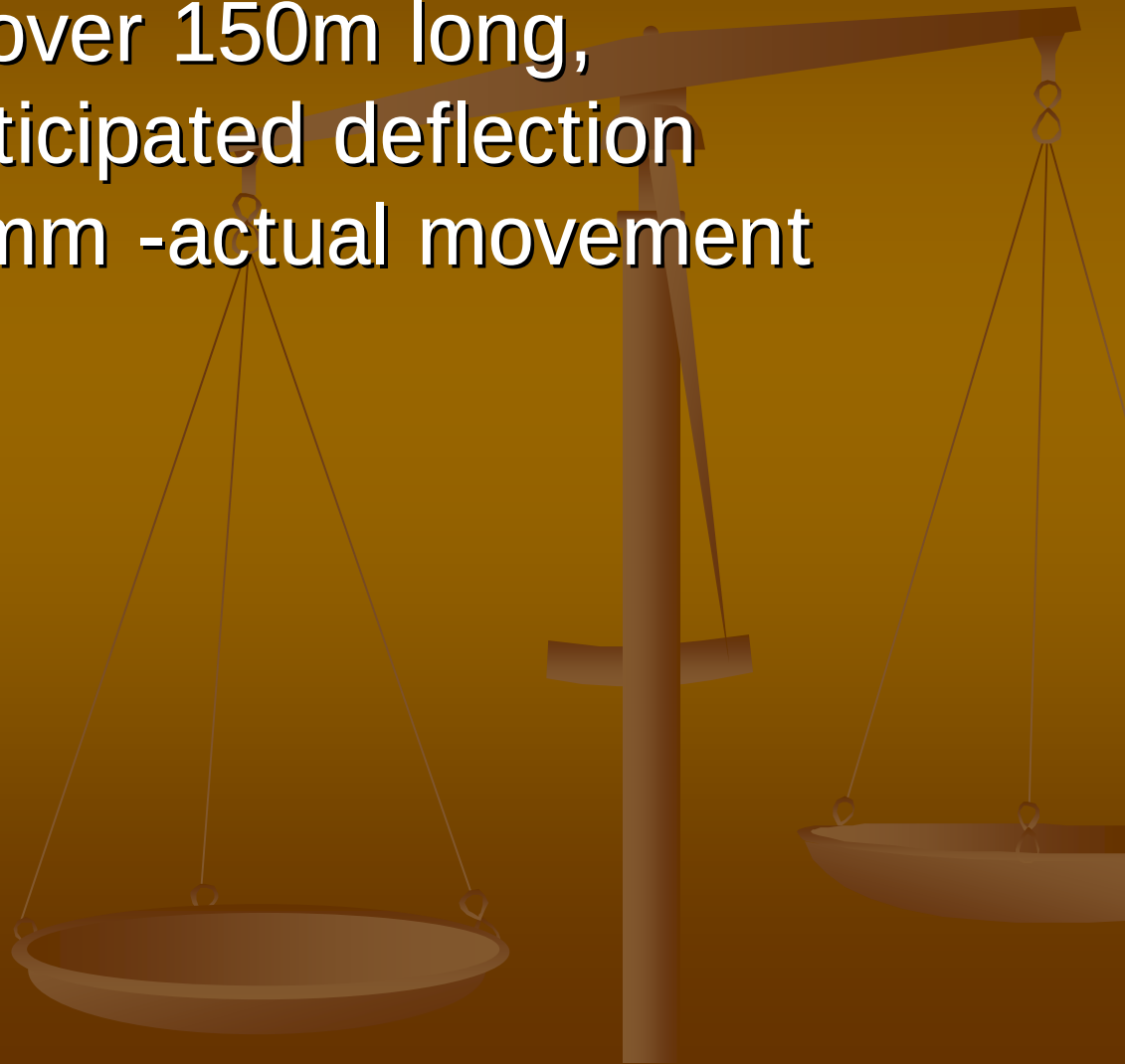
Singapore Collapse

- The MRT Circle line project consists of 33.6 km's of new works scheduled for completion in 2009 at a cost of US$ 3.9 Billion.
- The section which collapsed was part of a stations and tunnel contract worth US$161 Million

- Singapore
  - Expert Joint venture group
  - Expert Government Agency
  - Independent panel of experts {for technical dispute resolution and advice}.

-225 Days until collapse

- Vertical Cracks over 150m long, Settlement. Anticipated deflection movement 190mm -actual movement 500mm



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- *“We are taking a serious look at the temporary works …. It seems that the design has been stretched to the limit. … Many instruments have breached design – allowable values. The situation is beginning to look precarious.”* (email from the Design Manager of the Government Agency to the Project Director 21.8.2003)

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- The Project Manager of the Government Agency wrote to the Joint Venture on 1.9.04 requesting they employ a replacement for the Joint Ventures professional engineer responsible for the temporary works -

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- he *“does not possess the requisite qualifications in undertaking full time site supervision of the complex and very deep excavation works … he is also the project coordinator and deputy project manager … it is difficult to expect that he will be able to fulfill the very onerous professional duties … to supervise the very difficult temporary works”.*

- the Joint Ventures temporary works engineer provided a written (personal) undertaking that he would accept and comply with his professional duties as a professional engineer for the temporary works and that he would continuously supervise the works.)

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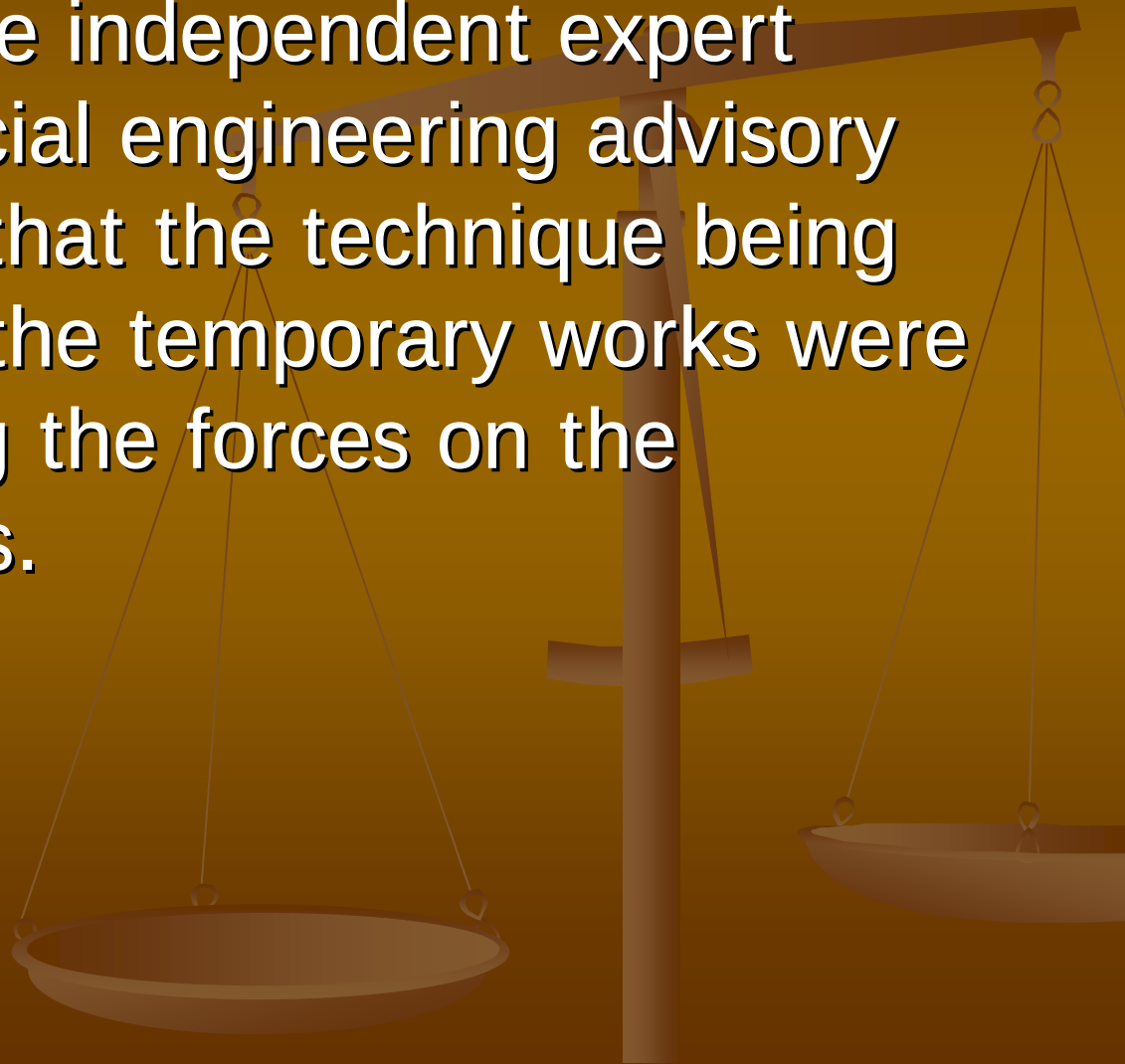
- A member of the independent expert panel,(the special engineering advisory panel) advised that the technique being used to design the temporary works were underestimating the forces on the diaphragm walls.



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- The joint venture was not prepared to reassess the design. The Joint Ventures temporary works engineer advised that the Government Agency could not dictate how the design was to be carried out and that the joint venture would only reanalyze the works if the Government Agency paid.

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- Another independent expert endorsed the first independent experts concerns stating: *“the walls … are potentially severely under designed throughout … [the] contractors’ [Joint Ventures] current temporary works design has no justifiable technical basis. In my opinion it would be irresponsible to continue with any excavation that has been designed on what we now know is an incorrect, and very unsafe, basis.”*

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- Heated exchanges between the second independent expert (retained by the Government Agency) and The Joint Ventures temporary works engineer occur (Minor recheck to be undertaken).

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- The Design Manager from the Government Agency attempts to purchase a copy of software to conduct analysis. There is one copy in the Government Agencies engineering divisions but the waiting period to use it is too long. His request to purchase a new copy is refused - in part due to lack of budget. (months later he is loaned a copy but cannot complete the analysis due to lack of engineering support.)

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- Excessive wall deflections

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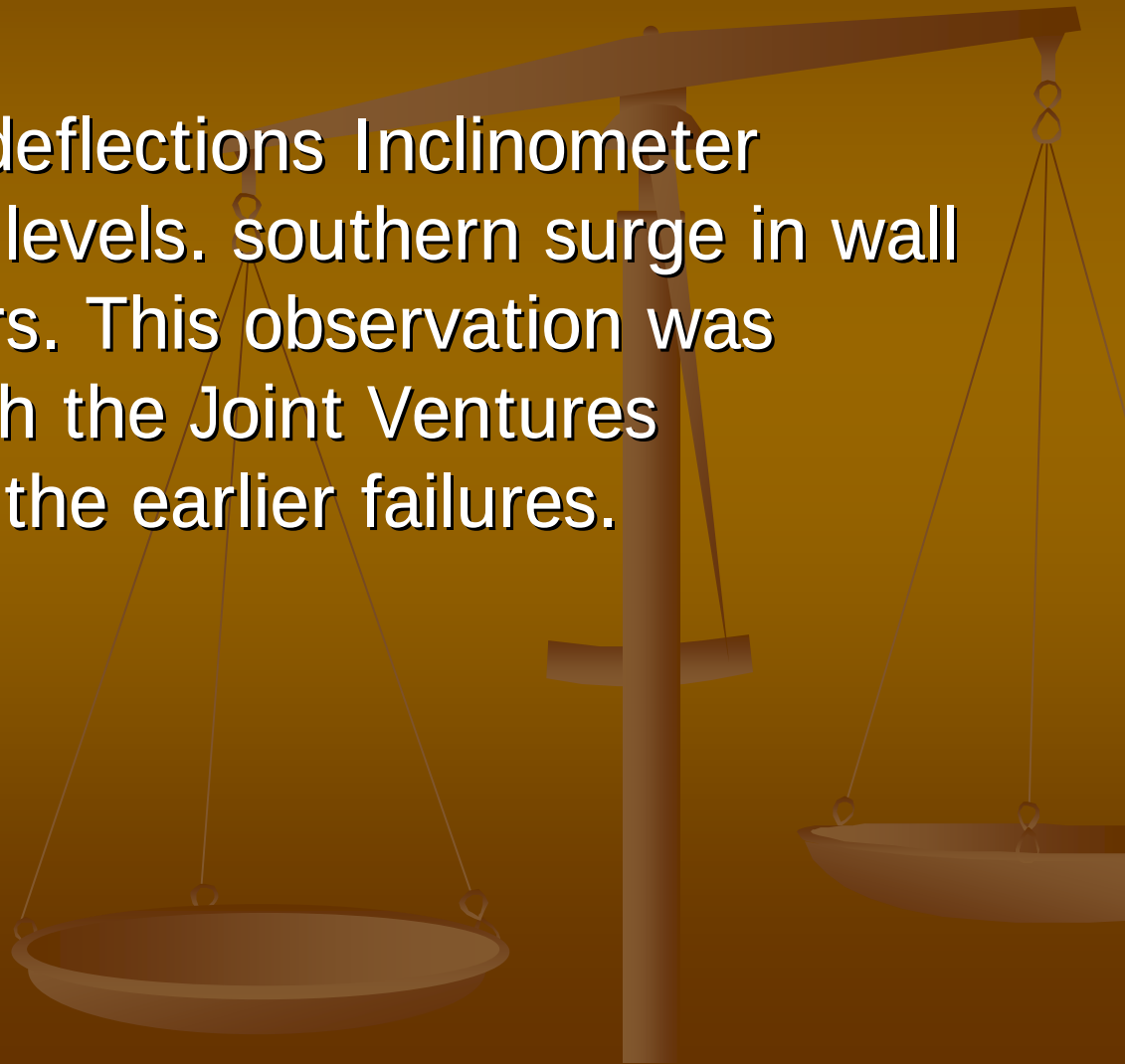
- Excessive wall deflections Inclinometer reaches trigger levels. southern surge in wall deflection occurs. This observation was inconsistent with the Joint Ventures explanation for the earlier failures.



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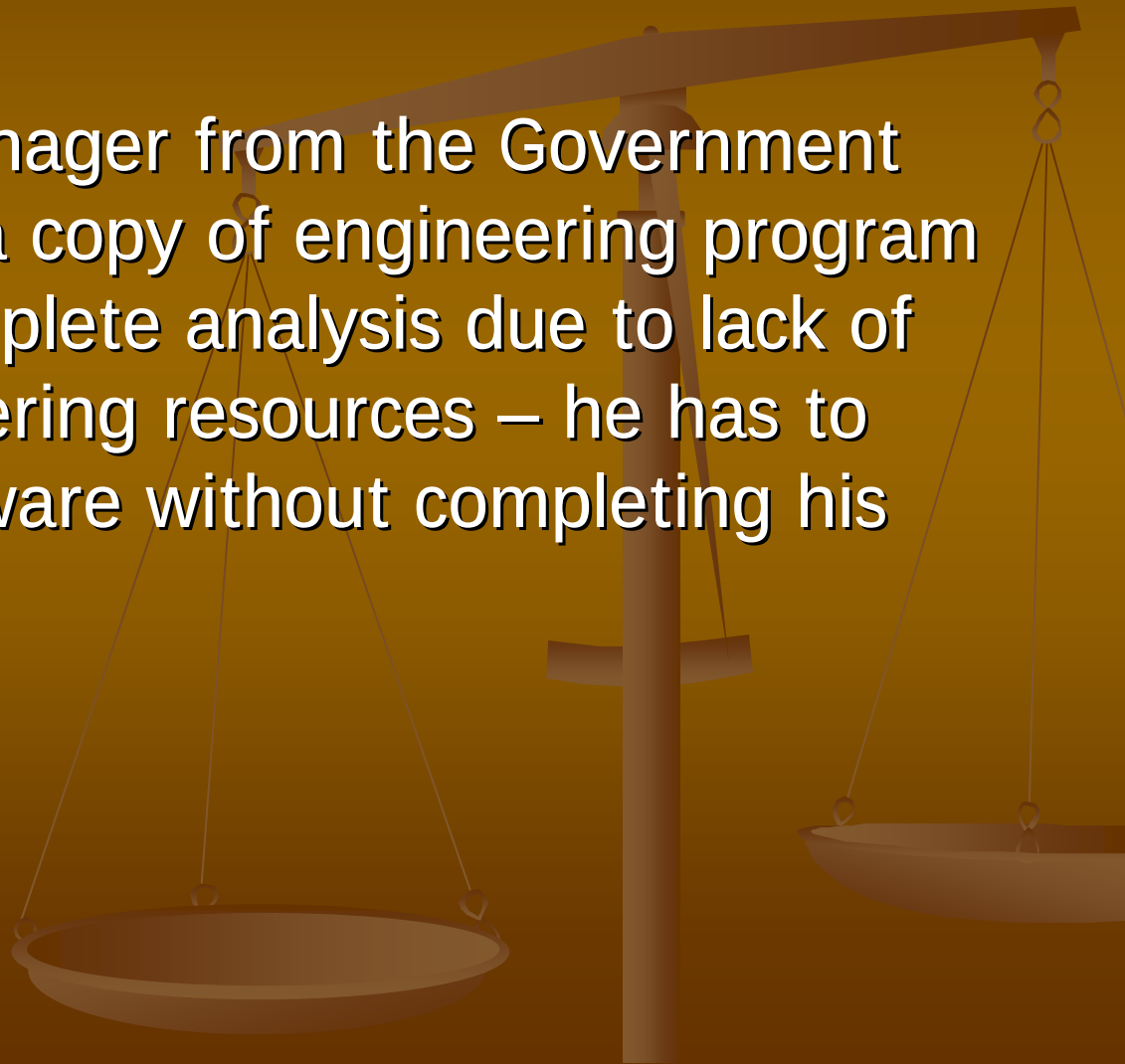

- The Design manager from the Government Agency is lent a copy of engineering program but cannot complete analysis due to lack of fulltime engineering resources – he has to return the software without completing his analysis.

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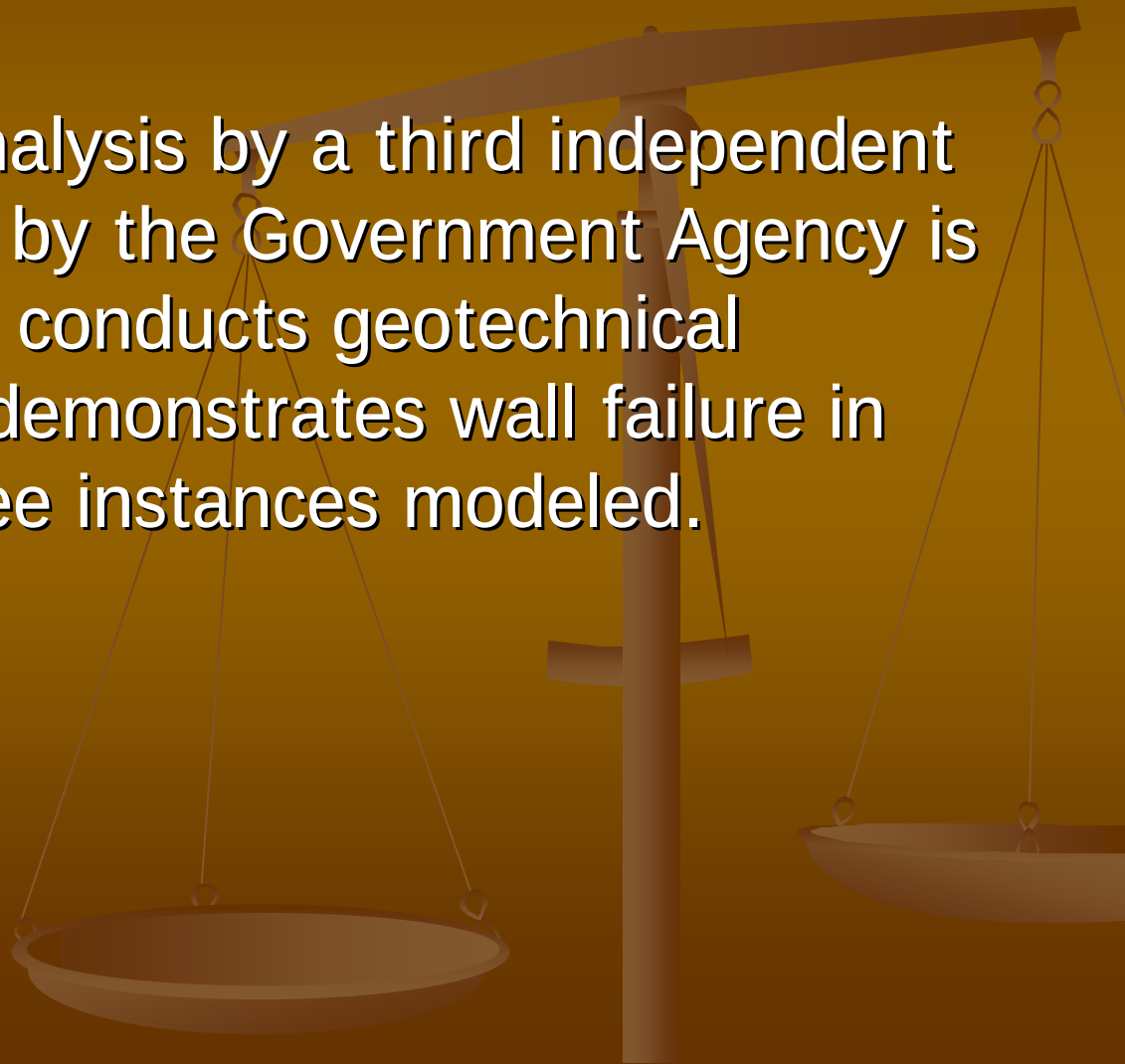
- Independent analysis by a third independent expert retained by the Government Agency is undertaken. He conducts geotechnical analysis which demonstrates wall failure in each of the three instances modeled.



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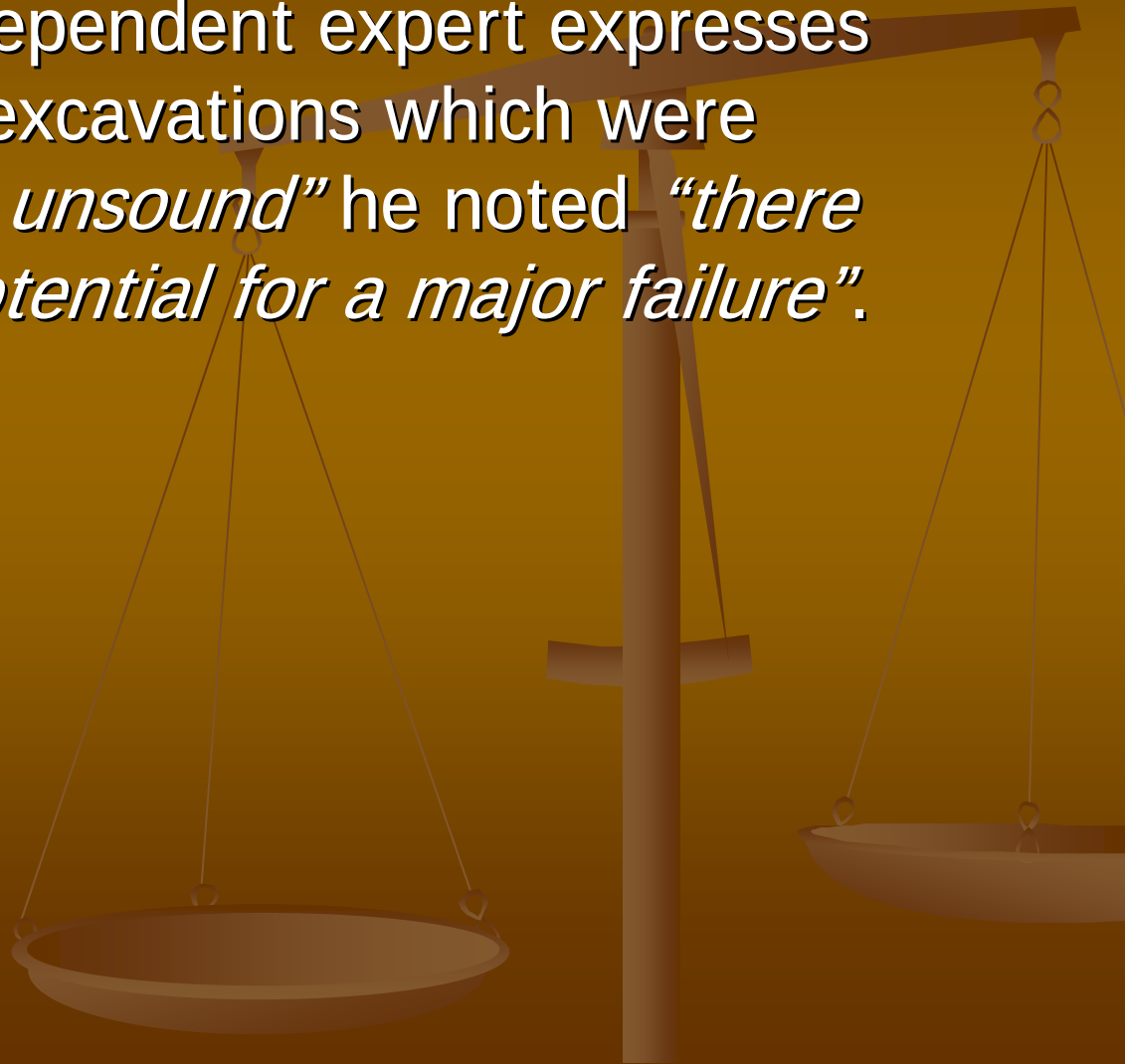
- The second independent expert expresses concern about excavations which were *“fundamentally unsound”* he noted *“there could be the potential for a major failure”*.



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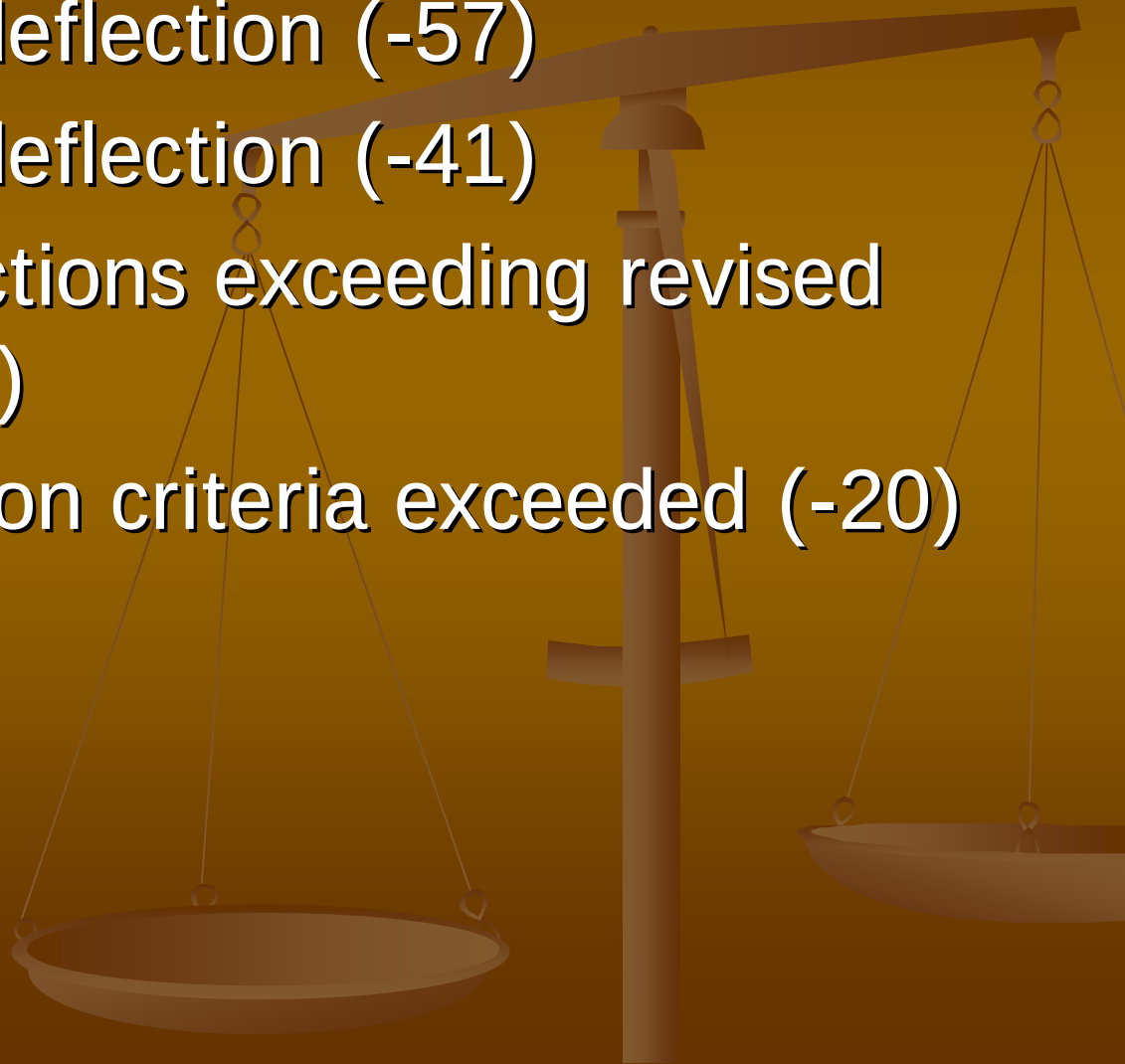
- The Government Agency writes to the Joint Venture noting that analysis has not adequately predicted current wall movement.

“This is of paramount importance as the excavation is carried out adjacent to a major thoroughfare, several buildings and critical utilities ... “

- Excessive wall deflection (-57)
- Excessive wall deflection (-41)
- Observed deflections exceeding revised predictions (-25)
- Revised deflection criteria exceeded (-20)



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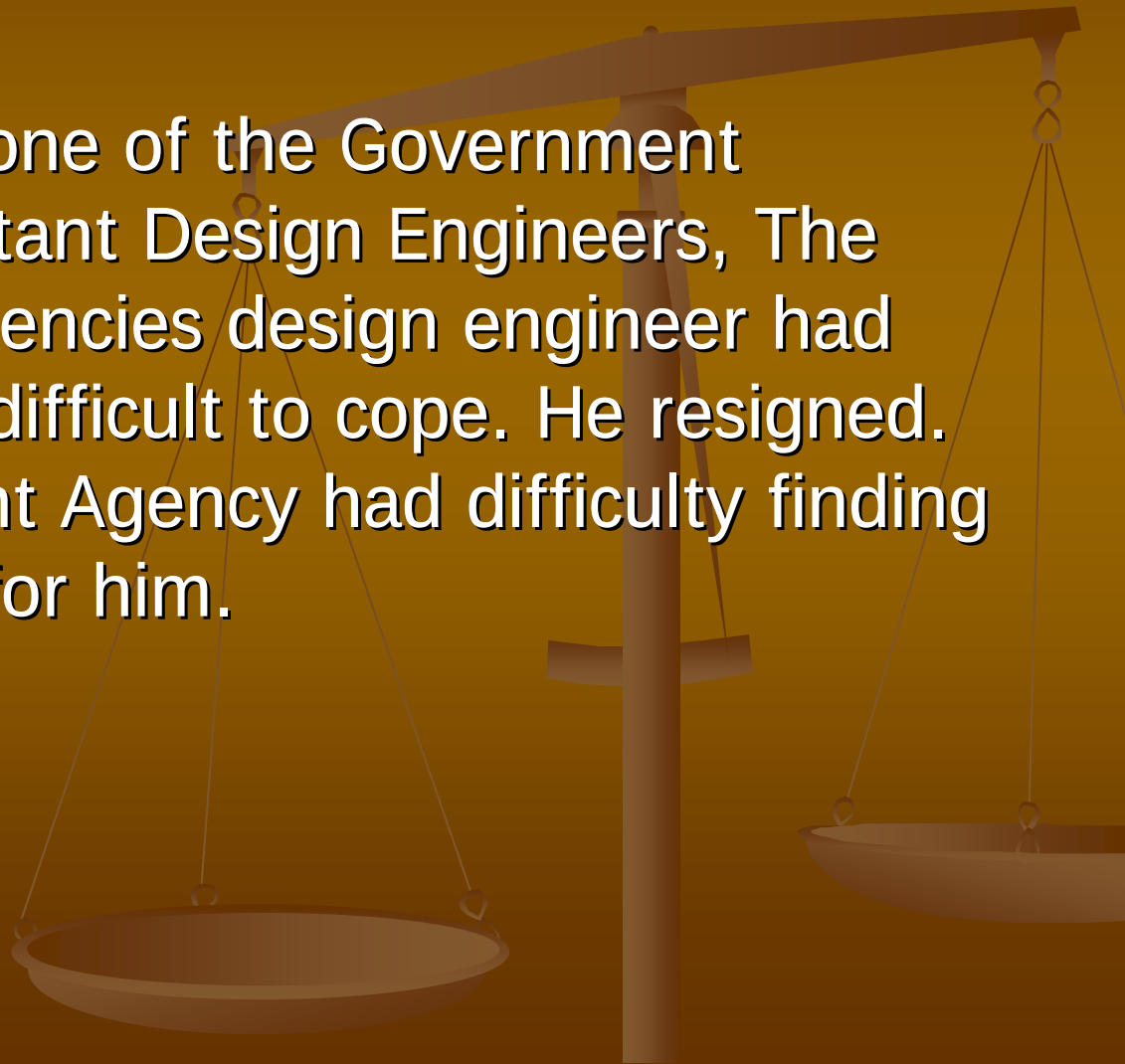
- Resignation of one of the Government Agencies important Design Engineers, The Government Agencies design engineer had been finding it difficult to cope. He resigned. The Government Agency had difficulty finding a replacement for him.



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- The first independent expert meets with representatives from the Joint Venture, the Government Agency., and other independent experts and notes:
  - more movements and bending as being underestimated by the Joint Venture
  - the people using the model should come to his advanced course so that they understand its limitations
  - if the excavation goes beyond 25 metres, failure may occur

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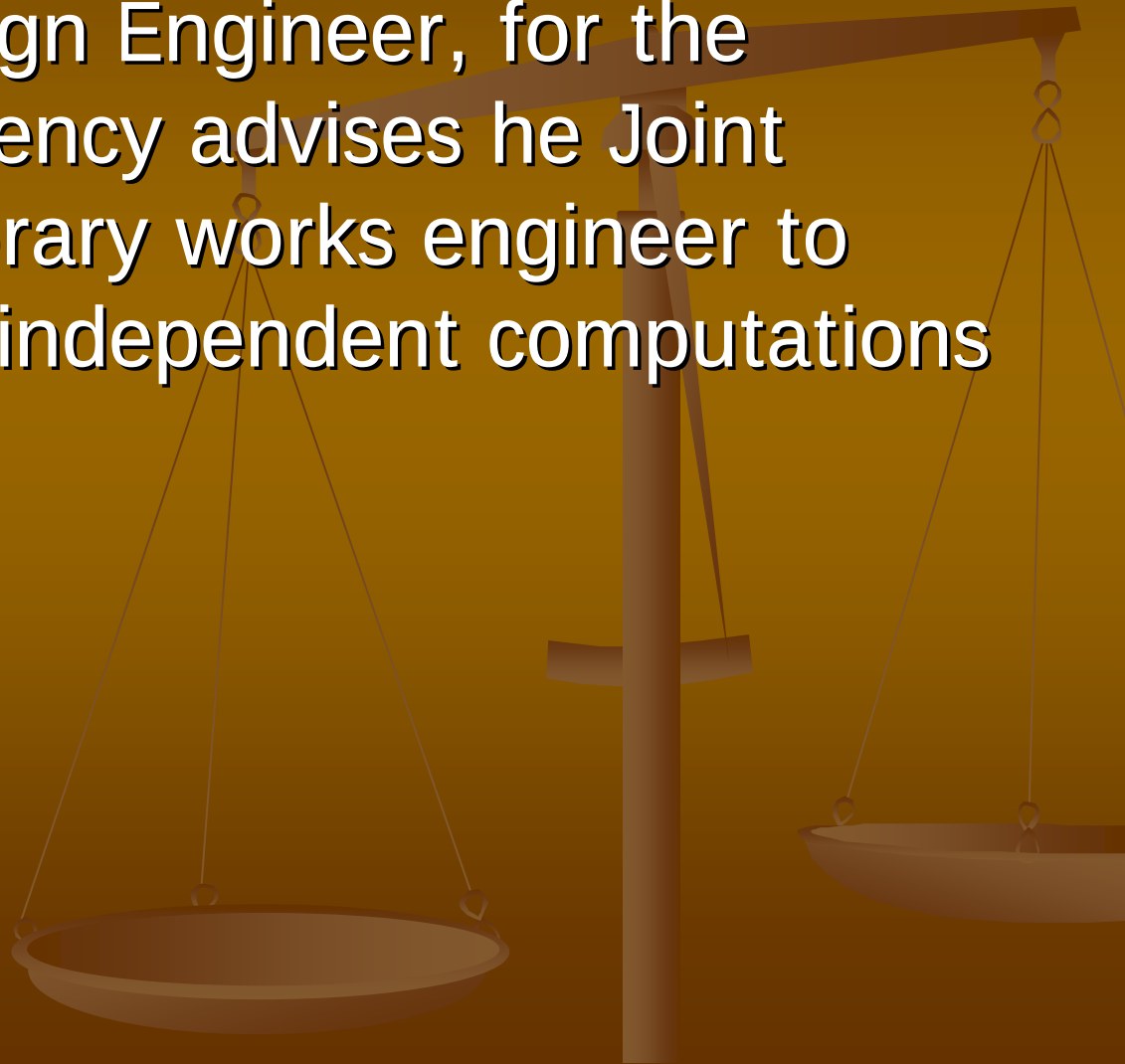
- The Senior Design Engineer, for the Government Agency advises he Joint Ventures temporary works engineer to request further independent computations be made.



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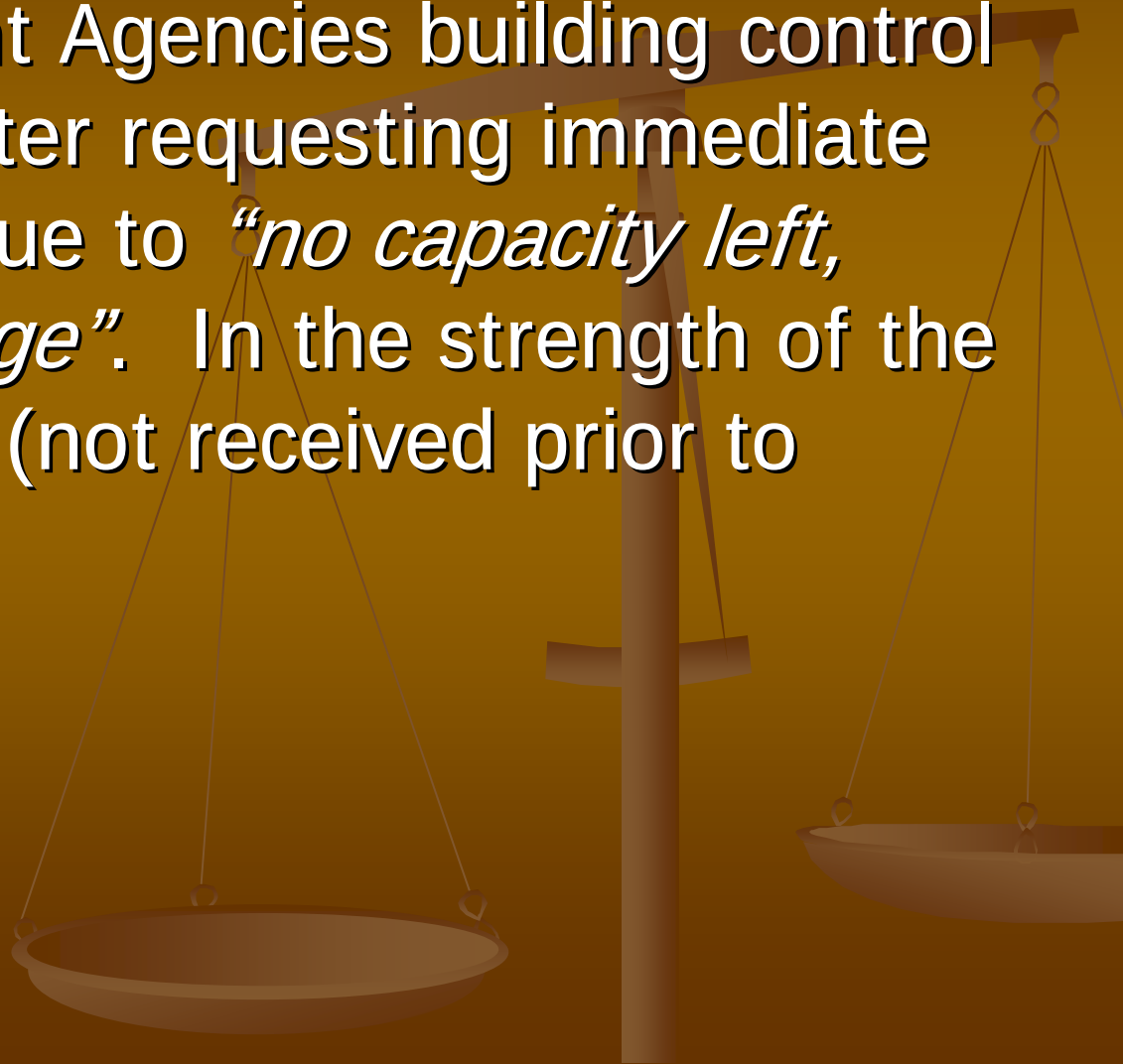
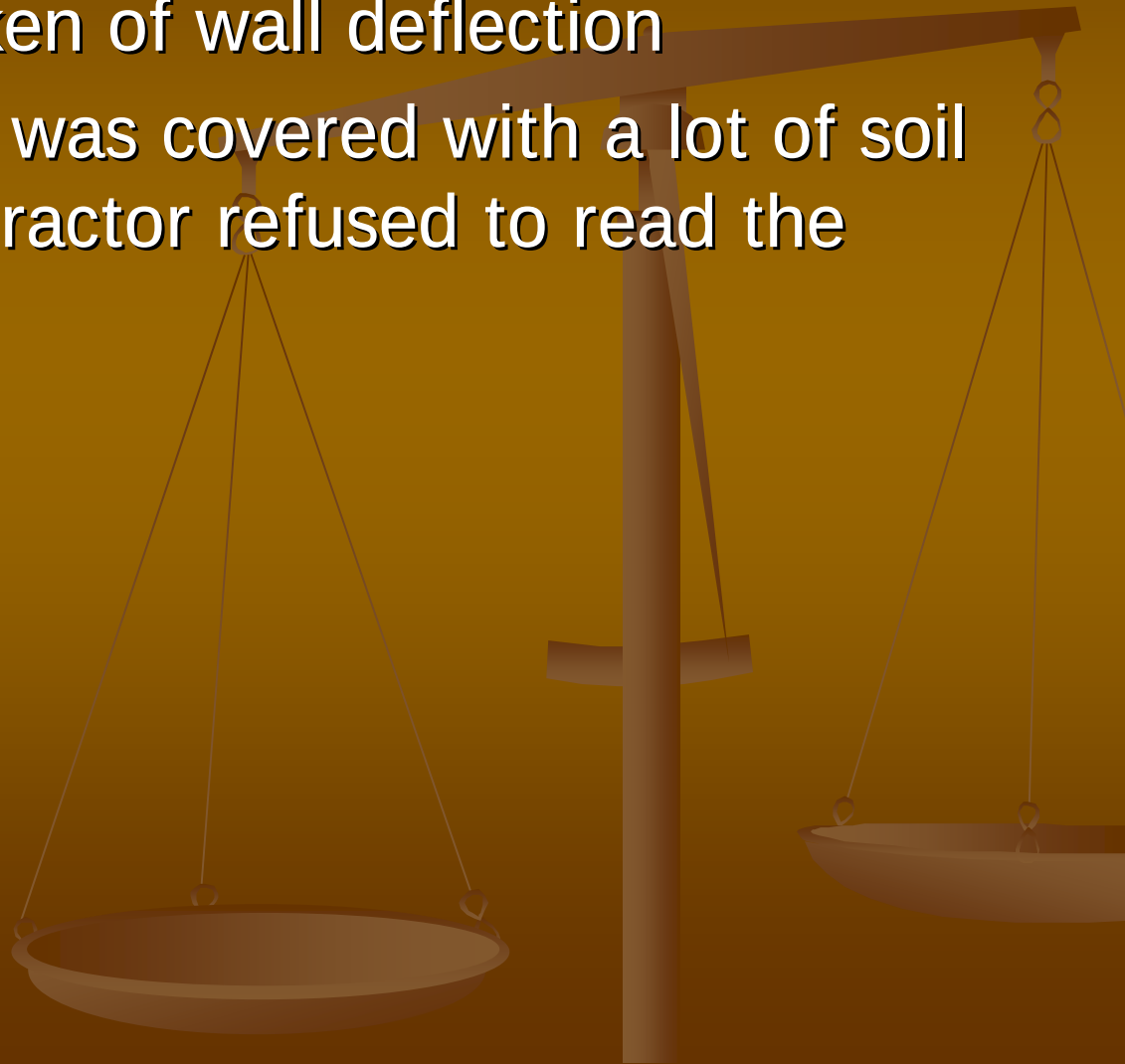
- The Government Agencies building control unit writes a letter requesting immediate design review due to *“no capacity left, even at this stage”*. In the strength of the diaphragm wall (not received prior to collapse).



-2 to 0

- No readings taken of wall deflection
- The instrument was covered with a lot of soil and so the contractor refused to read the instrument.

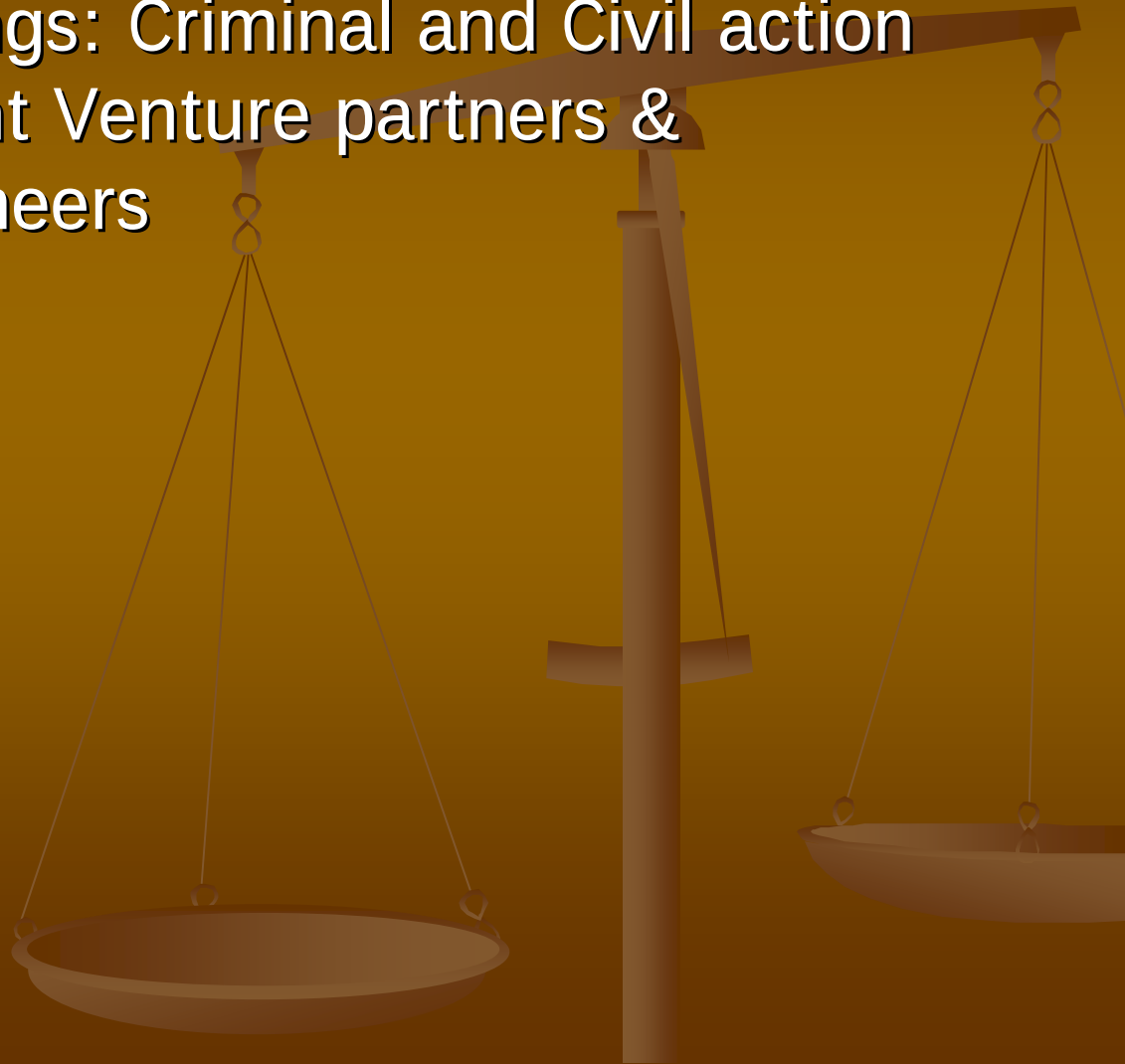


Day 0

Collapse occurs,

- 4 people killed
- Large damage
- US$100’s Millions

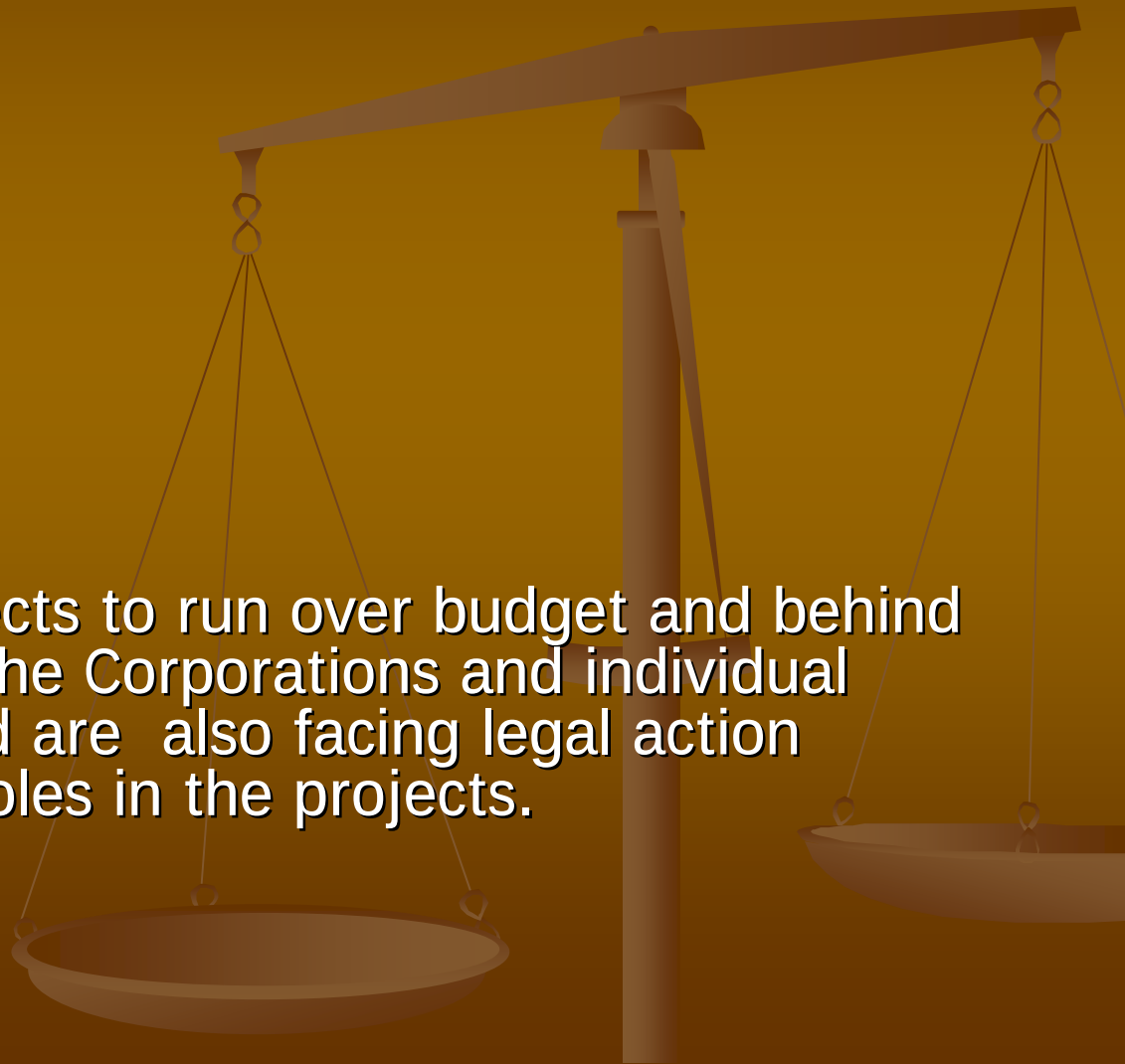
- Legal Proceedings: Criminal and Civil action against the Joint Venture partners & Individual engineers



Other Recent tunnel collapses

- Some examples:
  - China,
  - Singapore,
  - Spain
  - United Kingdom,
  - United States
  - Australia

  have caused projects to run over budget and behind schedule – while the Corporations and individual engineers involved are also facing legal action because of their roles in the projects.



Photograph: Wang Zhen Xin

ITIG

- seeking more stringent risk management strategies as a pre-requisite to providing construction insurance because of their fear of spiraling losses from a spate of tunnel collapses

WHY?

- Because of their fear of spiraling losses from a spate of tunnel collapses

Examples of some major claims since 2000

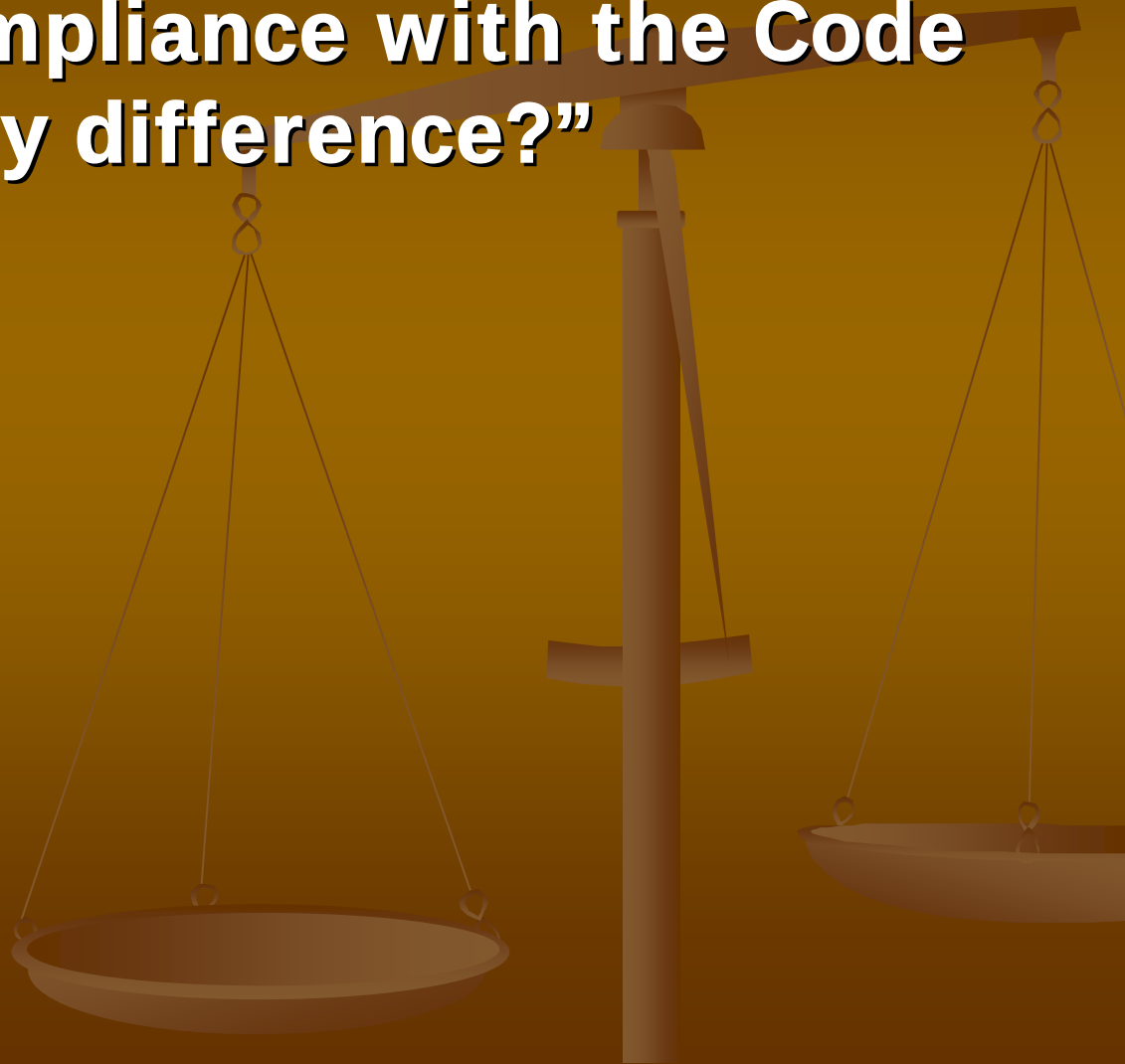
2000	Metro Taegu	Korea	Collapse	US $ 40 Mill
2000	TAV Bologna	Florence,Italy	Collapse	US $20 Mill
2002	SOCATOP Paris	France	Fire	US $13 Mill
2003	Shanghai	China	Collapse	US $ 100s of Mill ?
2004	Nicoll Hwy,	Singapore	Collapse	US $ 100s Mill ?

The Code

- A broad process of risk assessment
- Management of Risk more reliant on EXPERT input.

Singapore?

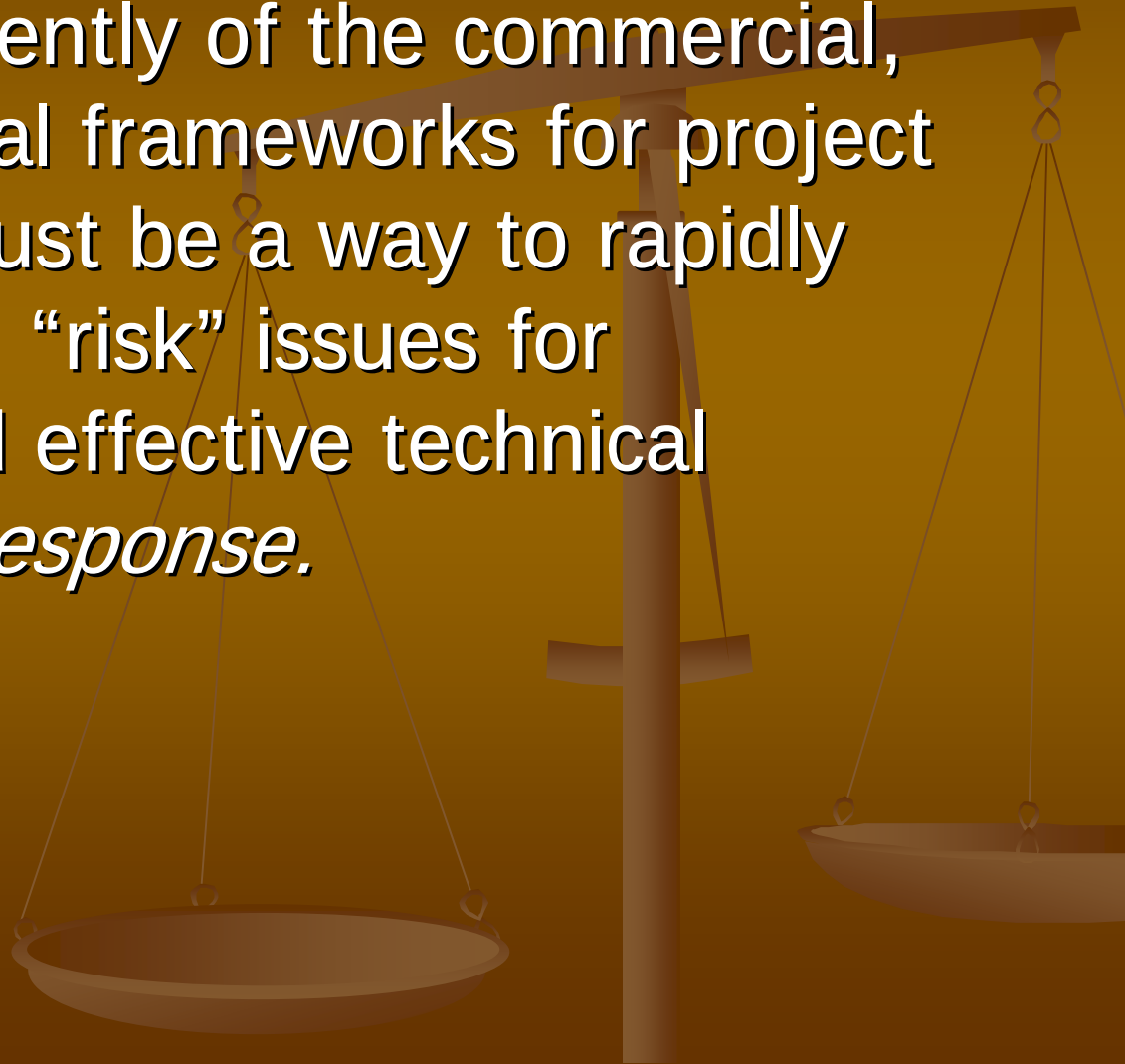
- **Q: “Would compliance with the Code have made any difference?”**
- **A: “perhaps”**



Conclusions

- Independently of the contractual arrangements engineers and other experts must maintain their professionalism and important roles in management of actual risks
- The International Code of practice is likely to reduce the probability of the collapse of underground works by placing higher reliance on expert assessments of risk management strategies..
- A rigorous approach to systematically managing effectively construction risks is to be encouraged.

- The Singapore collapse demonstrates that almost independently of the commercial, legal and financial frameworks for project delivery there must be a way to rapidly elevate technical “risk” issues for independent and effective technical evaluation and *response.*



References:

- *The Joint Code of Practice for Risk Management of Tunnel Works in the UK* (September 2003) [International Tunnelling Association and the British Tunnelling Association]
- *Draft A Code of Practice for Risk Management of Tunnel Works* 12 August 2005 [International Tunnelling Association Group]
- *Report on the incident at the MRT Circle Line worksite that led to the collapse of the Nicoll Highway on 20 April 2004 – by the Committee of Inquiry 10/5/05* [Chairman – Richard Magnus, Senior District Judge, Subordinate Court; Er. Dr. The Cee Ing, Associate Professor, Nanyang Technologocial University; Er. Lau Jooming, Director, Building Technology Department Housing and Development Board]