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# Aging concrete on our dams

Frank Denys - 22 February 2024

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CONCRETE WORKING FOR WATER – FEBRUARY 2024

# Outline



- 1 Paradigm shift
- 2 Background to dam design
- 3 Typical signs of aging
- 4 Examples

# Paradigm shift



## Paradigm shift

The era of big dam building in RSA is over



- Few new large dams are still being built in RSA.
- Many dams built in the 1970's, hence several are reaching their 50th anniversary.
- Shift in dam engineering field toward maintenance and rehabilitation.
- Extending the lifespan of existing dams
- Addressing previous:
  - Poor design
  - Poor construction
  - Poor materials

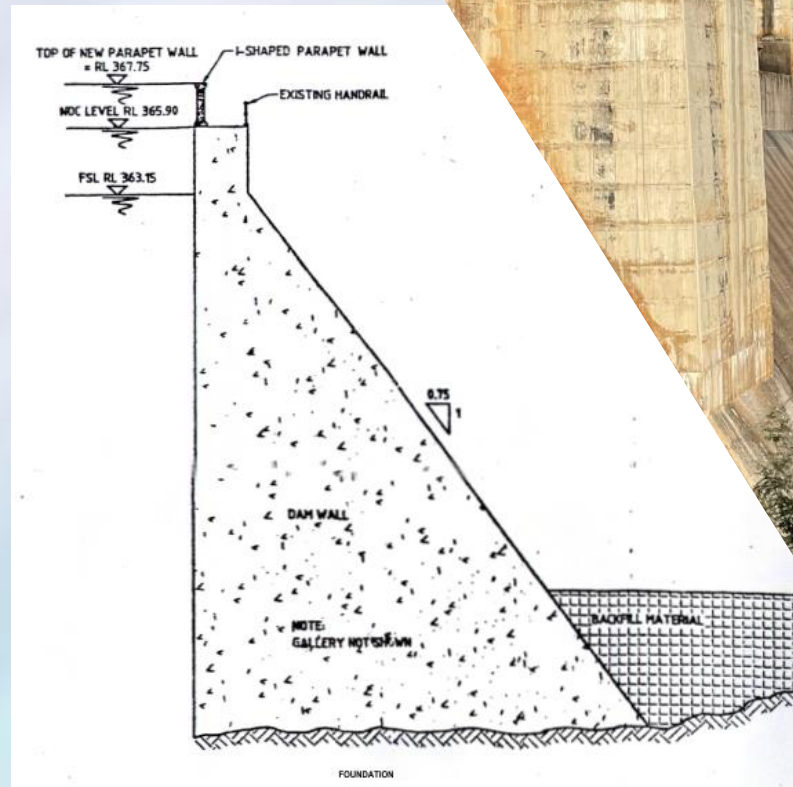


# Background to dam design

# Concrete dam design

Consider broad distribution of stress

- Concrete gravity structure
- Stability by its mass
- Low strength concrete
- No tensile forces

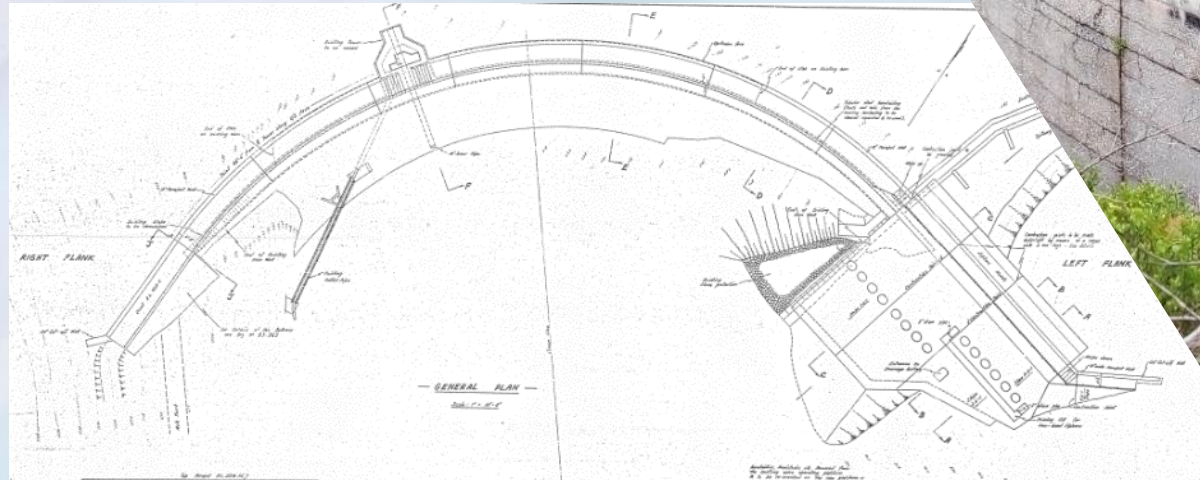




# Concrete dam design

Consider broad distribution of stress

- Arch dam structure
- Slender design
- Force distribution to its flanks
- Large scale movement





# Typical signs of aging

# Typical signs of aging



Mortar loss – exposed aggregate



Reinforcement corrosion



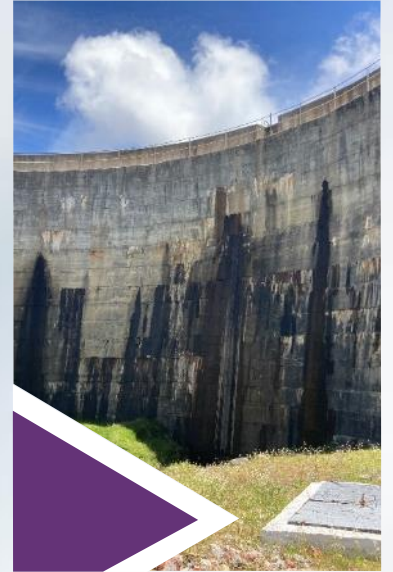
Joint damage / movement



AAR / ASR



Construction defects



Cracking / leakage

# Examples



# Hely Hutchinson Dam

16 m high masonry gravity dam

- One of original water supply dams to City of Cape Town – located on Table Mountain
- Built from 1889 to 1904
- Design consists of sandstone masonry blocks with an internal zone of plum concrete
- Empties annually
- Outdated design



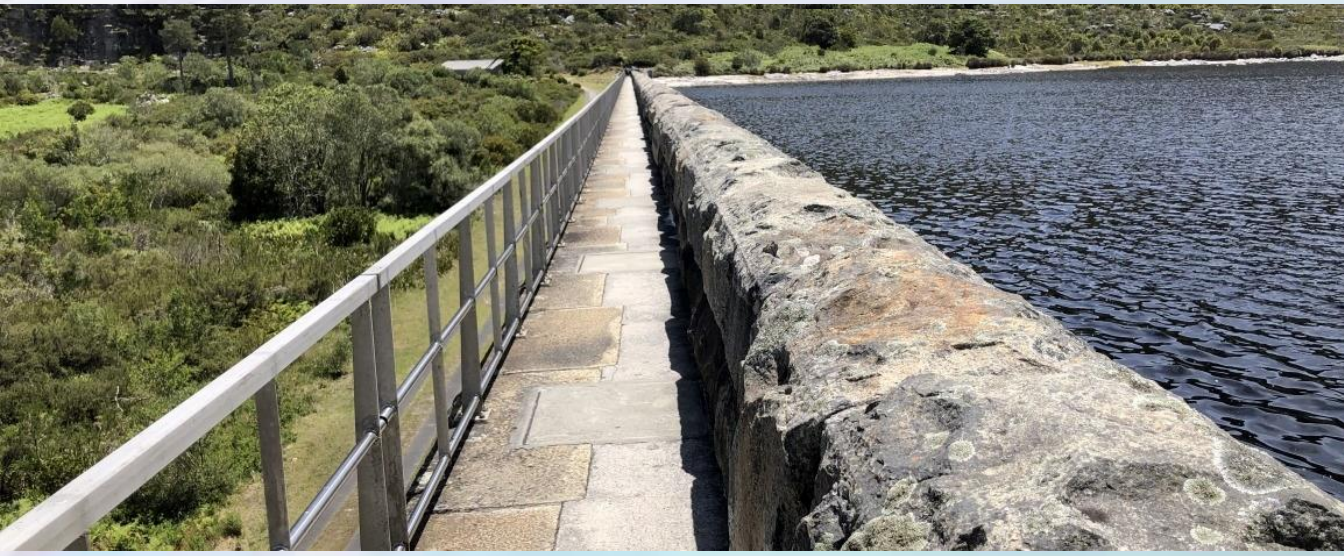


# Mortar loss





# Leakage and seepage







Repairs?



# Steenbras Lower Dam

28 m high concrete gravity and arch dam

- Originally built in 1921
- Raised in 1927 and again in 1954
- Concrete gravity structure with outdated design
- Strengthened in 1954 with post-tensioned steel cables
- Significant AAR concerns





# Mortar and aggregate loss on spillway



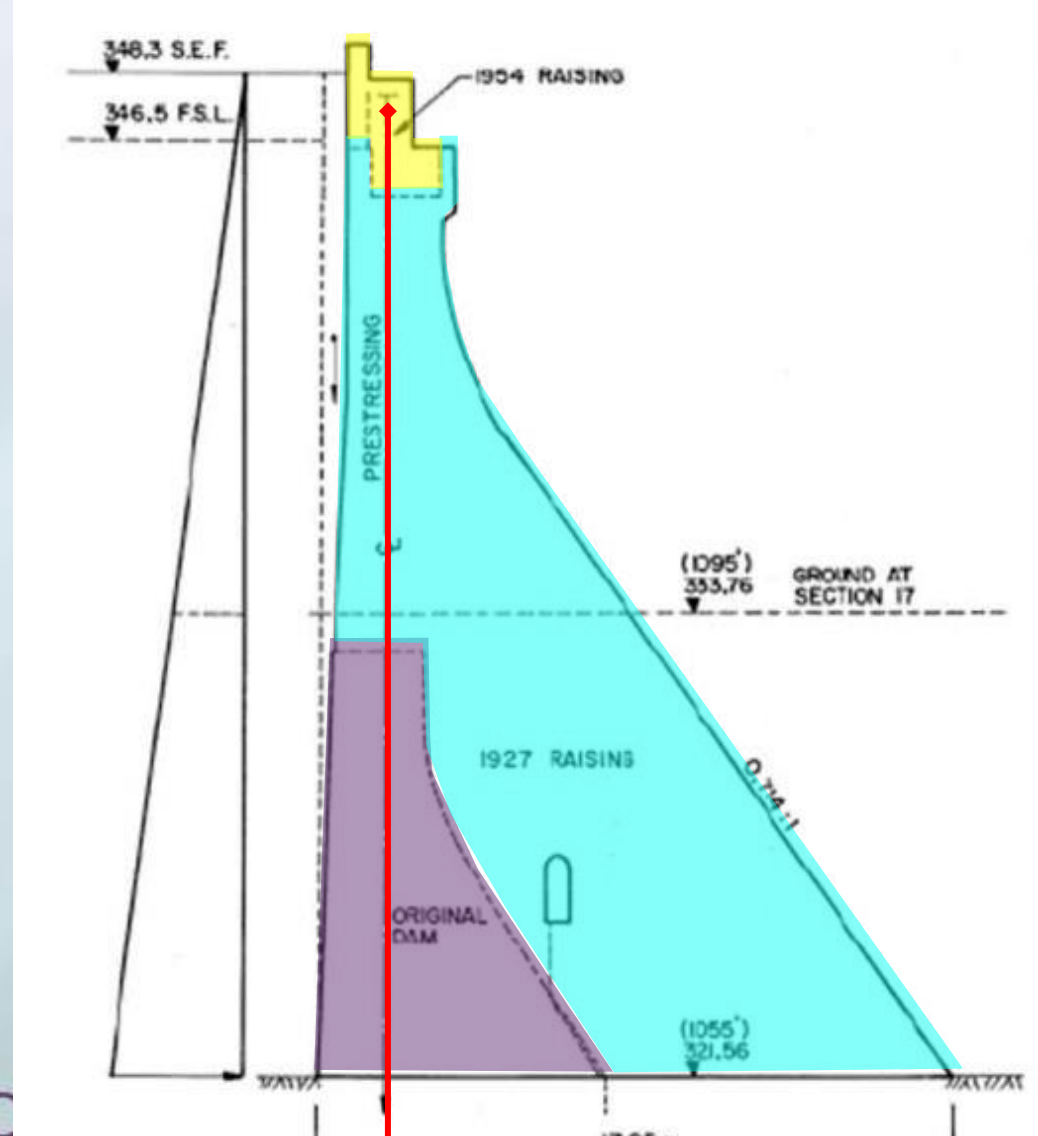


# Concrete swelling





# Anchor cables





# Lewis Gay Dam

16 m high concrete arch with gravity flanks

- Built in 1951
- Concrete arch dam supported by two buttresses
- Flanked by concrete gravity walls
- No expansion joints in arch section
- Only movement joints at buttress supports
- Severe vertical cracking and leakage in the arch





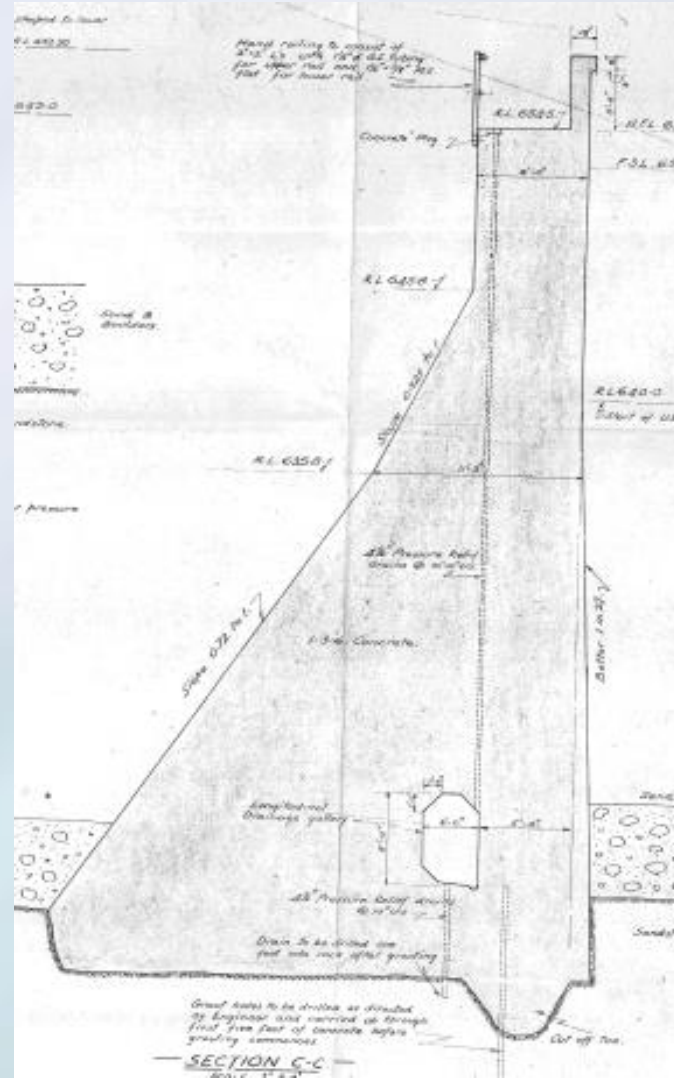
# Combined gravity and arch buttress dam



Gravity

Arch

Buttress



GRAVITY SECTION



ARCH SECTION

# Lewis Gay Dam behaviour

## WINTER

- Dam full
- Colder temperatures
- Downstream movement of the arch
- Limited by sand in cracks



## SUMMER

- Dam empty
- Hot temperatures
- Expansion of gravity flanks causes pinching of the buttresses
- Large upstream movement of the arch





# Cracking and leakage







Repairs?



# Swart River Dam

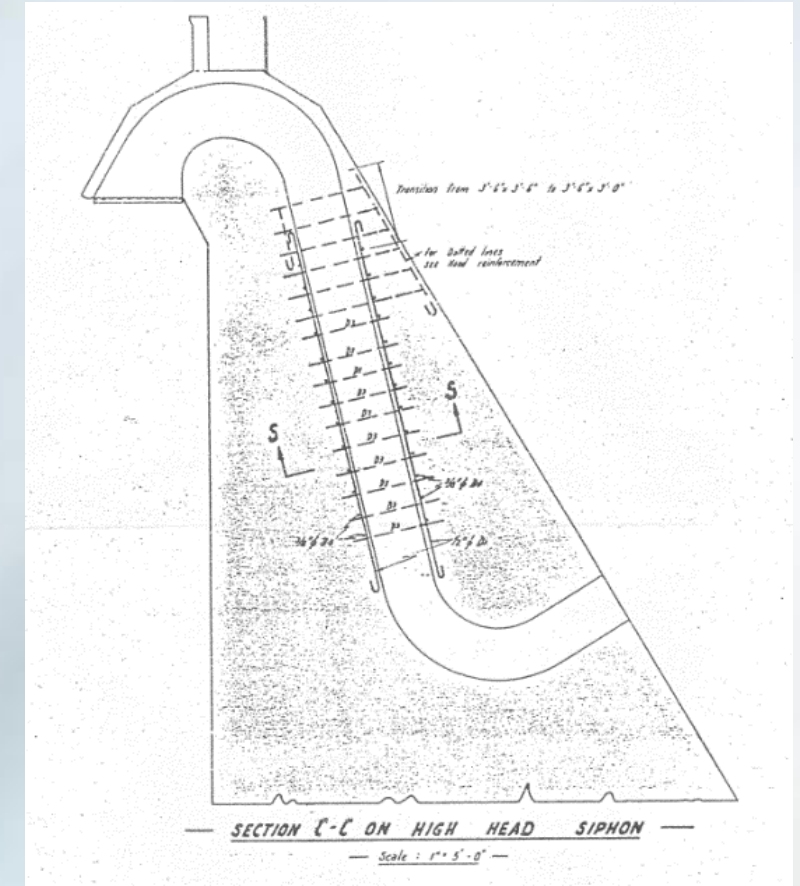
34 m high concrete arch dam

- Originally built in 1940 and raised in 1954
- Severe leakage
- Not able to store water
- Still structurally sound





# Siphon spillway priming





# Siphon up close







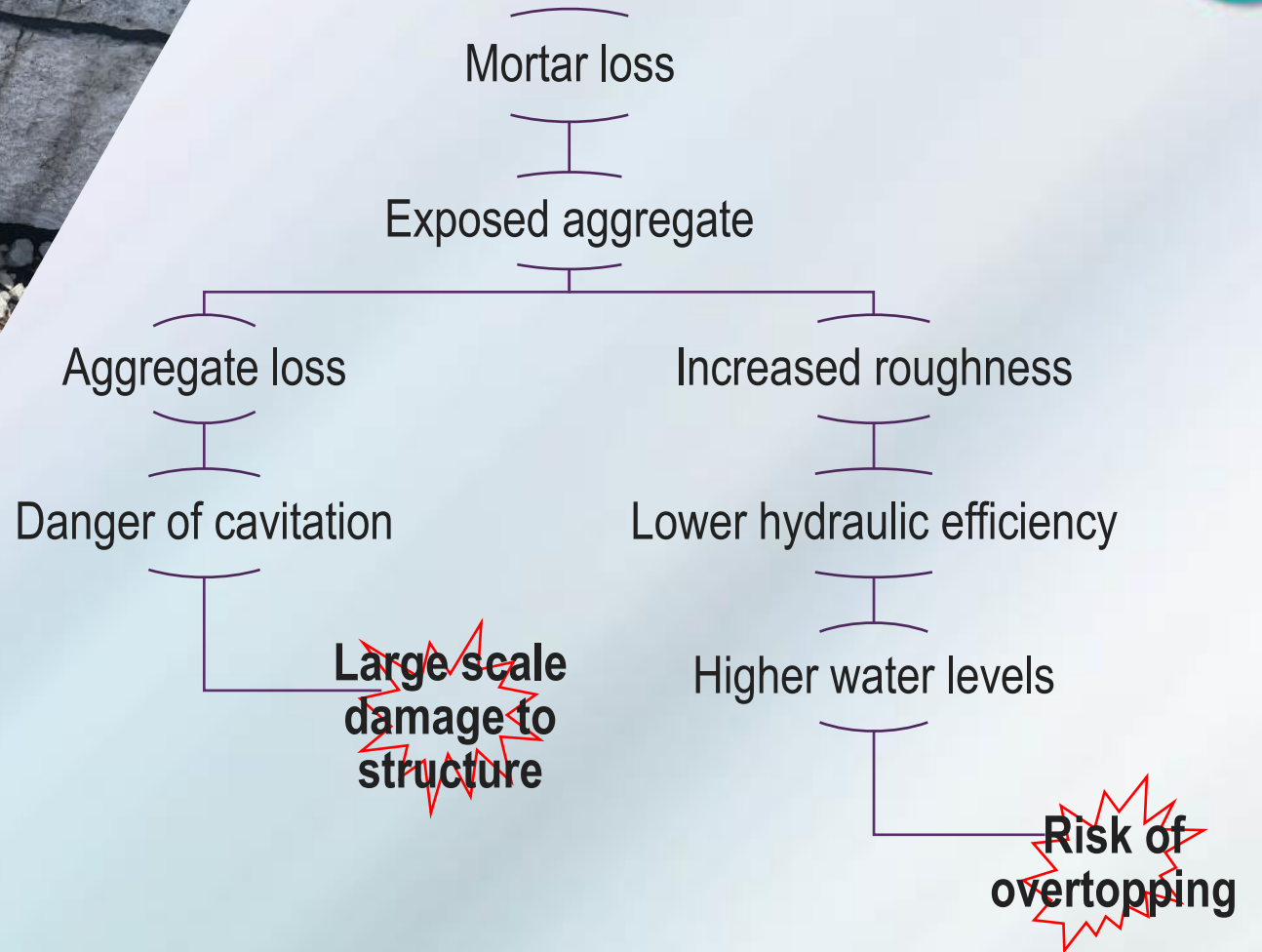
Repairs?

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# Spillway hydraulics





# Contact



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We owe it to ourselves and to the next generation to conserve the environment so that we can bequeath our children a sustainable world that benefits all.

WANGARI MAATHAI

**ZUTARI**

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