Big Dig – Ethics of Failure

THE BOSTON CENTRAL ARTERY/TUNNEL PROJECT

&

THE CHALLENGES OF PUTTING ETHICAL PRACTICES IN TO ACTION

USING DOCUMENTS FROM

The Boston Globe

NTSB National Transportation Safety Board

An independent U.S. Federal Government agency

boston.com

Objective

- Revise our knowledge of APEGM's ethical practices
- Use a case study approach to a situation where a catastrophe was caused by a series of mistakes by several persons / entities
- Discuss the causes
- Discuss what could have been done differently
- Draw lessons for our own behavior from the tragedy and consider how we would deal with similar circumstances

Agenda

- Introduction
  - Presenters:
    - David Grant P Eng,
    - Mike Gregiore P Eng,
    - Richard Jones P Eng,
- Importance of Ethics in Engineering – DG
- Background to the Big Dig
- The fateful day – July 10, 2006
- Investigation Part 1
- Break
- APEGM Ethics - MG
- Investigation Part 2
- Conclusions
- Stop Press – the latest on the story
- Close

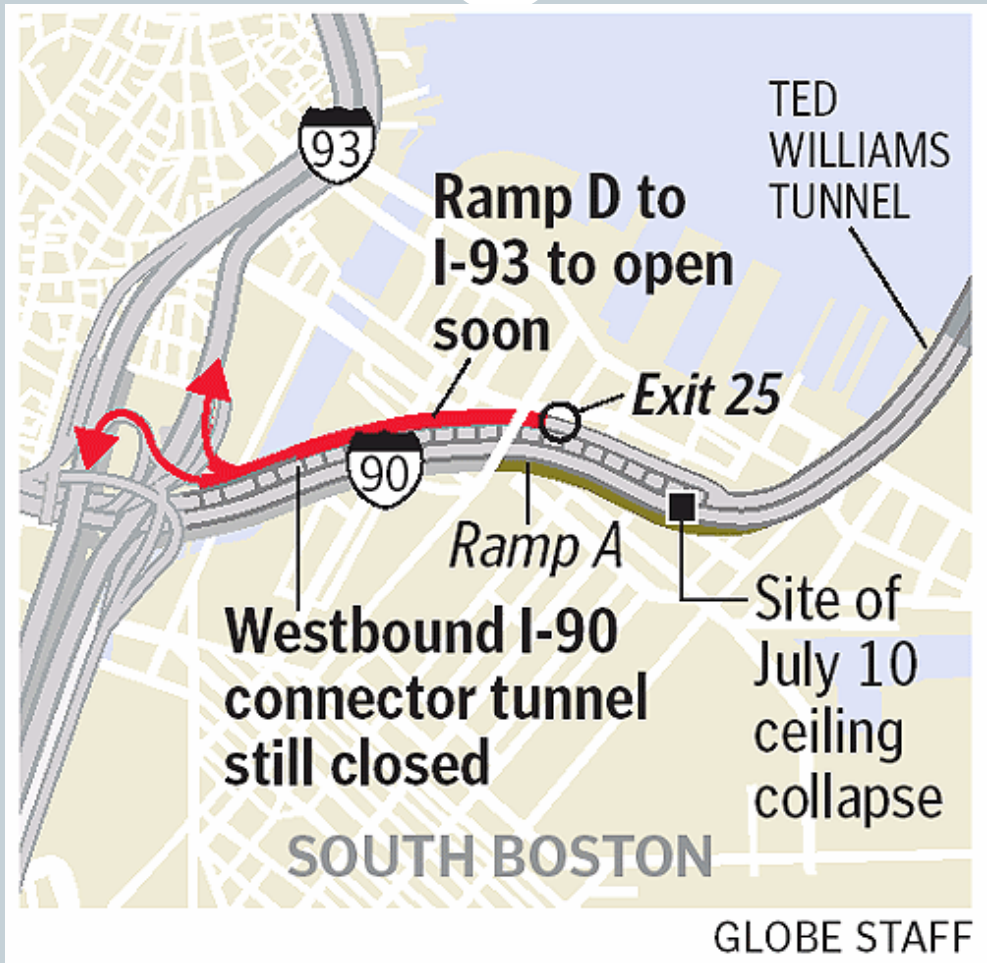
Background to the Big Dig

- Highly controversial: from inception in the 1980s, the project was beset by delays, engineering difficulties, and cost overruns.
- Long awaited completion of the Eisenhower Interstate system both I 90 and I 93.
- Proposed / Approved in 1985 with a $2.4 billion price tag
- Completed in 2003 at a cost of $14.6 billion

The fateful day – July 10, 2006

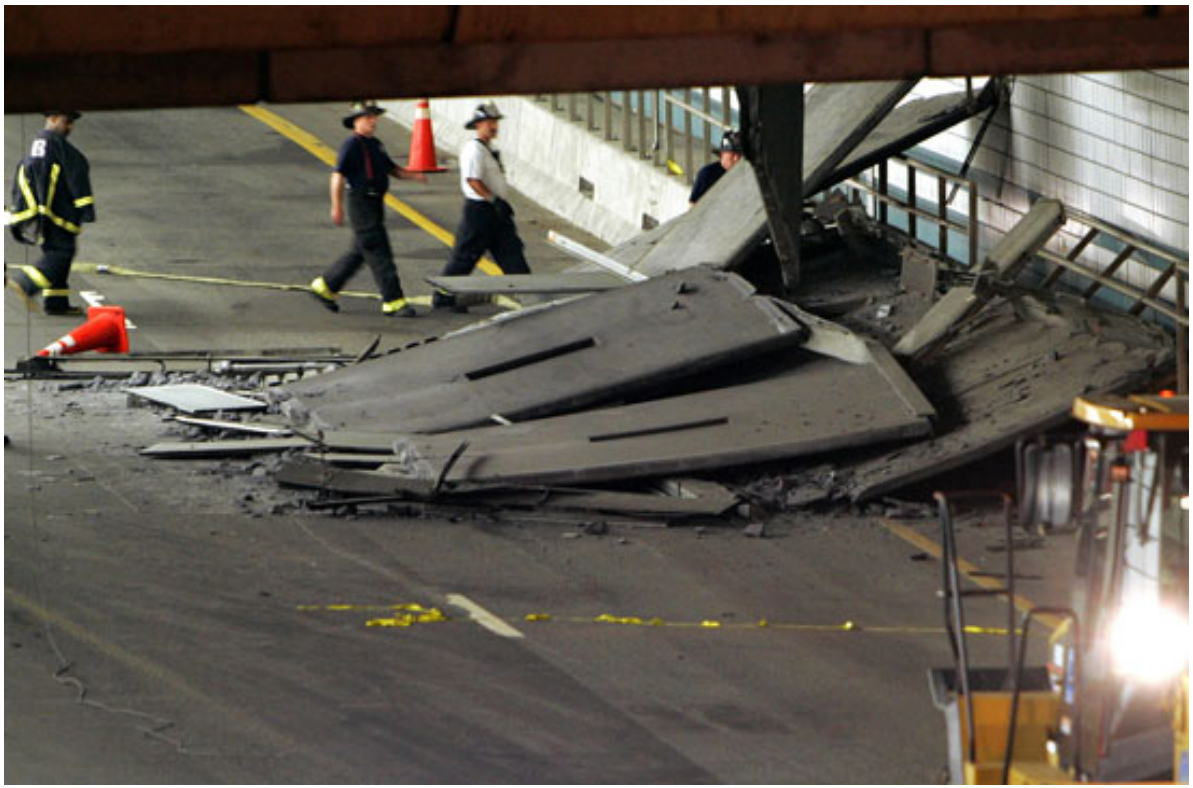
- Eastbound car on the I 90 extension heading to Logan Airport is hit by a falling concrete ceiling panel
- Driver, *Angel Del Valle*, escapes with scrapes and bruises
- Sadly, his passenger and spouse, *Millena del Valle*, a 38 year old mother of three is crushed under the concrete rubble and declared dead at the scene.
- The State Police, and Commonwealth of Massachusetts officials call for an official inquiry.
- National Transportation Safety Board begin a year long inquiry.

Map of the Central Artery Area*



*Courtesy of Boston Globe

The fateful day – July 10, 2006



The Scene at the I-90 Tunnel which collapsed on June 10, 2006. The falling concrete crushed Milena Del Valle to death.

The fateful day – July 10, 2006

The car that was crushed by falling ceiling panels, killing passenger Milena Del Valle in a Big Dig Tunnel in Boston.

Engineering Issues

- Not enough money to fix the remaining leaks, etc.
- As evidence of problems, treachery and cost over-runs appeared, each was featured in local media.
- For nearly 20 years, Big Dig problems have been *"headline news"*.
- These chronically contentious problems have resulted in bad relations between the Press, Massachusetts Turnpike Authority and Mega Contractors – Parsons Brinckerhoff

Engineering Issues

- Head-Office decision to use 2 anchors not 4, per hanger-rod.
- Manager's Written Instruction: if your staff cannot prove that 2 bolts will lead to a failure, we will use 2
- State law exempts projects like this from the usual *"drawing stamped by a P. Eng"* rules.
- There is no stamped document available to investigators to assign responsibility for the designs and the decisions made.

Engineering Issues

- Head-Office decision to use glued in anchors and not cast-in bolts or split-metal anchors.
- An “L” shaped bolt with concrete poured around it will never “pull out” but cannot later be “moved”; a new hole can be drilled if you later “change your mind” with “glue”.
- A split metal anchor is not vulnerable to creep.

Engineering Issues

- Head-Office decision to use glued in anchors and not cast-in bolts or split-metal anchors.
- Advantage: you can pour the “tunnel” ceiling before you design the ceiling panels (and know where the anchors will be needed).
- Drill/glue takes longest and is the most tedious of the 3 options.
- Drill/glue is the most unreliable of the 3 options.

Engineering Issues

- The glue maker offered 2 products: temporary and permanent epoxy.
- The temporary would be for short-term uses, like lighting during construction.
- Only the permanent type was intended for this job.
- Big Dig bought and used only the temporary type.
- The Massachusetts AG Martha Coakley, charged only the smallest fish in the guilty pond: the family-owned glue maker.

Engineering Issues

- Politician Coakley had the glue tested.
- However, only one tube tested
- If Testing had involved a statistically valid number of tubes, in a variety of drilled holes it could also have shown the influence that dust and big holes have on creep and pull-out.
- Reason 1: the Attorney-General did not understand testing and sampling.
- Reason 2: A-G knew she could win in court against the glue maker, but not against the contractor-team.
- Evidence was gathered only against Powers Fasteners.

Engineering Issues

- No sign of project control of the drilling: actual hole diameters, clearing dust, actual yield and pull-out force.
- If a hole is far too big, a split metal anchor will not hold at all.
- If “glue” is used in this same “too big” hole, it will have far less “pull-out” strength than intended.

The Incident Question One

In your table groups work together and try to answer:

- *Assume you were a part of the NTSB inquiry. What would you want to know as you are starting out on the task of investigating the incident?*

After 10 minutes be prepared to share your tables answers.

The Firms Involved

Multiple contractors are responsible:

1. Powers Fasteners Inc., which supplied the epoxy;
2. Modern Continental Construction Co., which installed the anchors;
3. Gannett Fleming Inc., designer of the tunnel section;
4. Bechtel/Parsons Brinckerhoff, a project managers, who had design and monitoring responsibilities.

Round Table - Investigation Part 1

- Review the documents you have been given and discuss what you think are the preliminary causes of the accident.

After 30 minutes be prepared to share your tables answers.

The Questions

1. Was it a screw up or a criminal breach of engineering ethics to use the wrong glue to hold up 3-ton concrete panels that would hang over a major roadway?
2. Was it a screw up or a a criminal breach of engineering ethics to fail to monitor those weighty panels even after problems were discovered?

APEGM Ethics

APEGM Ethics

- Types of Ethics
  - Meta-ethics
  - Descriptive Ethics
  - Normative Ethics
    - Moral theory
    - Applied Ethics

APEGM Ethics

- Meta-ethics
  - Meaning of moral terms
  - Nature of moral judgements
  - Method of supporting moral judgements

APEGM Ethics

What is ‘good’, as it pertains to determining an ethical course of action?

“*When we are happy we are always **good**, but when we are **good** we are not always happy*.” - Oscar Wilde

APEGM Ethics

- Applied Ethics
  - Consequentialism
    - Utilitarianism
  - Virtue Ethics
  - Deontological
    - Categorical imperative

"*Act only according to that maxim whereby you can at the same time will that it should become a universal law.* " - *Immanuel Kant*

APEGM Ethics

APEGM 1921	APEGM 2000
To the State	… obey the laws of the land
To His Client	… employ all reasonably attainable skill and knowledge
To His Fellow Engineer	… be fair to colleagues
	… regard the … well-being of the public as the prime responsibility
	…uphold and enhance the … professions

APEGM Ethics

- APEGM Code of Ethics 1921

10. He shall not accept employment by a Client while a claim for compensation or damages, or both, of a fellow Engineer previously employed by the same Client and whose employment has been terminated, remains unsatisfied, or until such claim has been referred to arbitration, or issue has been joined at law, or unless the Engineer previously employed has neglected to press his claim, except in special cases where authority has been obtained from the Council to accept such employment.

APEGM Ethics

- Are Codes of Ethics relevant in modern society?
- How will APEGM's Code of Ethics change?

APEGM Ethics

Round Table - Investigation Part 2

- What were the nature of the ethical lapses identified by the investigation?
- Which of the companies involved should review their processes for clearing work?
- What was Keaveney's responsibility when Modern Continental decided to do nothing in response to his 1999 memo?

How Do we Handle these Issues

In your table groups discuss together:

- From your own experience: *How have you handled issues where you felt the solution being recommended had issues concerning either safety or a possible violation of a part of the Association's ethical standards?*

After 20 minutes be prepared to share your tables best story so we can compile a set of possible approaches.

Conclusions

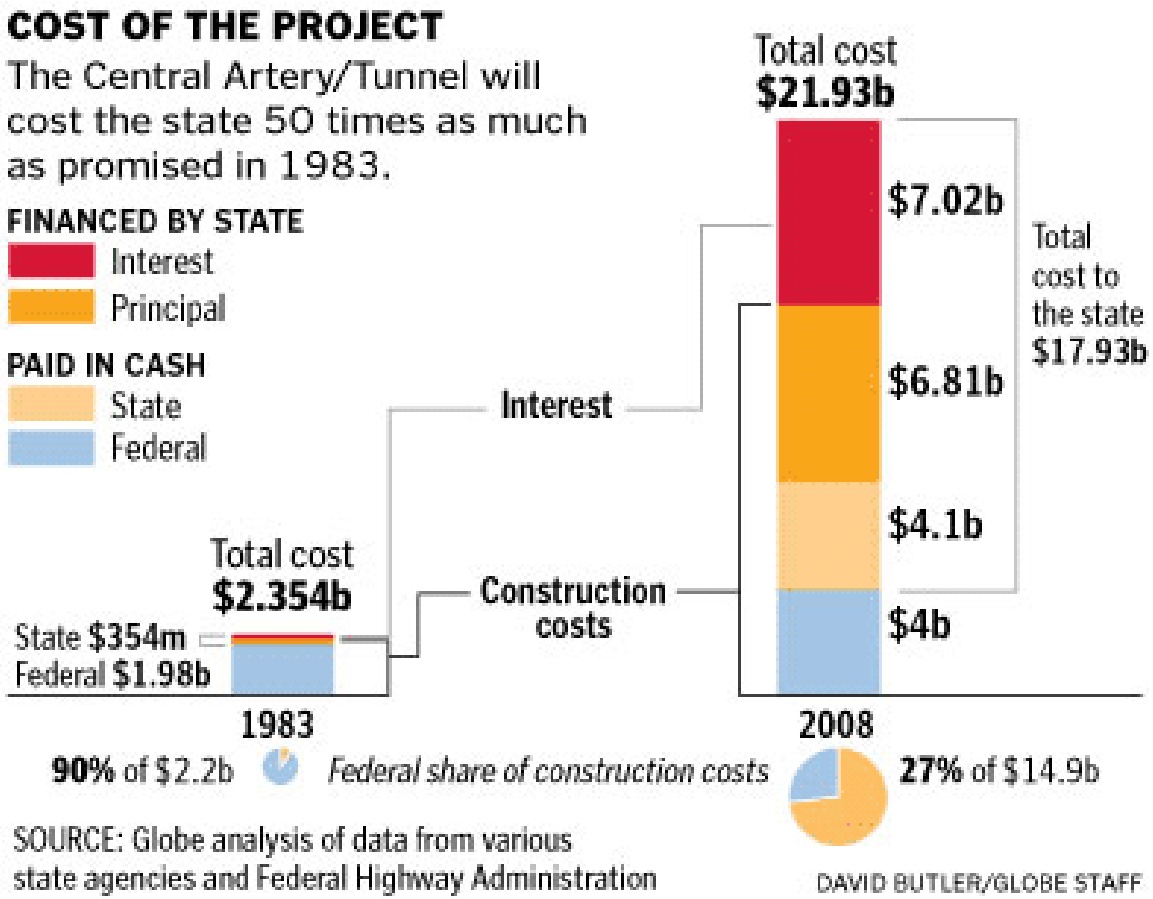
- What conclusions can we draw from this incident that will help us for our future careers as engineers?

After 30 minutes be prepared to share your tables answers.

Stop Press – the latest on the story

- PB settled with Commonwealth of Massachusetts in January 2008
- State prosecutors drop a manslaughter charge against Powers Fasteners Inc., after the New York epoxy vendor agreed to pay $16 million to the state and city.
- Modern Continental Corp., agreed to a settlement of $21 million for damages
- Newman Associates Inc., the company that sold Modern Continental the epoxy to secure the ceiling panels, has agreed to pay $5 million in damages
- The family of the Milena Del Valle woman will collect more than $28 million
- The cost of repairing the tunnel to date is $39.5 million

The Costs!!


COST OF THE PROJECT
The Central Artery/Tunnel will cost the state 50 times as much as promised in 1983.
FINANCED BY STATE
Interest
Principal
PAID IN CASH
State
Federal
Total cost
$21.93b
$7.02b
$6.81b
$4.1b
$4b
Total cost to the state $17.93b
Interest
Construction costs
Total cost
$2.354b
State $354m
Federal $1.98b
1983
2008
90% of $2.2b
Federal share of construction costs
27% of $14.9b
SOURCE: Globe analysis of data from various state agencies and Federal Highway Administration
DAVID BUTLER/GLOBE STAFF

The Final Word

- ANCHOR BOLTS, poorly secured by epoxy, failed.
- But what motivated the human beings who installed those bolts?
  - Who knew the bolts were coming out, but didn't stop the ceiling from going up?
  - Who kept the problem as quiet as possible until 26 tons of concrete crashed onto the Del Valle family, as they headed to Logan International Airport on July 10, 2006?
  - Four project *engineers* cited their Fifth Amendment right against self-incrimination and refused to testify.