

Presentation 15: Concrete Spillway Repairs

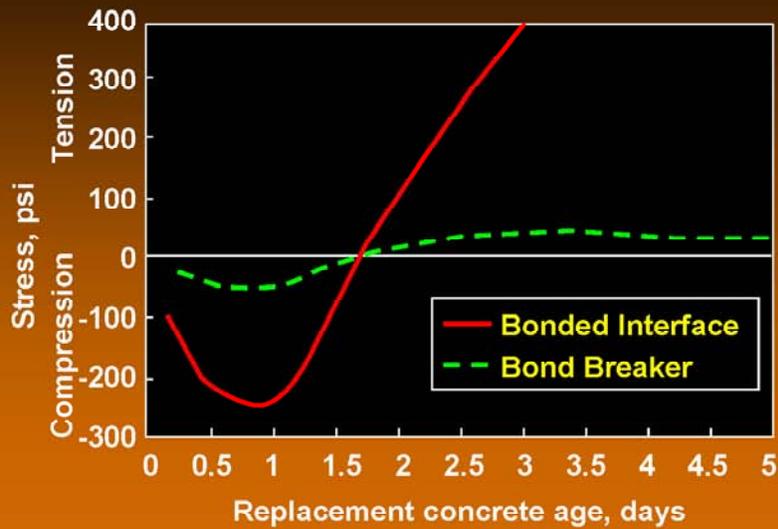


Repair/Substrate Compatibility

Definition - The capacity of two or more entities to combine or remain together without undesirable aftereffects: mutual tolerance.



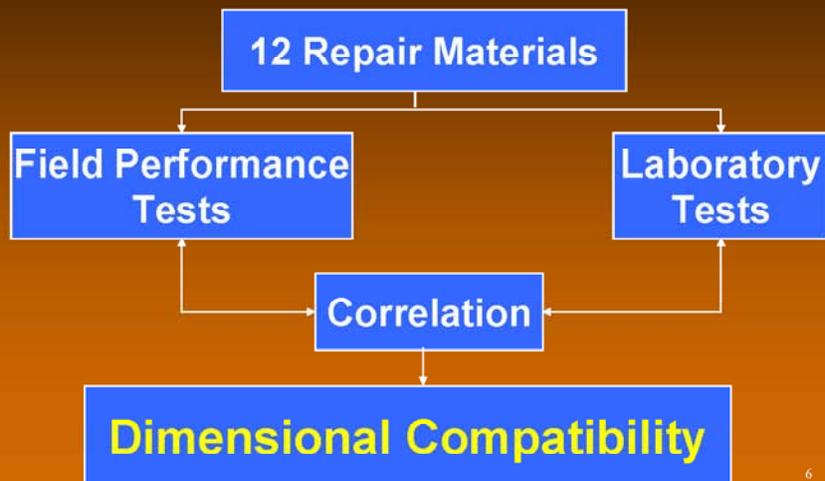
Effect of Bond Breaker at Interface



Effect Of Restraint



Performance Criteria Cement-Based Materials



Performance Criteria

Laboratory Tests

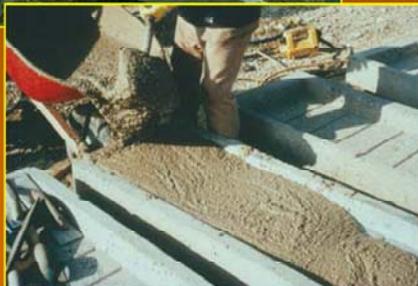
- **Drying Shrinkage**
 - Unrestrained
 - Restrained
- **Modulus of elasticity**
- **Creep**
- **Thermal expansion**
- **Strength**



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Performance Criteria

Field Tests



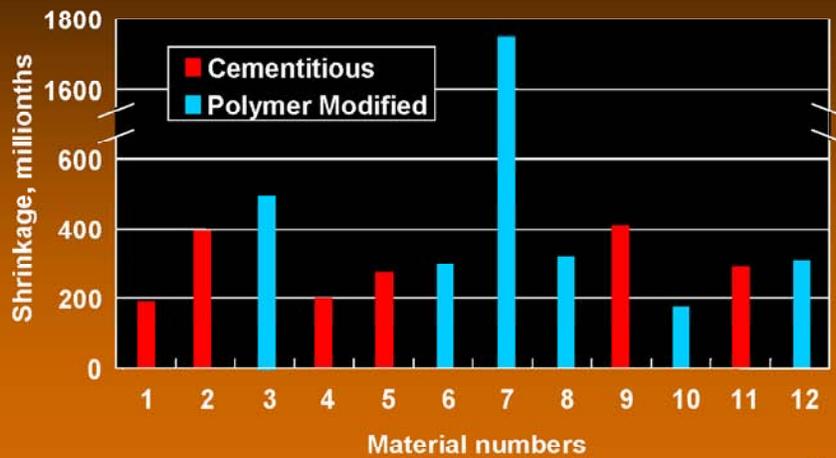
- **3 exposure sites (FL, IL, & AZ)**
- **3 repairs with each of the 12 materials**
- **Conduct restrained shrinkage tests**
- **Monitor performance**

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Field Exposure Tests Relative Performance Ratings



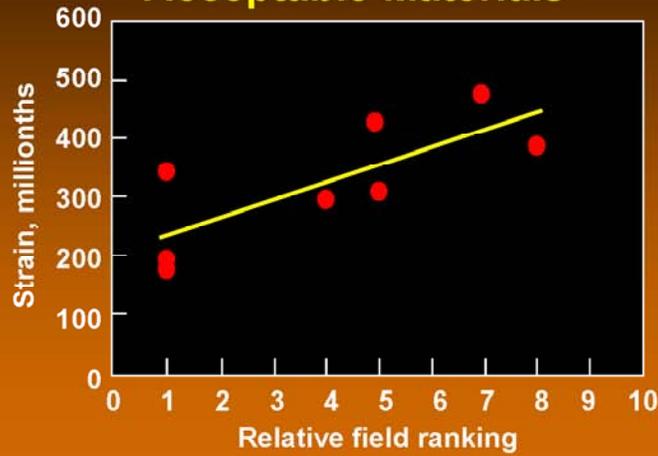
Drying Shrinkage 50% RH, 28 Days



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28-Day Shrinkage & Field Performance

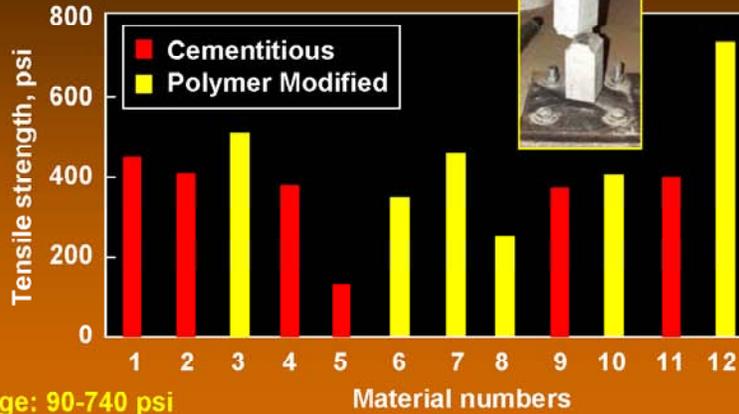
Acceptable Materials



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Tensile Strength Test Results

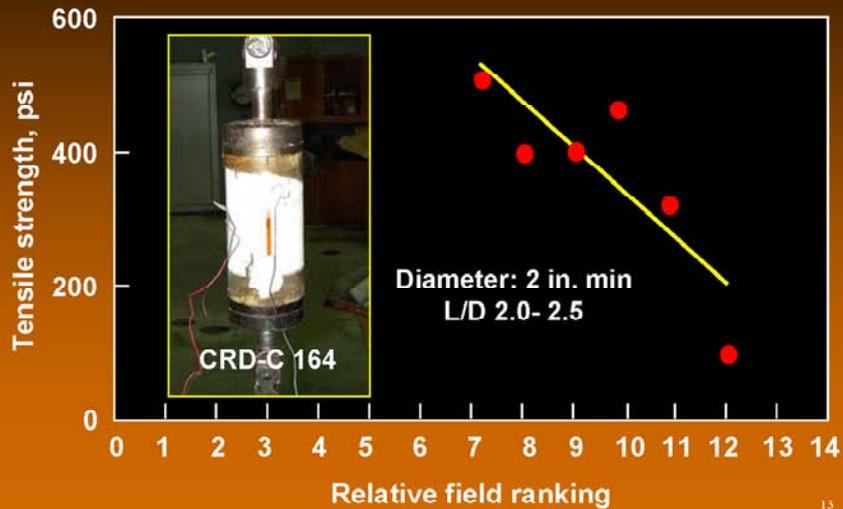
28 Days



Range: 90-740 psi
Average: 390 psi

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Tensile Strength & Field Performance Marginal and Unsatisfactory Materials



Performance Criteria for Cement-Based Repair Materials*

<u>Property</u>	<u>Test Method</u>	<u>Requirement</u>
Tensile strength, min	CRD-C 164	400 psi
Modulus of elasticity, max	ASTM C 469	3.5×10^6 psi
Thermal coefficient, max	CRD-C 39	7 millionths/deg F
Drying shrinkage, max	ASTM C 157 (Modified)	
28 days		400 millionths
1 year		1,000 millionths
Restrained shrinkage	Ring Method	
Cracks		None < 14 days
Implied strain (1 yr), max		1,000 millionths

* <http://www.wes.army.mil/SL/HPMS/bulletins.htm>

Laboratory/Field Correlation

Satisfactory Performance

Field Rank	Mat'l No.	Modulus			Drying Shrinkage		Ring Test	
		Tensile Strength, (>400)	of Elasticity (<3.5)	Thermal Coefficient (<7)	28 Days (<400)	Peak (<1,000)	1 st Crack (>14)	Implied Strain (<1,000)
1	1	451	2.8	5.8	178	366	6	667
1	4	348	3.8	8.3	201	703	140	560
1	11	390	5.9	7.6	339	641	14	810
4	12	742	3.0	9.3	293	634	None	0
5	8	215	2.7	9.2	305	1,109	8	1,222
5	9	323	2.7	6.9	429	877	23	955

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HPM&S

High-Performance Materials and Systems Research Program

<http://www.wes.army.mil/SL/HPMS/bulletins.htm>

“Performance Criteria for Dimensionally Compatible Repair Materials” (Jan 2000) 0.4 MB, PDF file

[Key words: cement-based materials, concrete repair, drying shrinkage, performance criteria, tensile strength]

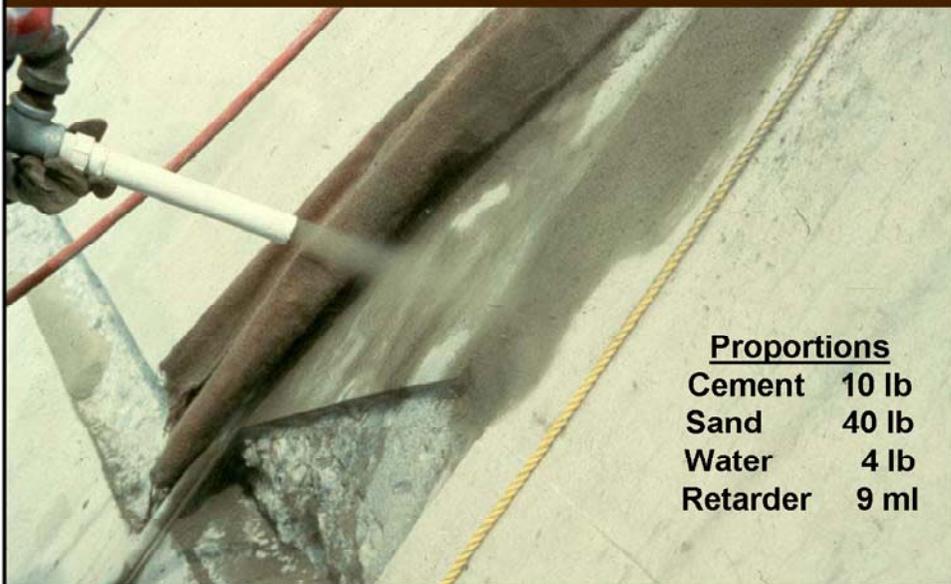
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Libby Dam



Libby Dam

Pneumatically Applied Mortar



Proportions

Cement	10 lb
Sand	40 lb
Water	4 lb
Retarder	9 ml

Libby Dam

Mortar Gun



- Easily assembled from readily available material
- Only a few critical dimensions
- Can be operated by personnel without extensive training
- EM 1110-2-2002, Evaluation and Repair of Concrete

Libby Dam



Research Needs

- Tools to reduce O&M costs and extend functional life of existing water-resource infrastructure
 - Sustainable repair technology
 - Innovative repair materials that satisfy compatibility requirements
 - Underwater concrete repair
 - Inspection techniques

Research Needs

- Reliable NDT equipment/procedures to evaluate gate anchorage systems
 - Detect corrosion activity and determine rate
 - Determine stress levels, particularly post-tensioned systems
- Materials and methods to mitigate ASR in existing mass concrete structures
- Capture corporate knowledge and promote technology infusion into the field

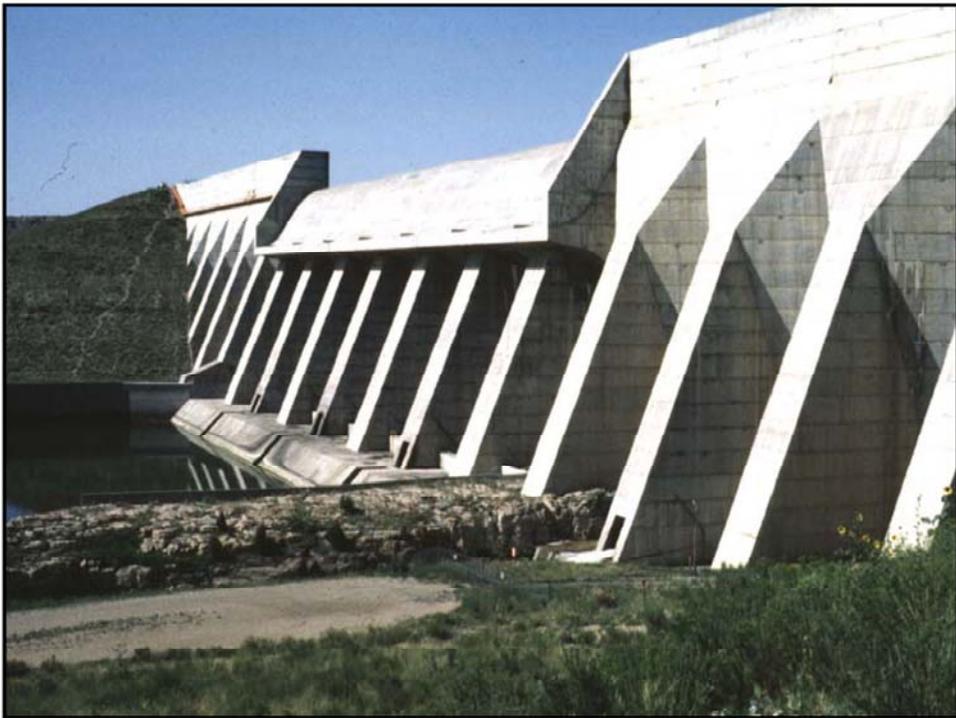
**Presentation 16:
Inspection of Concrete Spillways —
Gated and Uncontrolled**

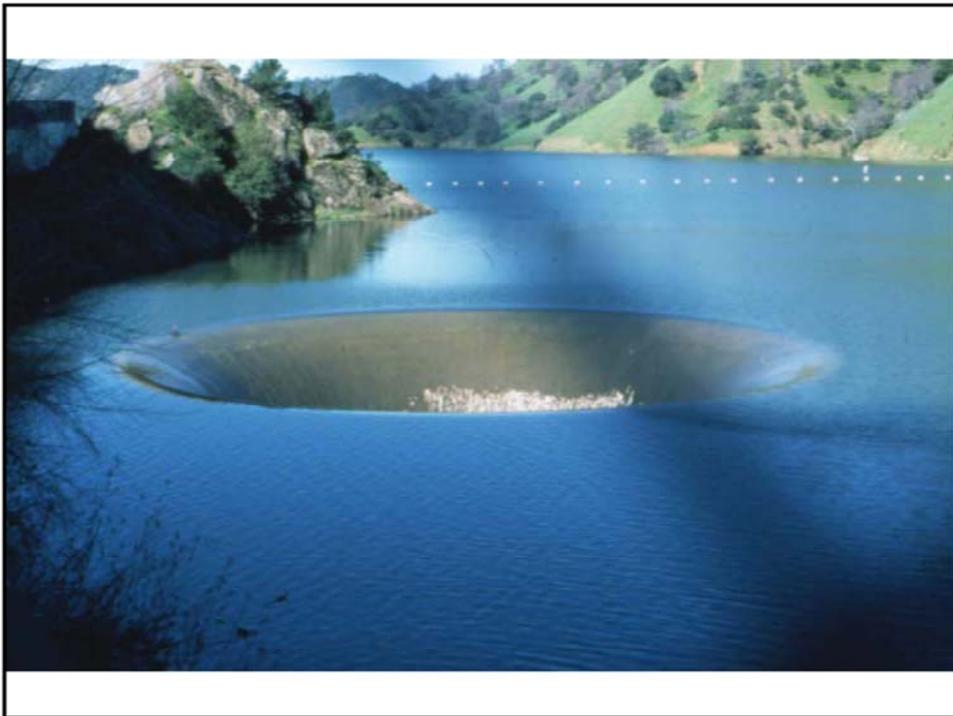
Inspection of Spillways

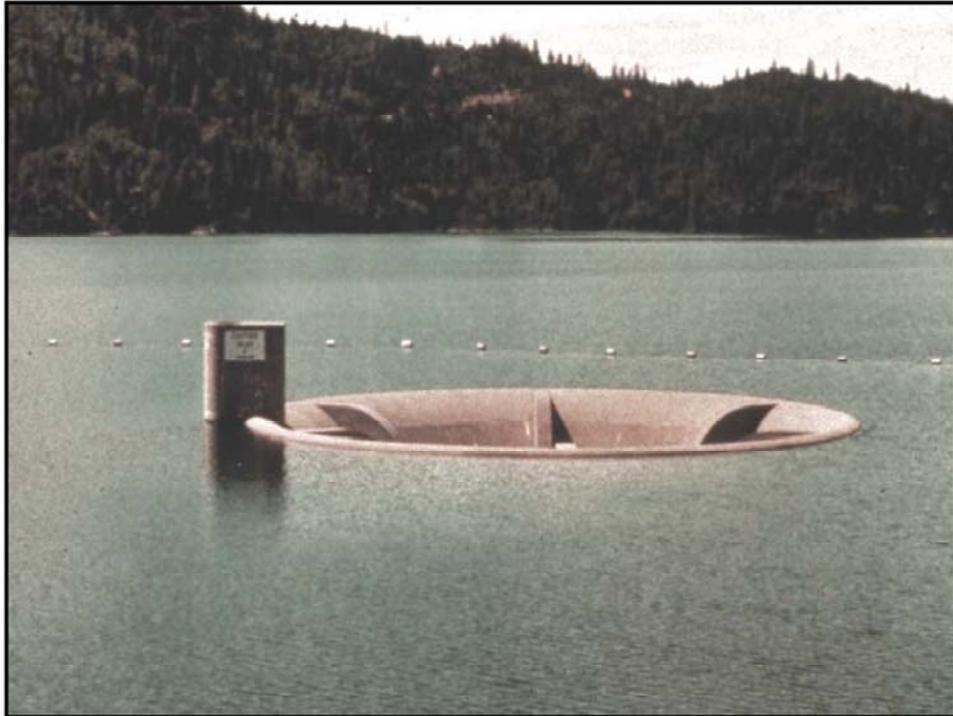
Gated
and
Uncontrolled









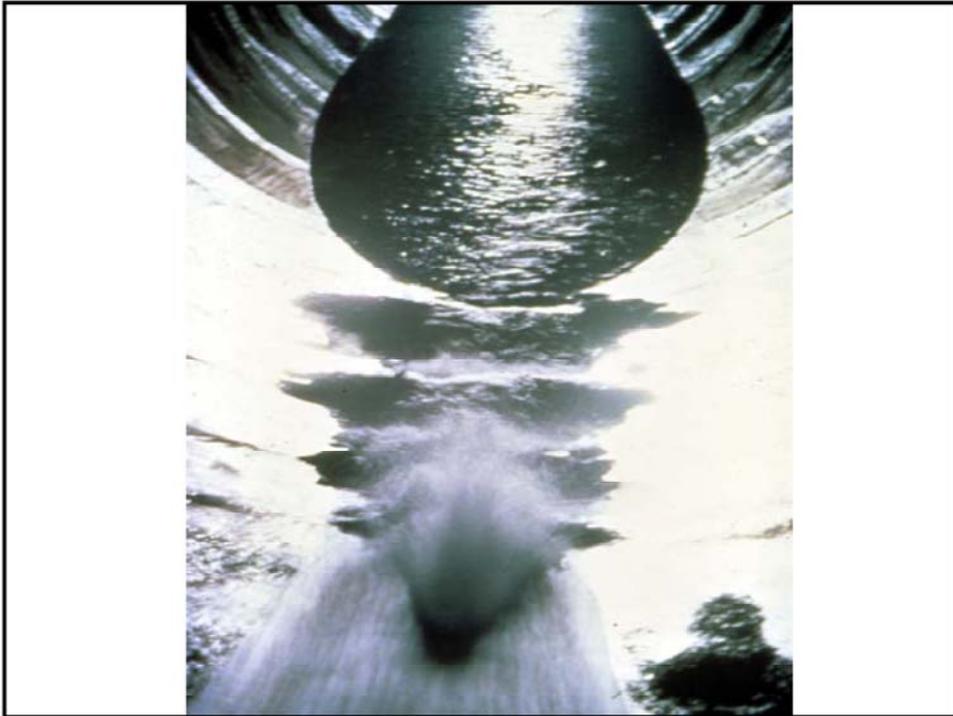


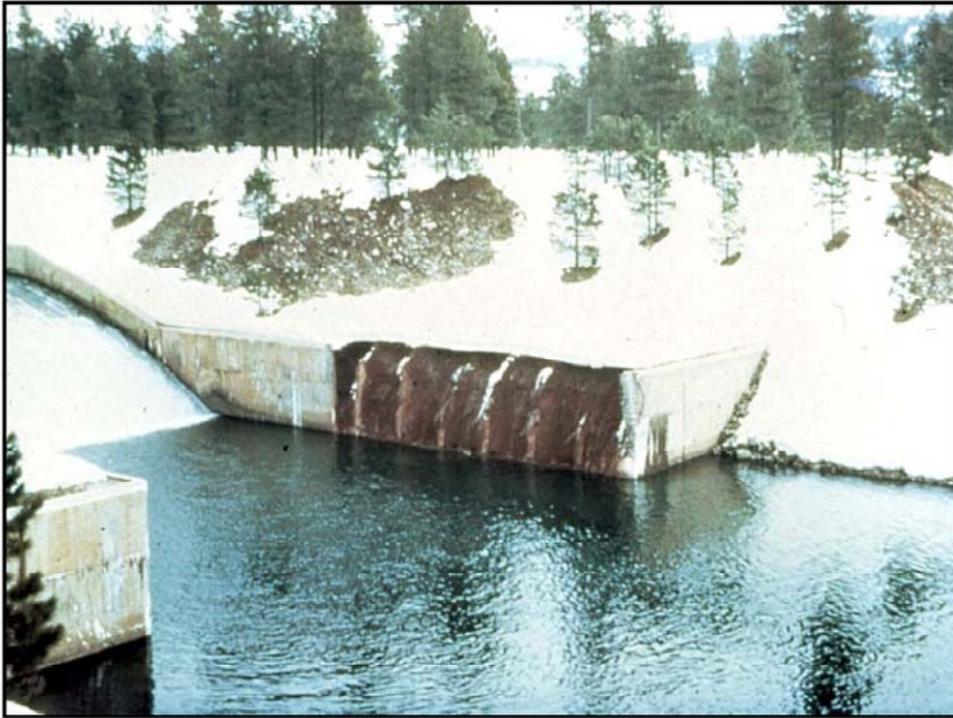
Chutes, Tunnels, & Stilling Basins











Inspection Techniques



