NDT TOOLS
To Investigate Infrastructure Projects

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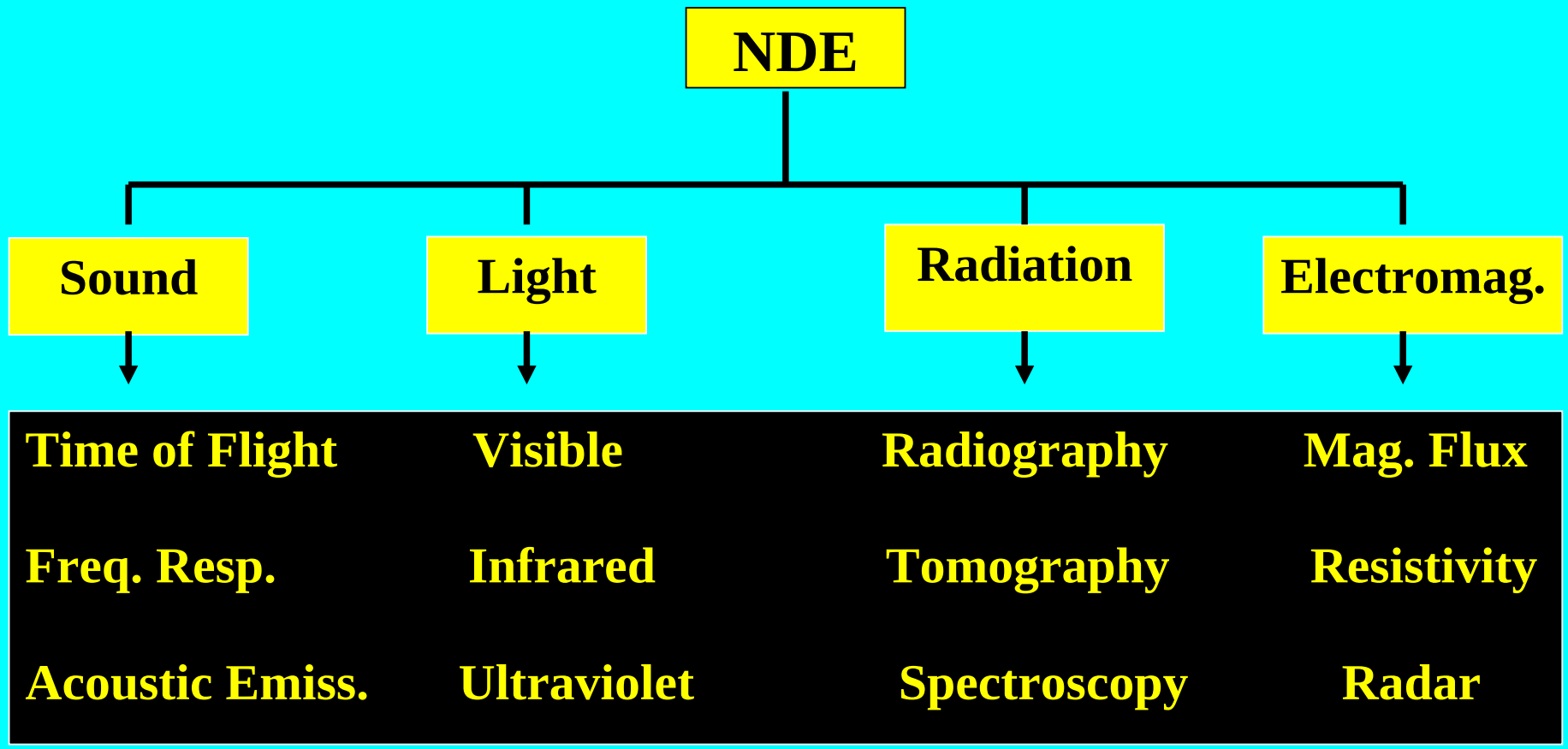
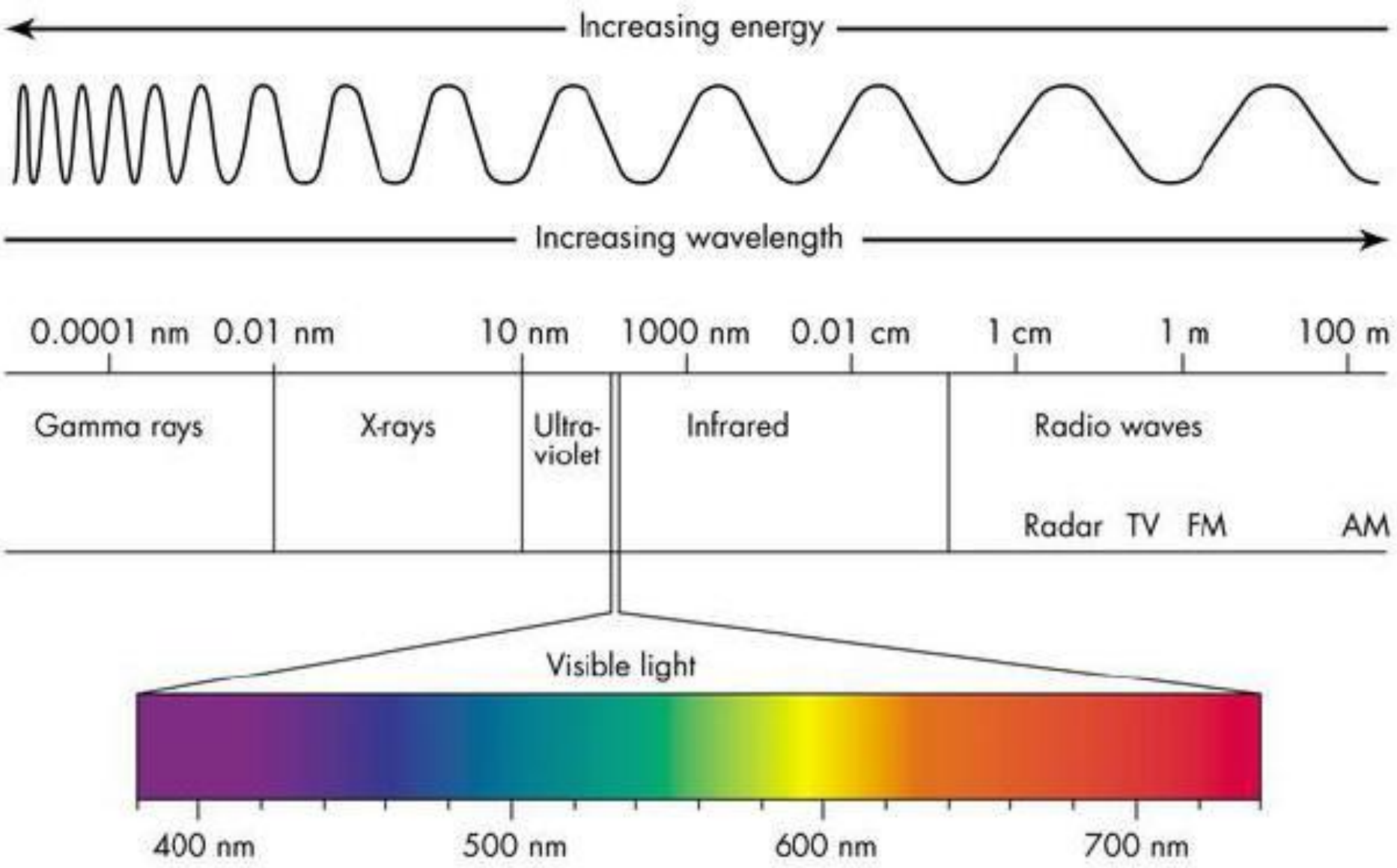

NDE
Sound
Light
Radiation
Electromag.
Time of Flight
Freq. Resp.
Acoustic Emiss.
Visible
Infrared
Ultraviolet
Radiography
Tomography
Spectroscopy
Mag. Flux
Resistivity
Radar

NDE Methods


Increasing energy
Increasing wavelength
0.0001 nm
0.01 nm
10 nm
1000 nm
0.01 cm
1 cm
1 m
100 m
Gamma rays
X-rays
Ultra-violet
Infrared
Radio waves
Radar
TV
FM
AM
Visible light
400 nm
500 nm
600 nm
700 nm

Nondestructive Testing

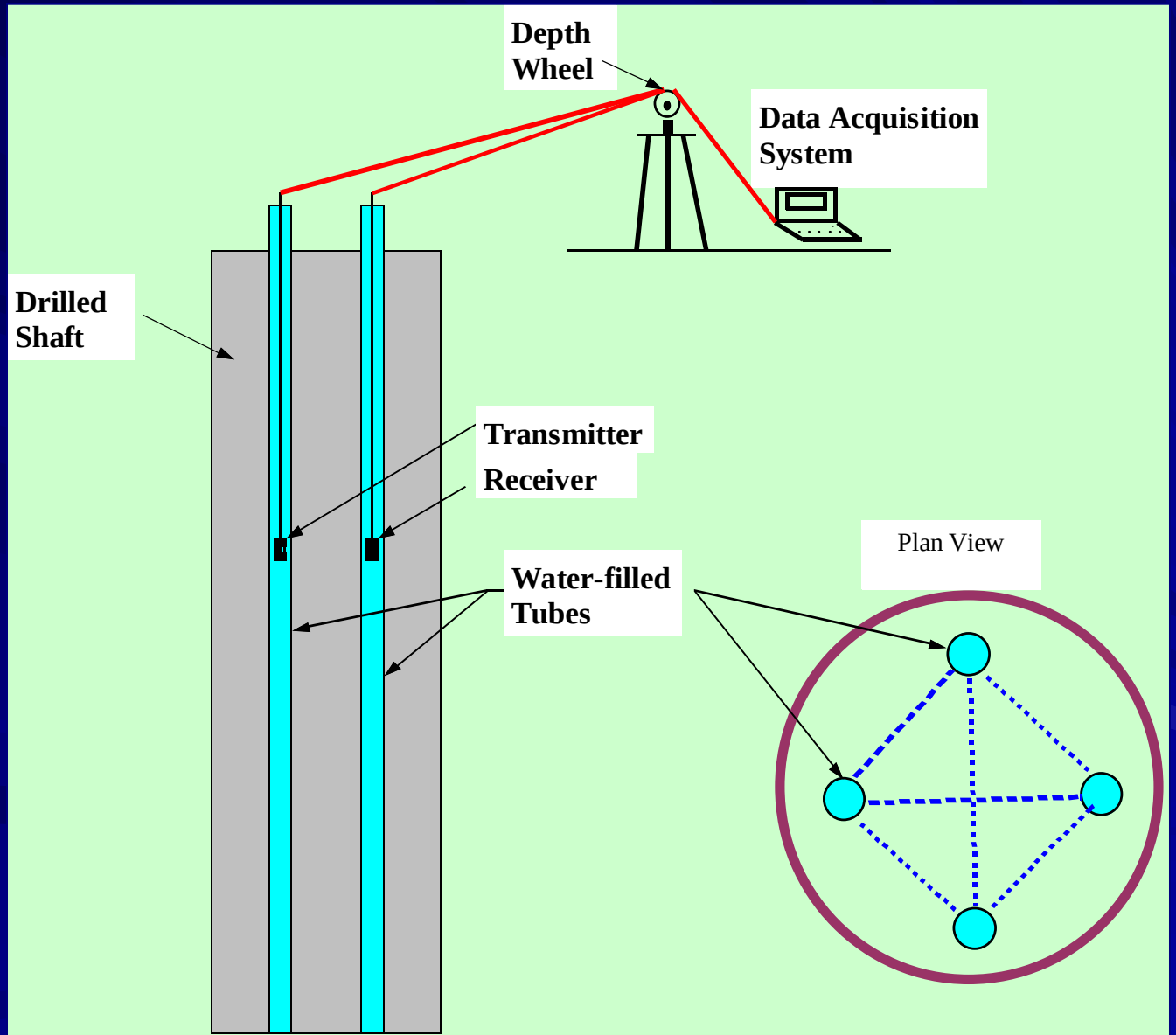
- **Cross-hole Sonic**
- **Impact-echo**
- **Pulse velocity**
- Pulse-echo
- Impulse Response
- Radar
- X-Rays

Richmond Bridge/ Testing of Drilled Shafts

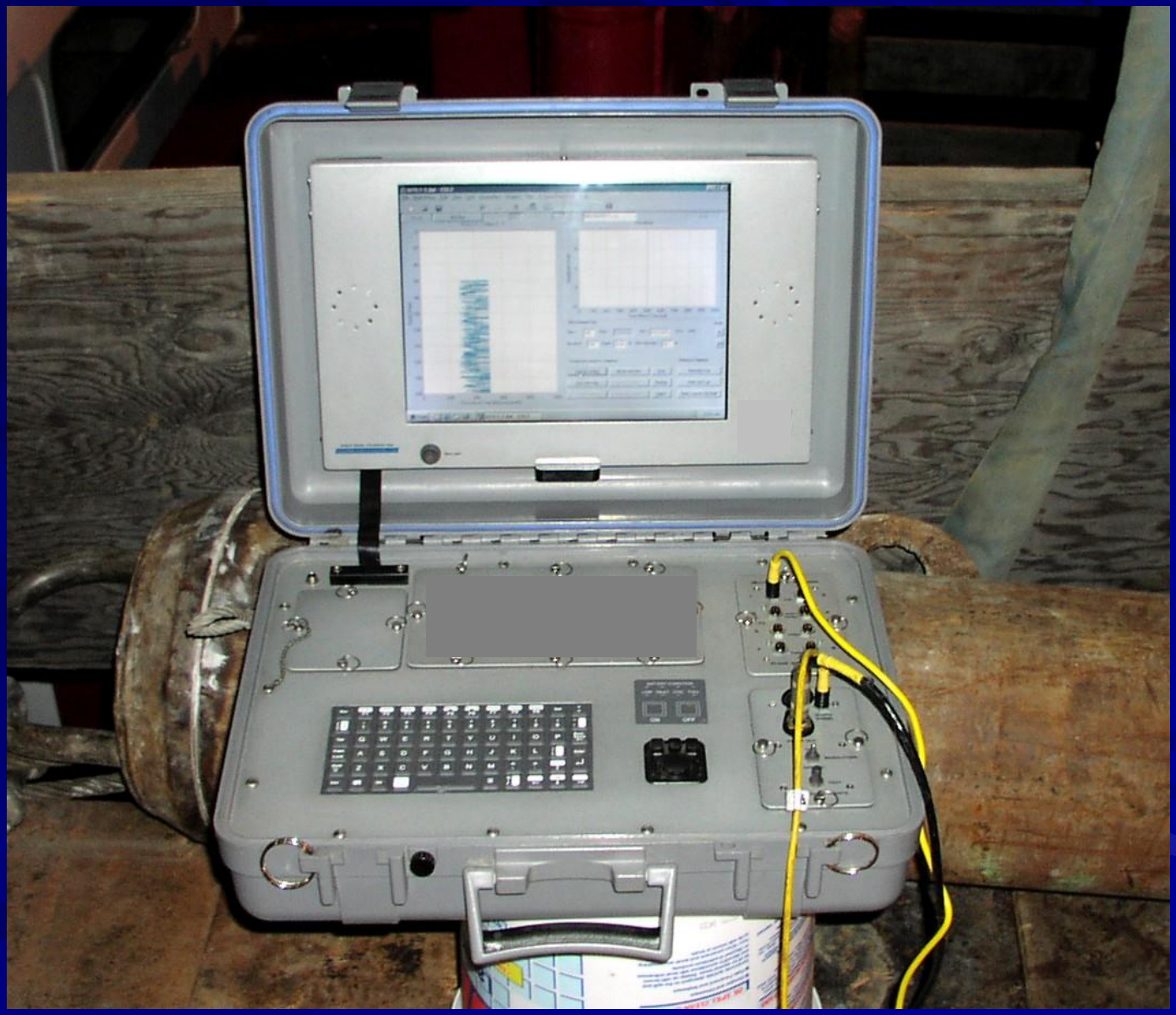
Used Cross-hole Sonic Logging Method to test the drilled shafts

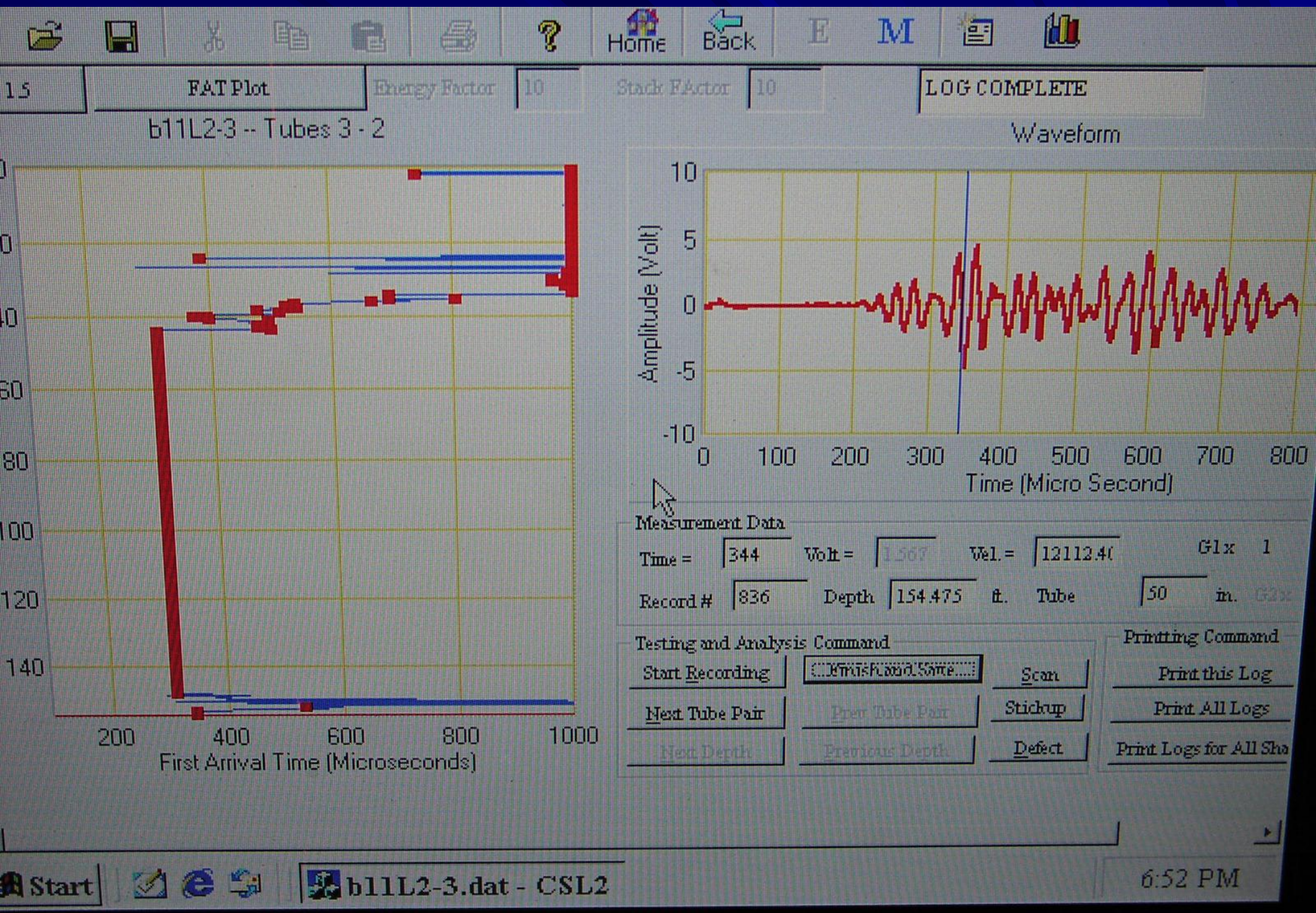

CATERPILLAR

Cross-hole Sonic Logging Method

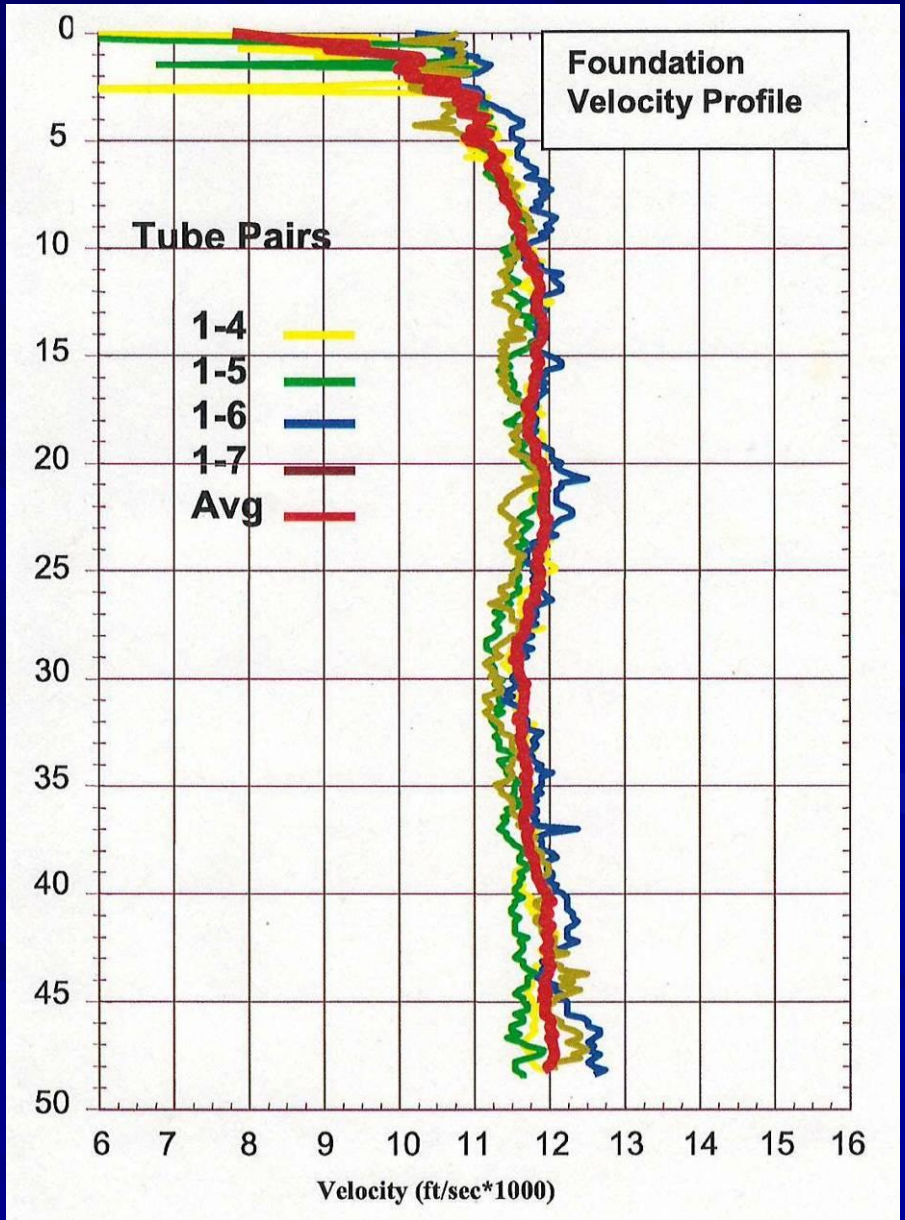


Drilled Shaft Construction



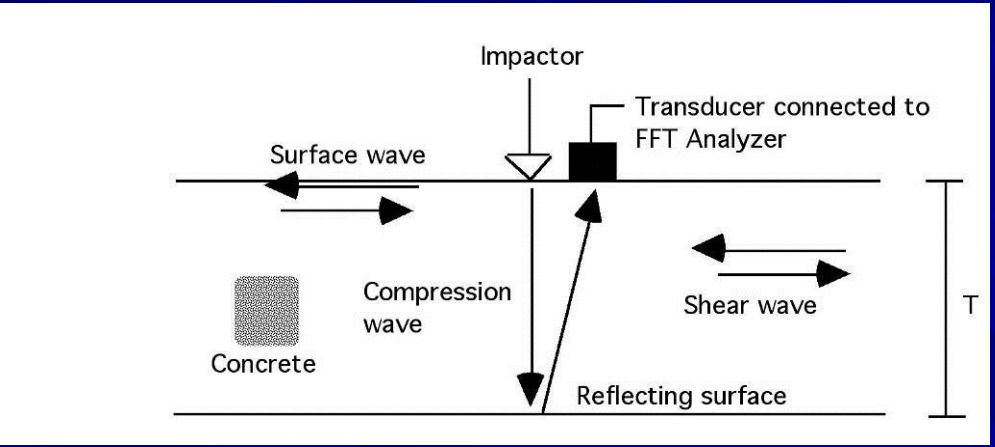

Home
Back
FAT Plot
Energy Factor
10
Stack FActor
10
LOG COMPLETE
b11L2-3 -- Tubes 3 - 2
Waveform
Amplitude (Volt)
10
5
0
-5
-10
0
100
200
300
400
500
600
700
800
Time (Micro Second)
200
400
600
800
1000
First Arrival Time (Microseconds)
Measurement Data
Time =
344
Volt =
Vel. =
Record #
836
Depth
154.475
ft.
Tube
50
in.
Testing and Analysis Command
Start Recording
Scan
Next Tube Pair
Stickup
Defect
Printting Command
Print this Log
Print All Logs
Start
b11L2-3.dat - CSL2
6:52 PM

CSL Result

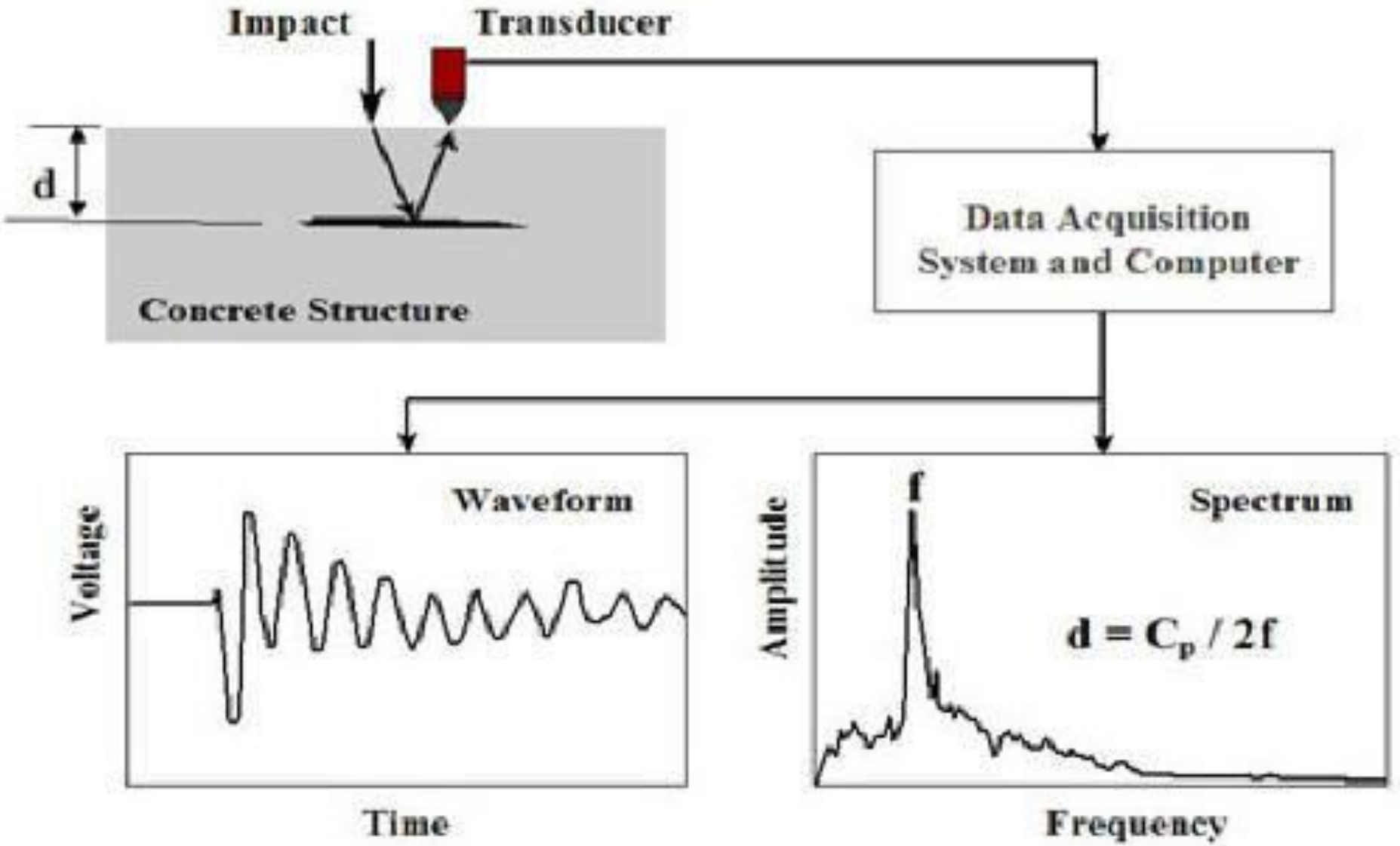

Foundation
Velocity Profile
Tube Pairs
1-4
1-5
1-6
1-7
Avg
0
5
10
15
20
25
30
35
40
45
50
6
7
8
9
10
11
12
13
14
15
16
Velocity (ft/sec*1000)

Impact-echo Principle

- A short pulse is introduced in the structure.
- Reflected waves are analyzed with the waveform analyzer in the frequency domain.
- Dominant frequencies relate to the condition of the structure.



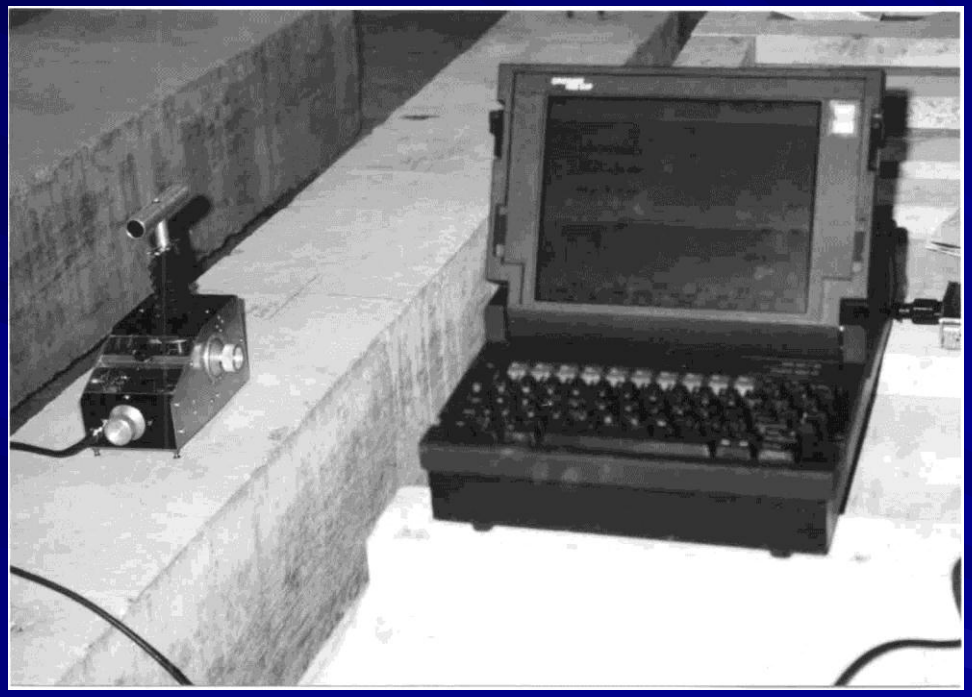
How Impact-echo works



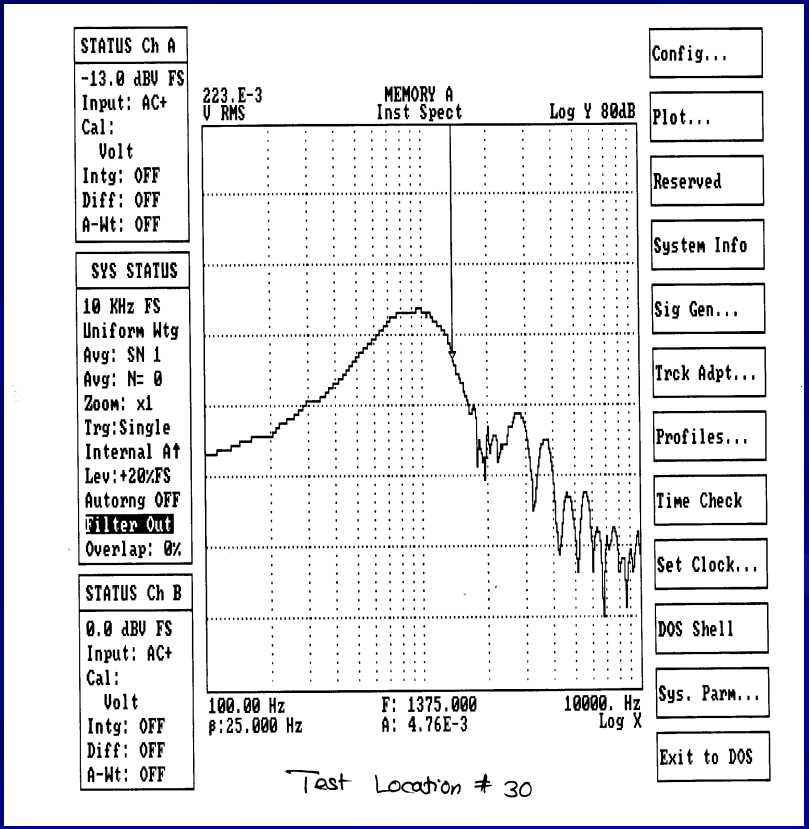
Impact-echo

- Based on propagation of a stress wave through the material.
- Needs an access from only one side to conduct the tests.
- “Local” Test
- On-site Evaluation- most often no further analysis is needed.

Impact Echo Instruments



Impact Echo Response Spectrum



Impact-echo Capabilities

- Determine thickness and overall condition.
- Locate internal voids, cracks, delaminations, honeycombing.
- Helps to identify core locations.

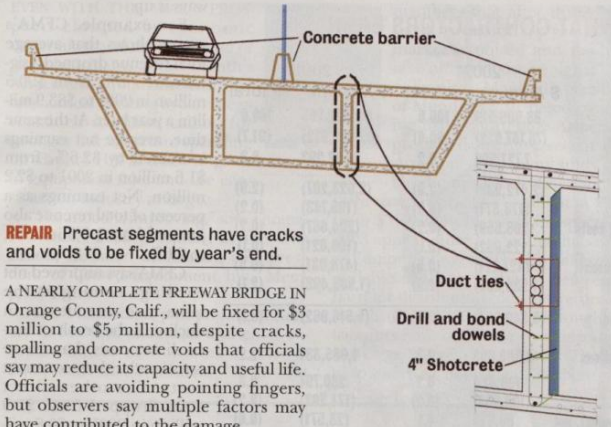
Caltrans Overpass

Determination of Grout Status in PT Ducts

- Carpool overpass I-405 & 55 in Costa Mesa, CA
- ENR Articles 12/2/2002 & 1/27/2003
- Used Impact-echo technique to determine status of the grout
- Worked for Caltrans through a sub-contract

Highways

REPAIRS UNDER WAY FOR RAMP THAT WENT AWRY IN CALIFORNIA



REPAIR Precast segments have cracks and voids to be fixed by year's end.

A NEARLY COMPLETE FREEWAY BRIDGE IN Orange County, Calif., will be fixed for $3 million to $5 million, despite cracks, spalling and concrete voids that officials say may reduce its capacity and useful life. Officials are avoiding pointing fingers, but observers say multiple factors may have contributed to the damage.

The $12-million carpool ramp connecting Interstate 405 with State Route 55 is key to a $125-million upgrade of a heavily congested interchange in Costa Mesa. Damage in the 9-ft-deep concrete box girder bridge was discovered last August during installation of a seismic restraint across the moment joints.

Now, the scheduled April 2003 opening has been postponed. General contractor C.C. Myers Inc., Rancho Cordova, Calif., is expected to complete repairs for opening by the end of 2003, says T. Rick Grebner, manager of the interchange project for the Orange County Transportation Authority. The Santa Ana, Calif., office of design consultant CH2M Hill Cos. proposed installing duct ties, or U-bolts, around the tendons. A 4-in.-thick layer of shotcrete would thicken the web so that the ducts regain their central position.

After work stopped last year, investigation found spalled and cracked concrete, exposed rebar, rock pockets, ungrouted tendons and variable thickness in girders and slabs (ENR 12/2/02 p. 14). "Clearly this is nothing new," says Freider Seible, dean of the School of Engineering at the University of California, San Diego, and a consultant to OCTA. European bridges sustained similar damage decades ago, as did several Californian bridges more recently, Seible says.

Most damage is in the interior webs of the bridge's two curved sections, where radial forces are most likely to place stress on tendons, says H. Tony Rahimian, senior vice president with CH2M Hill. Inspectors found cracks, primarily hairlines, along 40% of the 7,218 linear ft of two curved sections. Tendon grout voids were found along 2%, or 656 ft of the bridge's 29,000 ft of tendons. The damage, especially the voids, could reduce bridge durability and capacity, he says.

"It's not one thing in the end that caused the problem but a whole series" of issues, says Seible. Further study is likely to focus on such possibilities as overstressing of tendons, variability in thickness of girder webs, and whether duct ties of the type that will now be installed could have avoided the damage by resisting the tendency of radial forces to pull tendons outward. "We need to consider those radial forces when we have a curved bridge," Seible says. Inspection of the entire bridge after prestressing "should be common practice," he adds.

Bob Schneider, C.C. Myers' project manager, says Seible's analysis points to "an underlying design problem" of absence of duct ties and the location of prestressed tendons relative to girder height. It also suggests that "the bridge constructed perfectly as designed was going to have cracks in the girders," Schneider adds. Negotiations over who will pay for the repairs are ongoing. ❑

By Paul Rosta

Unions

OWNERS INITIATE COLLABORATION

IN AN INDUSTRY FIRST, A HIGH-LEVEL group of construction owners, contractors and building trades unions have formed a "tripartite initiative" to improve construction through meaningful dialogue, collaboration and mutual commitment to positive change.

But the industry leaders' goals go beyond rhetoric. The group, in a series of planned regular meetings, intends to tackle an array of concerns including eliminating jurisdictional disputes, improving productivity and enhancing workplace safety. Work teams comprised of owners, top officials from contractor groups and presidents of AFL-CIO Building and Construction Trades Dept. unions will develop proposals for implementing these initiatives by the next meeting, scheduled for May 22. Another meeting will be held in October.

Building trades unions have a long history of jurisdictional disputes. But in this instance, it was the owners that identified it as a problem, claims Gregory L. Sizemore, executive vice president of the Construction Users Roundtable, the owners group that was instrumental in getting the initiative off the ground. The owners' involvement could be "a catalyst for resolution," he says. One owner indicated he'd switch to an open shop contractor to avoid further labor disputes. "That served as an epiphany for many unions," Sizemore says. "Owners don't want to be the rope in that tug of war."

Each sector will take a turn hosting a meeting, but the sessions are facilitated by Richard Barnes, deputy director of the Federal Mediation and Conciliation Service. Using a top-level facilitator underscores the seriousness of the endeavor and the commitment to building a relationship between owners and the organized sector of the industry, says Sizemore. "If any of the three constituents had run the meeting it would be hard not to have any bias," he adds.

Attendees were surveyed on areas of importance. The only guidelines were that the undertakings should be doable, meaningful, mutual and measurable, says Sizemore. "We can do anything, but we can't do everything," he says. Participants were also interested in improving craft awareness of the owners' role in construction, recruitment and retention and improving labor relations at the local and regional levels. ❑

By Sherie Winston

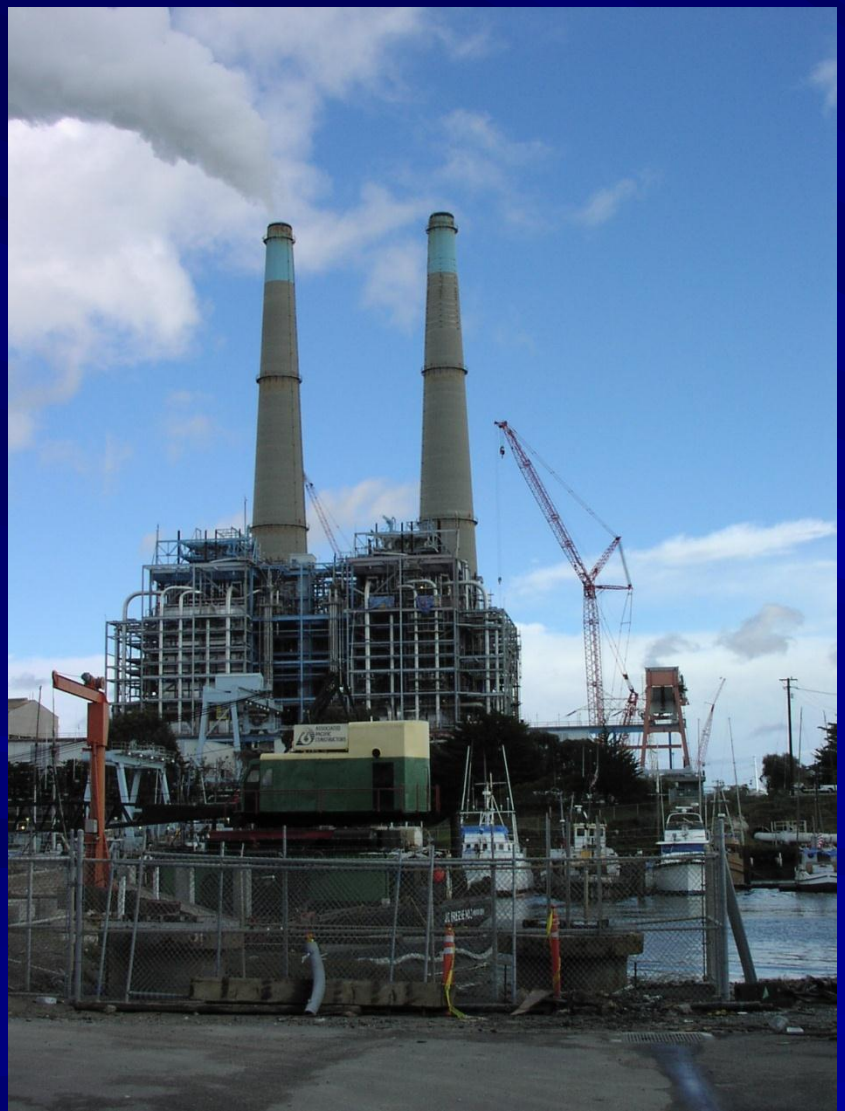

1.75mm thk.
9-30-02
1.75MM
2mm thk.
Crack
9-30-02
2.0MM
17mm thk.
Spall

Caltrans Overpass

- Impact-echo Testing

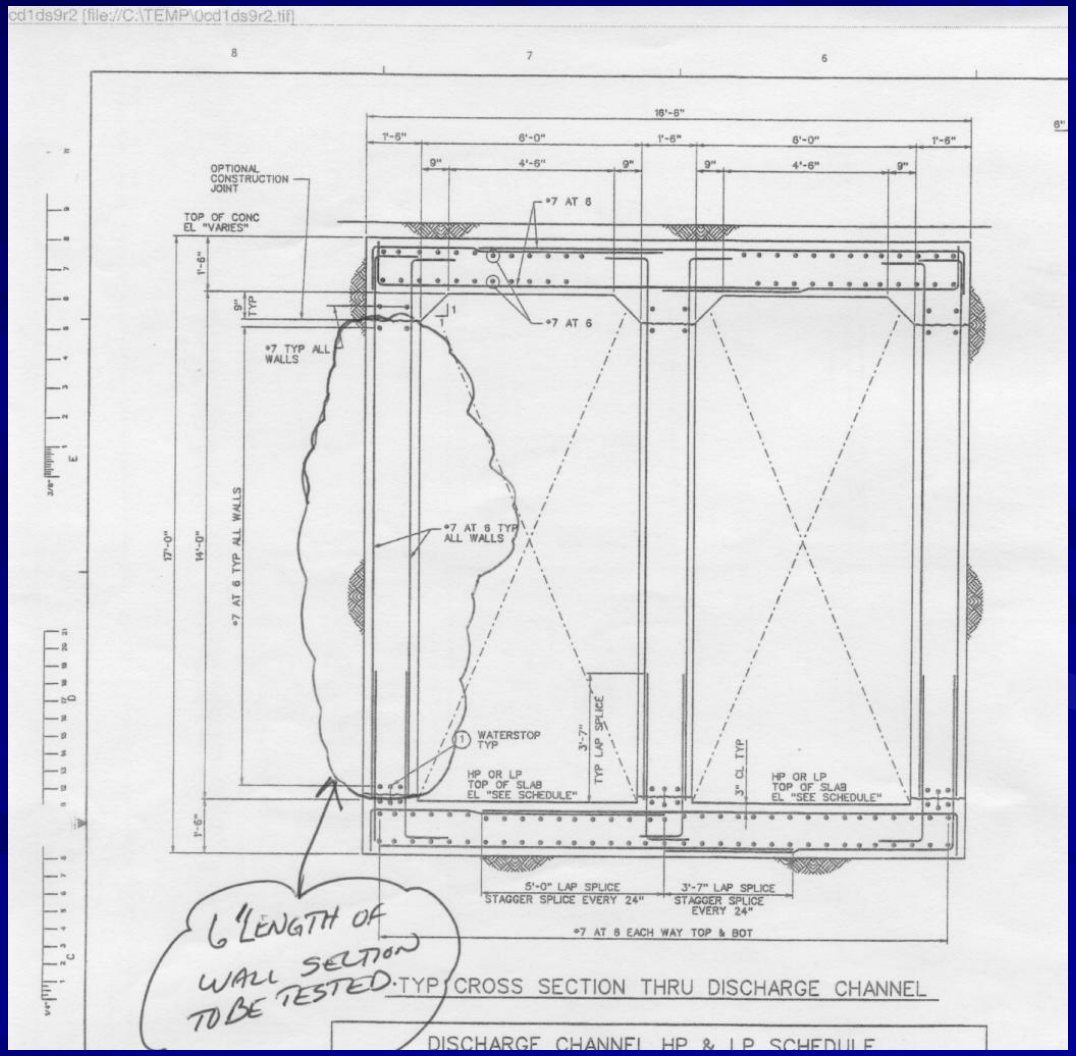
Caltrans Overpass

Moss Landing Power Plant

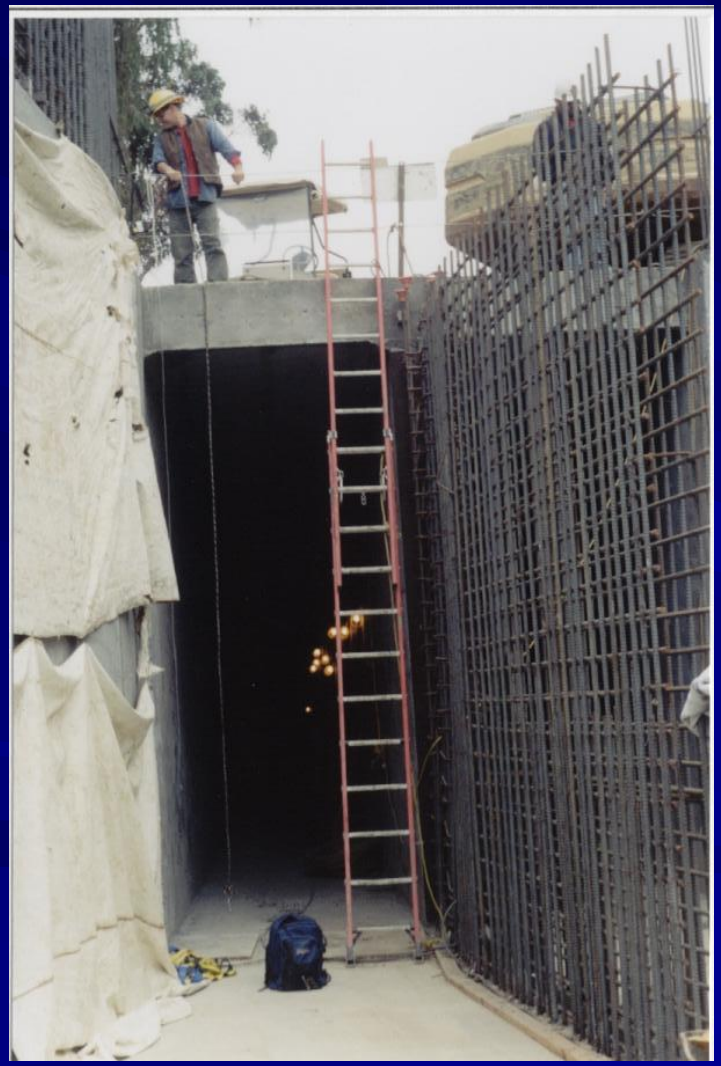


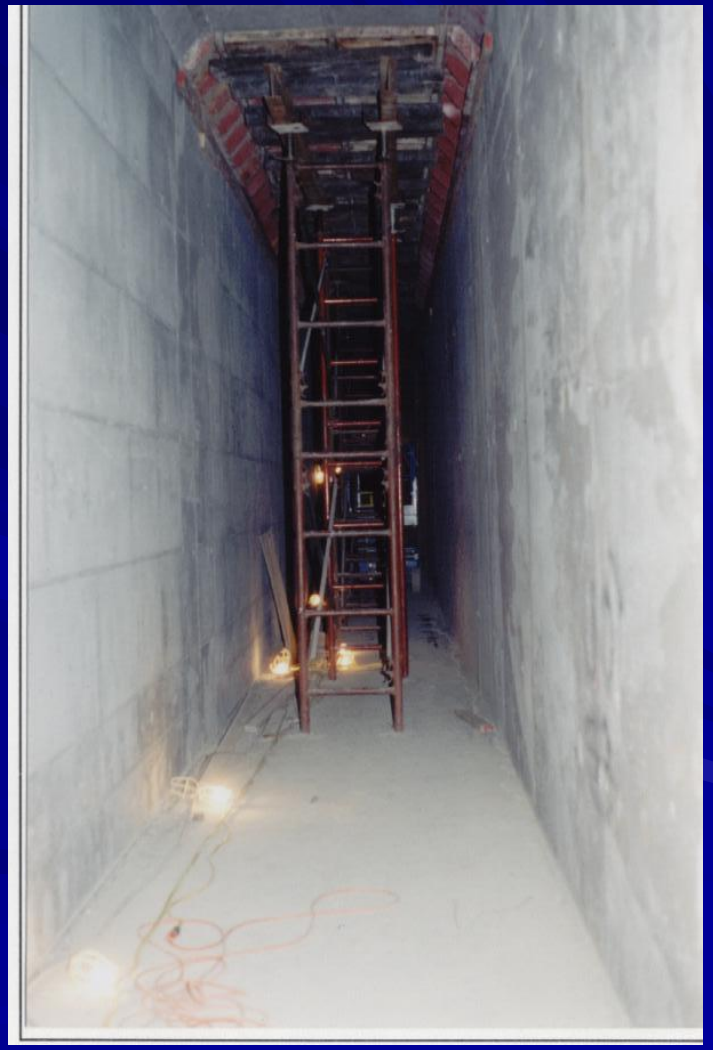
- Testing of intake and discharge tunnels
- Conducted condition survey, impact-echo testing, coring, petrographic examination
- Found internal delamination & ASR

Moss Landing Discharge Tunnel Wall



Tunnel Views





IE Spectrum Plot

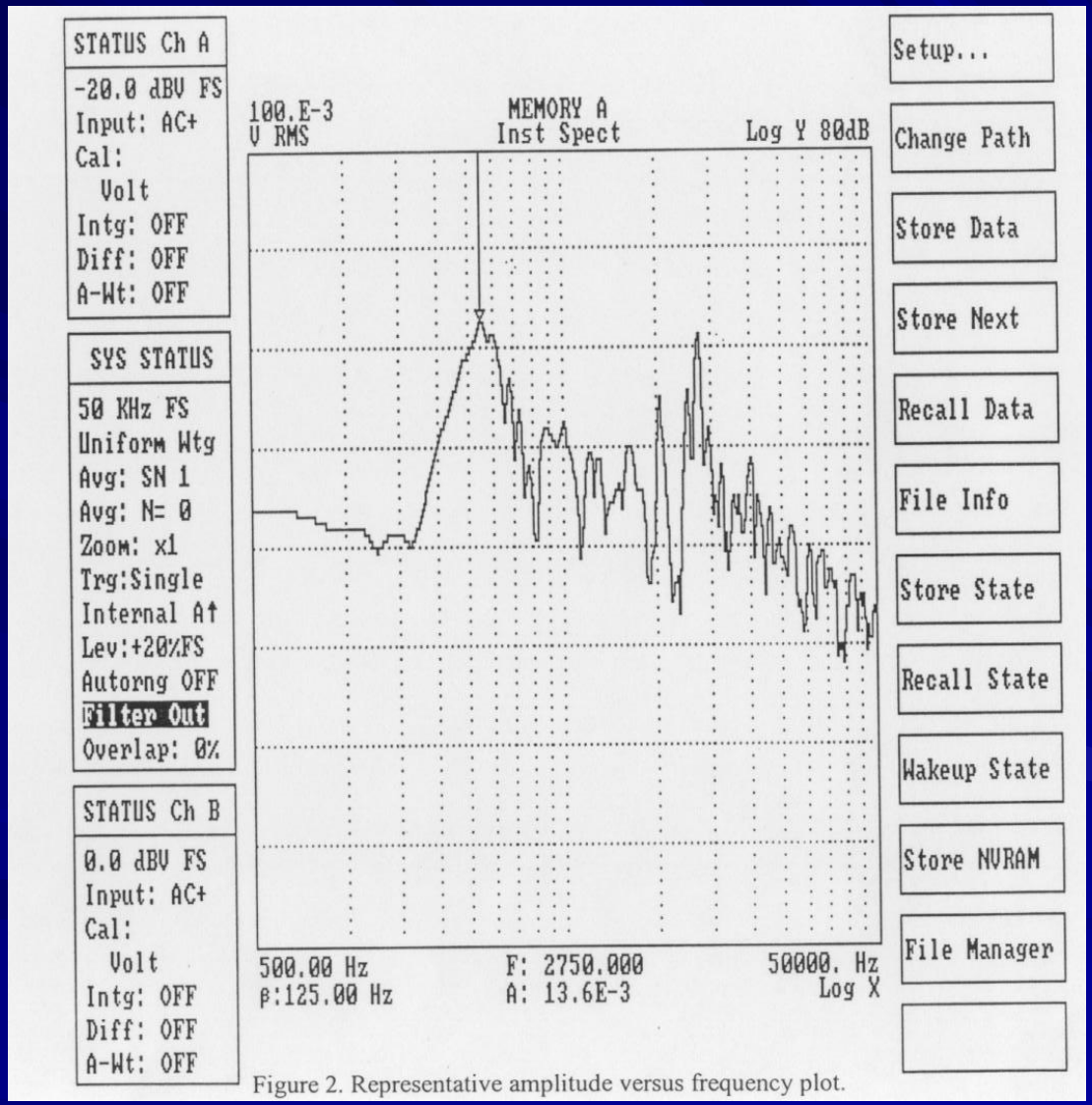
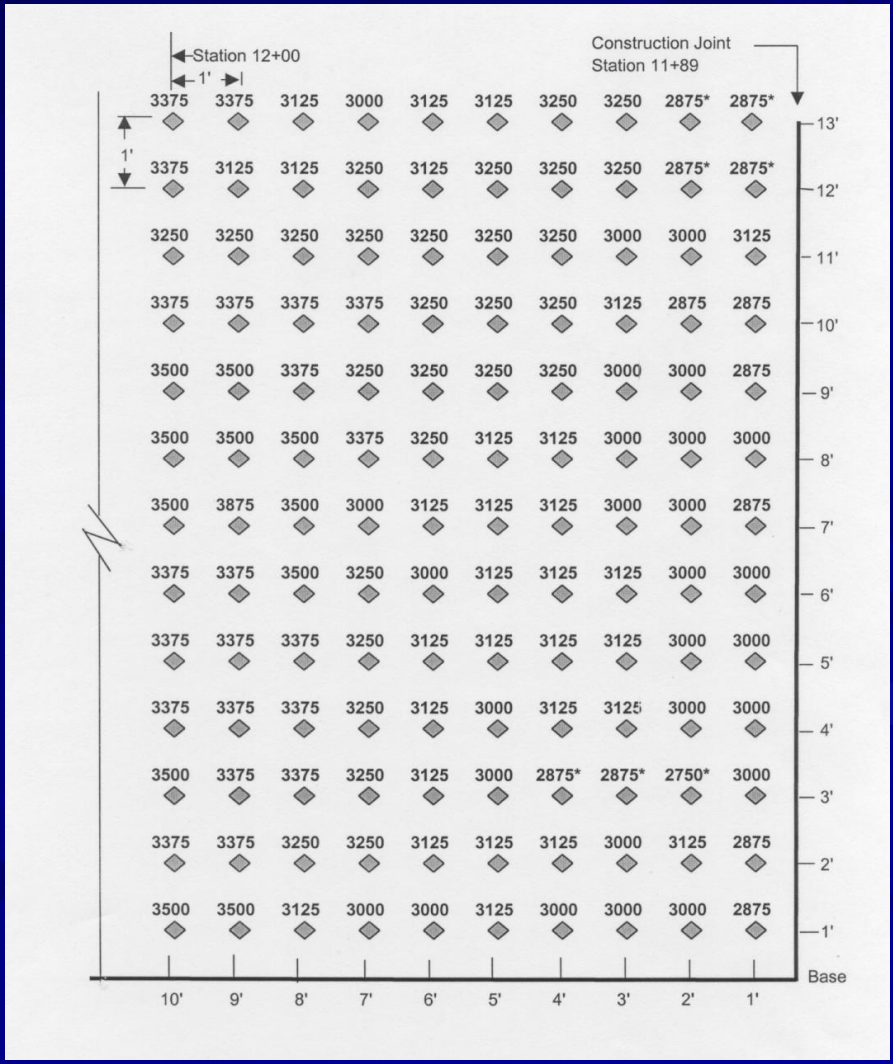


Figure 2. Representative amplitude versus frequency plot.

IE Measurement Grid



Sample Projects/Water Retaining Structures

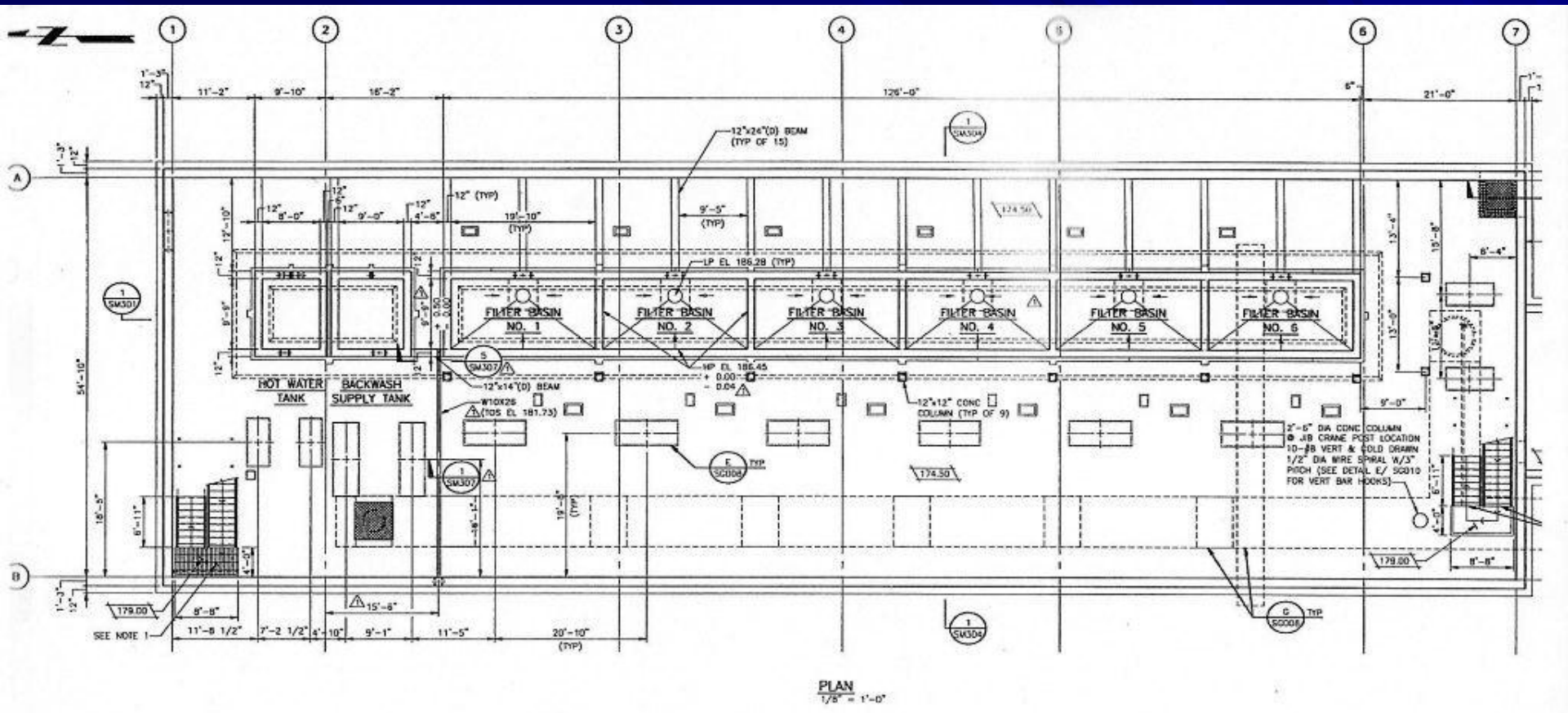
Water Treatment Plants

Waste Water Treatment Plants

Water Retaining Structures

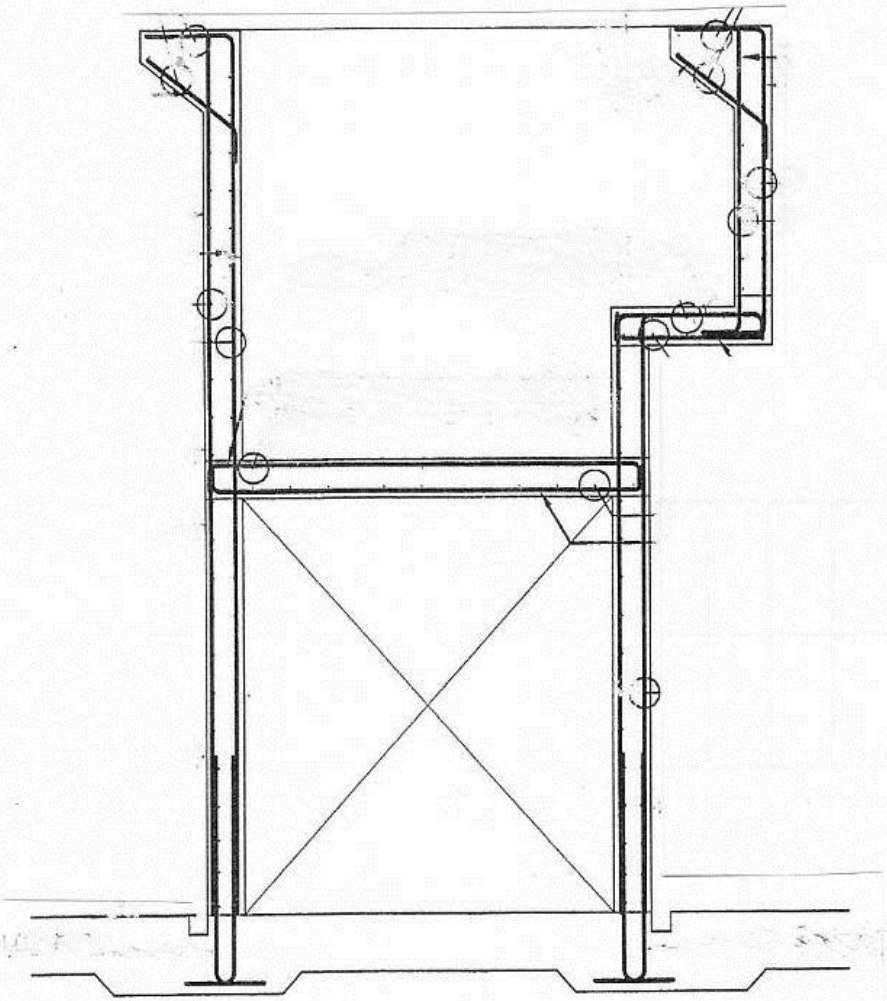
- Ozone Contactor
- Hot Water Tank
- DAF Structure
- Filter Chambers
- Pump Stations
- Digester Tanks
- Sewer Vault

Filter Chambers



Plan View

Filter Chamber



Elevation View

Filter Basin Interior View

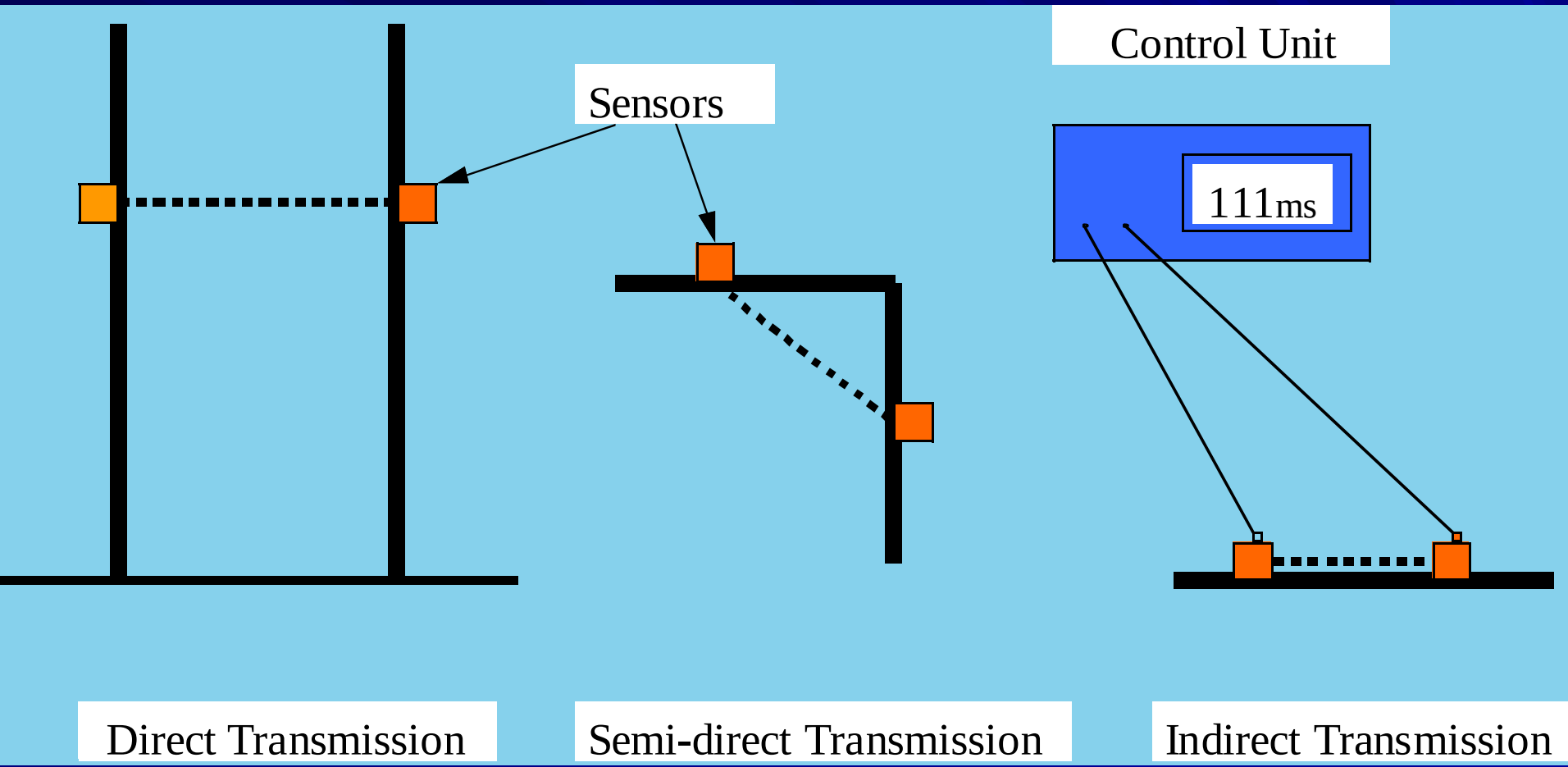
Filter Basin Test Locations

No	Location		Interior Delamination
1	Basin 1 & 2	Divider Wall	Yes
2	Basin 1 & 2		Yes
3	Basin 1	Lower West Wall	Yes
4	Basin 1	Upper West Wall	Yes
5	Basin 2	East Wall	Yes
6	Basin 2	Lower West wall	Yes
7	Basin 3	East Wall	Yes
8	*Basin 3*	*Upper West Wall*	*No*
9	*Basin 5*	*Upper West Wall*	*No*
10	Basin 6	East Wall	Yes
11	Basin 6	South Wall	Yes
12	Basin 6	Lower West Wall	Yes

Pulse Velocity

- Based on sound propagation through the concrete.
- Need access from opposite sides.
- Time of arrival is measured electronically.
- Velocity is indicative of relative quality of the concrete.
- Can be used to detect internal flaws.

Pulse Velocity Method



Pulse Velocity Equipment

- Two sensors : Transmitter and a receiver
- Electronic measuring and controlling unit.
- Portable and light-weight.
- Once the grid is established, measurement process is quick.

Pulse Velocity

- Access from opposite sides is not always available.
- Does not detect location of the flaw.

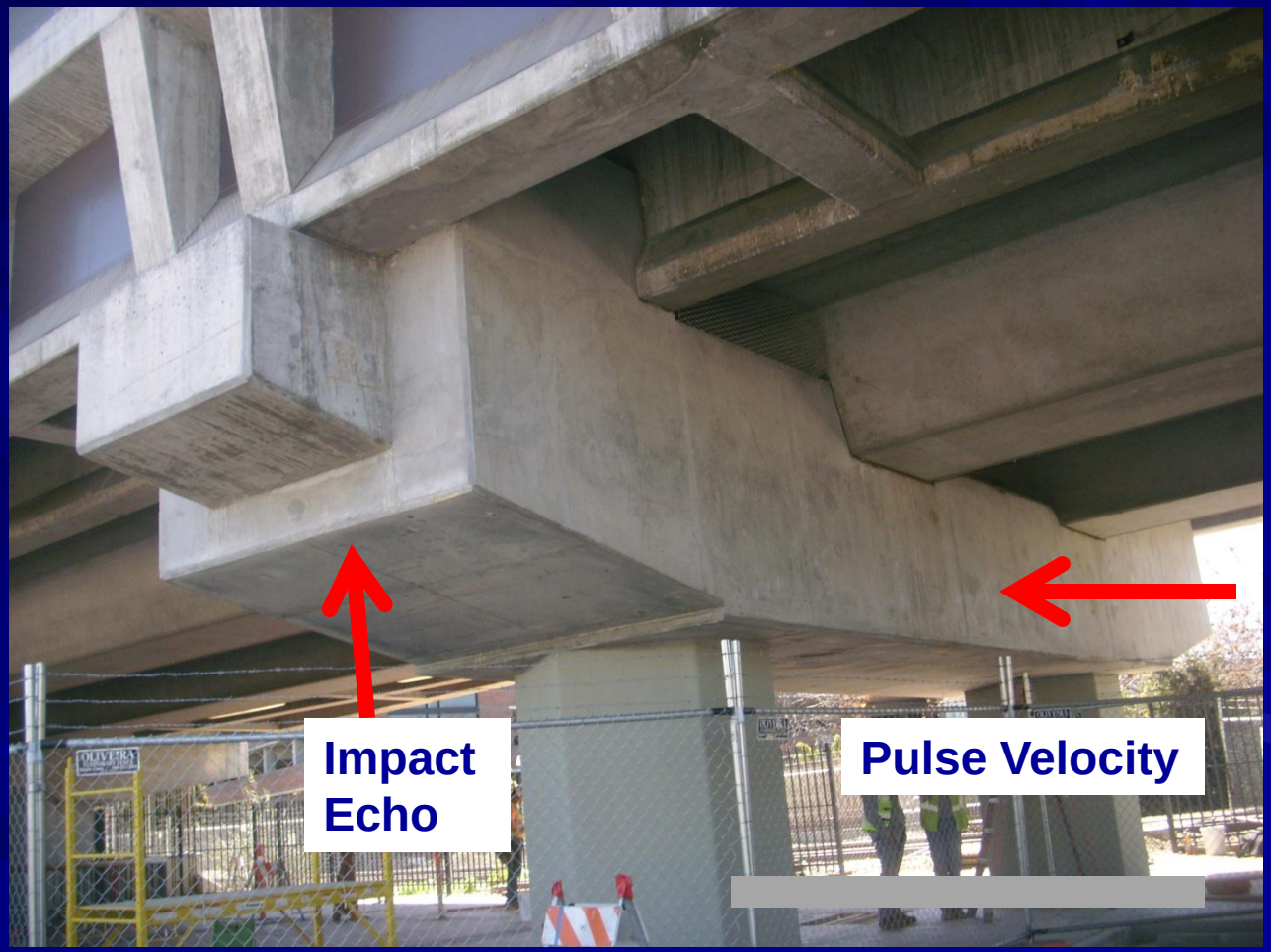
A combination

- Impact Echo
- Pulse Velocity

BART

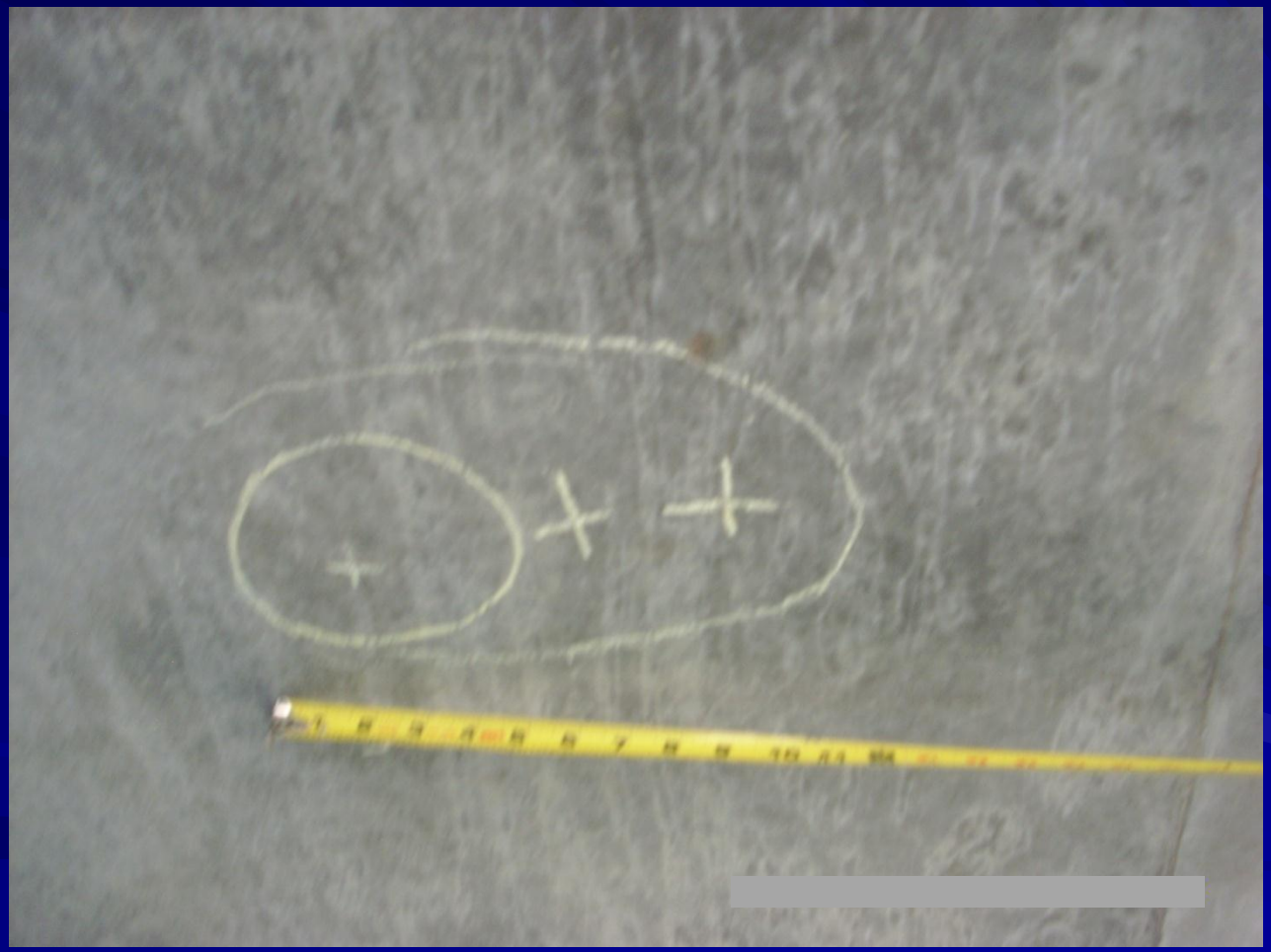
Testing

Pulse Velocity
Impact Echo



Impact Echo-Testing

Defect



Thank You !

Any Questions?

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