Noise and Impact Hammers

by
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Made for the Pile Driving Unions

Dale Carnegie® Training

Introduction

The purpose of this presentation is to discuss noise created by pile driving equipment with a focus on impact hammers.

Presentation outline

- What is noise. Where does it come from?
- How is it measured.
- The two main types of noise pile driving creates.
- What kind of regulations are we facing.
- Where is the noise coming from?
- What has been done in the past.
- What's being done now.
- What should be looked at in the future.

What is noise? Where does it come from?

Noise is a vibration. The kind of vibrations we are discussing are those created by impact pile driving. As we will see, these noise vibrations may not be coming from the hammer, but from the pile driving system as a whole.

APE D-46-32 at full stroke on test stand in California undergoing sound tests.

Measuring noise:

Noise can be measured using a decibel meter.

The name comes from Alexander Graham Bell and the unit of measurement is called- the bel.

Usually the value in bels is multiplied by ten and the sound level is expressed in decibels (dB).

More advanced devices are being used to determine the type of sound coming from impact pile hammers.

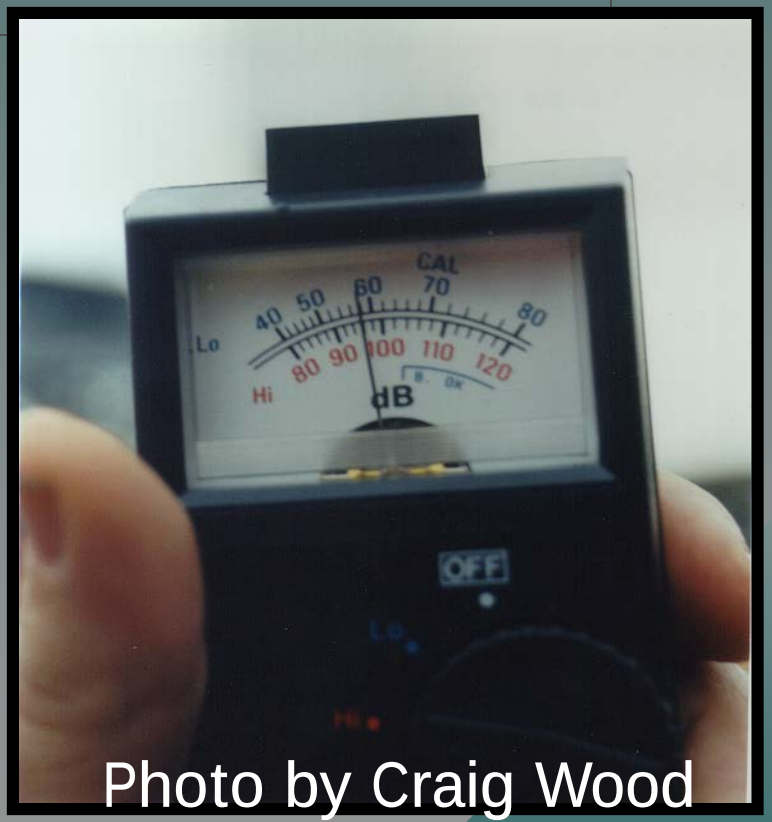


Photo by Craig Wood

This meter totals all noise.

The two types of noise we are interested in:

1) Point Source

2) Line source

Point source

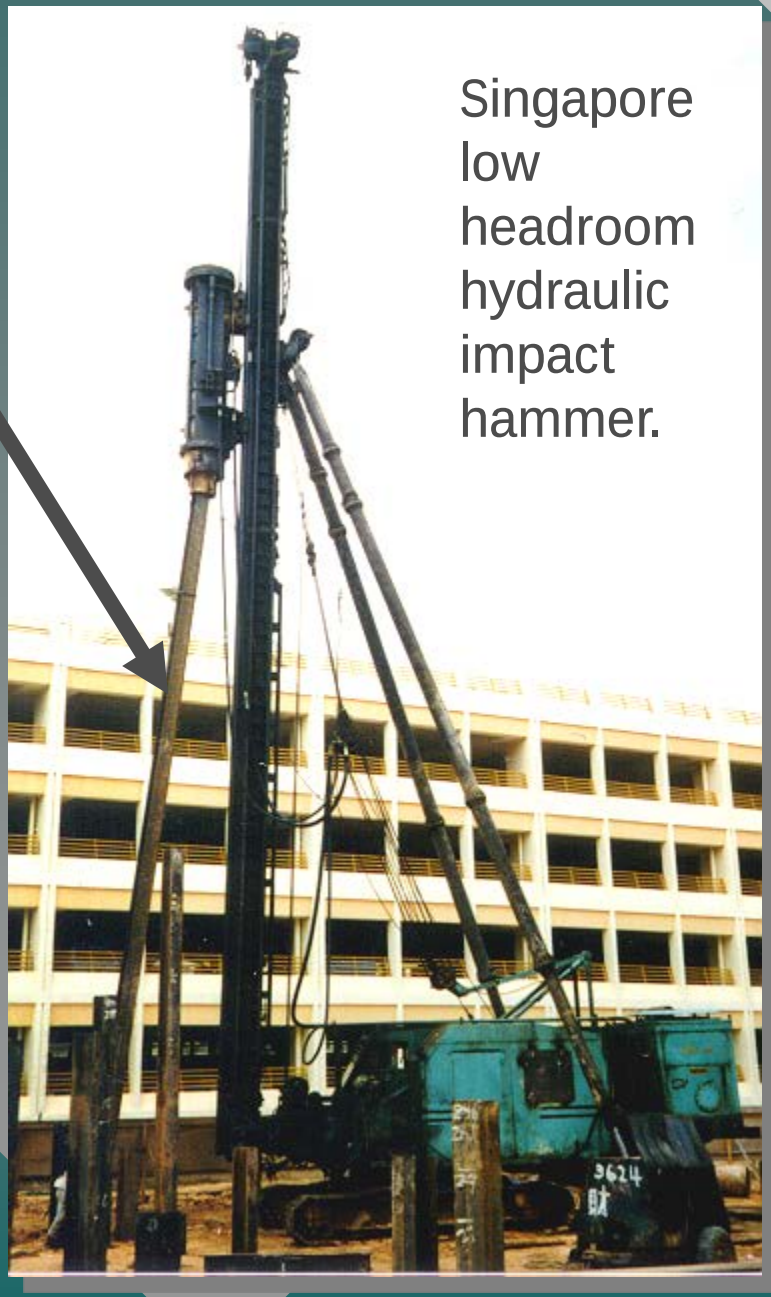
An example of a point source is sound coming from a single point, such as the noise coming from the anvil striking the striker plate.

D30 anvil hits striker plate

Line Source

An example of a line source is sound coming from a long pile as shown in this picture from Singapore of a Hydraulic drop hammer driving an H-beam pile.

Type: Hydraquip



Measuring facts:

Noise from a point source will drop 6 dBA for each doubling of distance.

Noise from a line source will only drop 3 dBA for each doubling of distance.

Noise from a point source

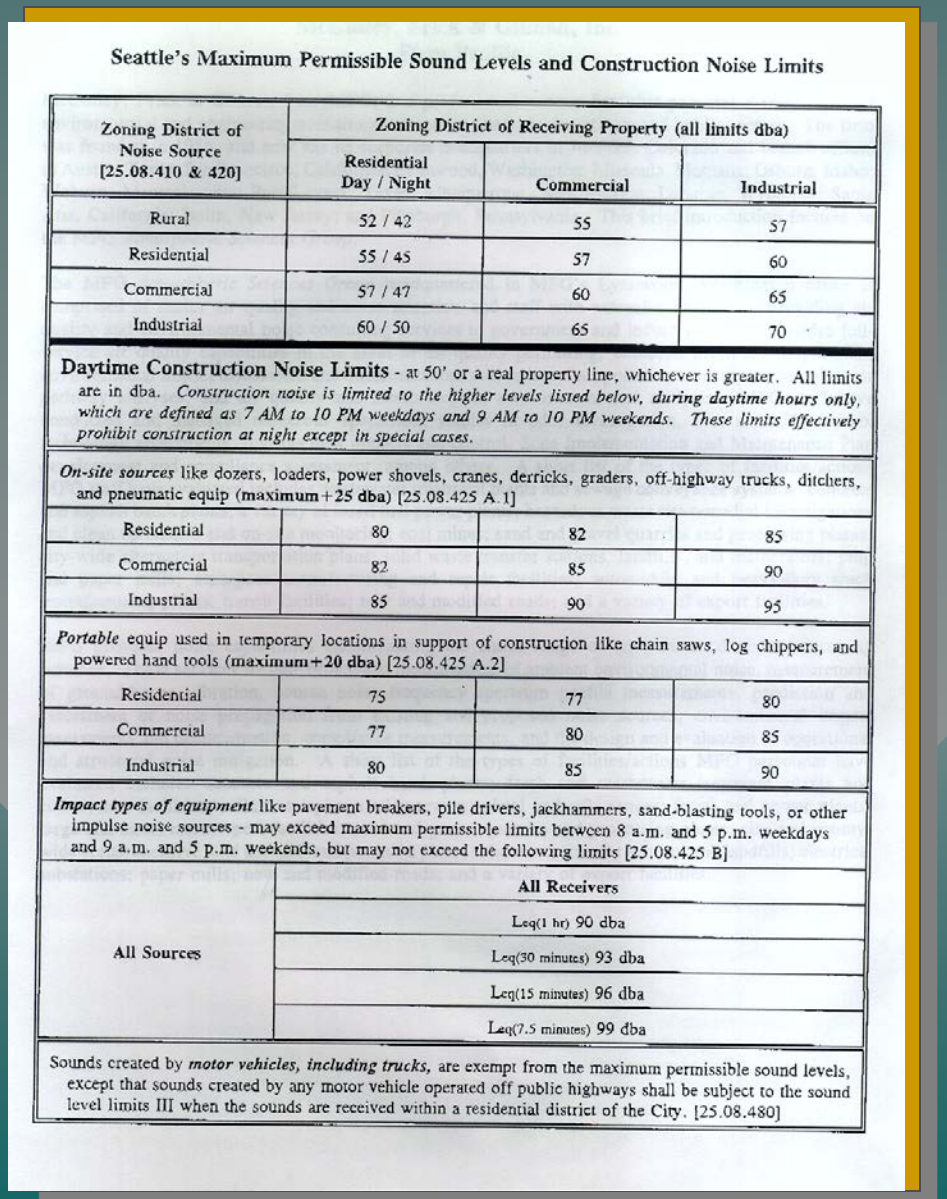
Noise	50 ft	100 ft	200 ft
Source	80 dBA	74 dBA	68 dBA

Noise from a point source will drop 6 dBA for every doubling of distance.

Note: Noise from a line source will only drop 3 dBA.

What regulations are we facing?

Seattle's maximum permissible sound levels and construction noise limits.



Seattle's Maximum Permissible Sound Levels and Construction Noise Limits

Zoning District of Noise Source [25.08.410 & 420]	Zoning District of Receiving Property (all limits dba)		
	Residential Day / Night	Commercial	Industrial
Rural	52 / 42	55	57
Residential	55 / 45	57	60
Commercial	57 / 47	60	65
Industrial	60 / 50	65	70

Daytime Construction Noise Limits - at 50' or a real property line, whichever is greater. All limits are in dba. *Construction noise is limited to the higher levels listed below, during daytime hours only, which are defined as 7 AM to 10 PM weekdays and 9 AM to 10 PM weekends. These limits effectively prohibit construction at night except in special cases.*

On-site sources like dozers, loaders, power shovels, cranes, derricks, graders, off-highway trucks, ditchers, and pneumatic equip (**maximum+25 dba**) [25.08.425 A.1]

Residential	80	82	85
Commercial	82	85	90
Industrial	85	90	95

Portable equip used in temporary locations in support of construction like chain saws, log chippers, and powered hand tools (**maximum+20 dba**) [25.08.425 A.2]

Residential	75	77	80
Commercial	77	80	85
Industrial	80	85	90

Impact types of equipment like pavement breakers, pile drivers, jackhammers, sand-blasting tools, or other impulse noise sources - may exceed maximum permissible limits between 8 a.m. and 5 p.m. weekdays and 9 a.m. and 5 p.m. weekends, but may not exceed the following limits [25.08.425 B]

	All Receivers
All Sources	Leq(1 hr) 90 dba
	Leq(30 minutes) 93 dba
	Leq(15 minutes) 96 dba
	Leq(7.5 minutes) 99 dba

Sounds created by ***motor vehicles, including trucks,*** are exempt from the maximum permissible sound levels, except that sounds created by any motor vehicle operated off public highways shall be subject to the sound level limits III when the sounds are received within a residential district of the City. [25.08.480]

Pile driving noise. Where is the noise coming from? Depends on the following:

- Impact hammer type- hydraulic, air/steam, diesel
- Height of hammer off the ground
- Leader system
- Pile type- wood, steel, concrete, pipe, plastic
- Pile dimensions-length, diameter, thickness
- Cushion type
- Energy output of hammer- stroke
- Type of soils- soft driving, hard driving
- Rebounding
- Ground surfaces- water, land, buildings
- Weather

Hammer type- hydraulic

low headroom.

No provisions for sound reduction.

Junttan free fall made in Finland

Hydroquip lowhead room manufactured in Singapore

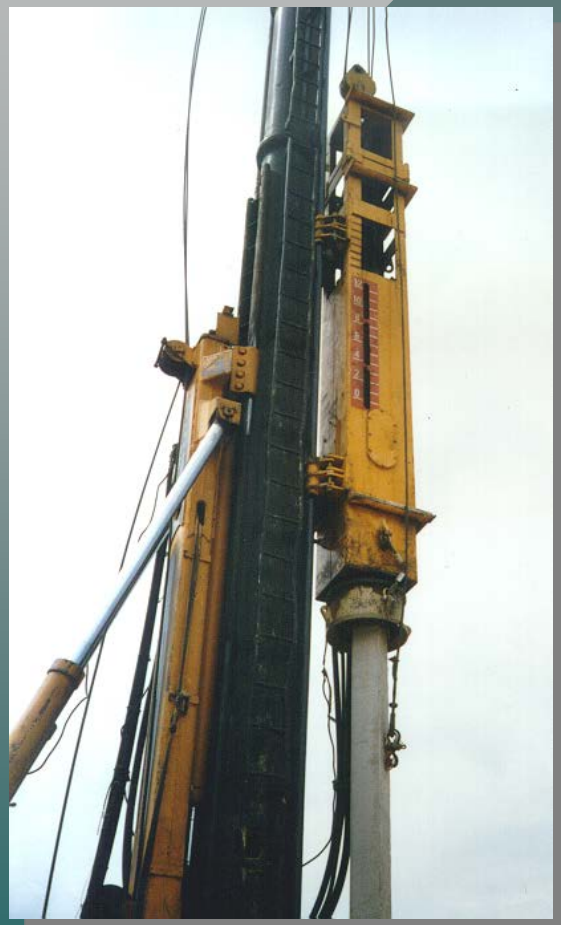
Low head room Junttan hammer. HHK3 5 feet and

HHK12

14 feet tall

Low head room hammer working in Singapore.

Hammer type-closed



Twinwood

BSP
with sound proofing

Delmag
with sound proofing

Hammer type- Air/steam

Open type

Stroke is fixed, or semi-fixed. Noise does not vary as much as diesels.

Hammer type- Diesels

ICE 100S with

sound shielding (ICE Seattle)

APE D30 without sound shielding

Height off the ground

Does the height of the hammer really matter.
Yes.

Depends on:

Hammer type: single acting diesels stroke up. They make less noise at first, but as pile meets soil resistance, hammer strokes up, increasing energy. More energy, more noise.

May seem louder because hammer is closer to you. However, tests show differently, depending on pile type.

Leader systems

American style lead systems reflect sound waves. Not a big factor over European style leads, but could be.

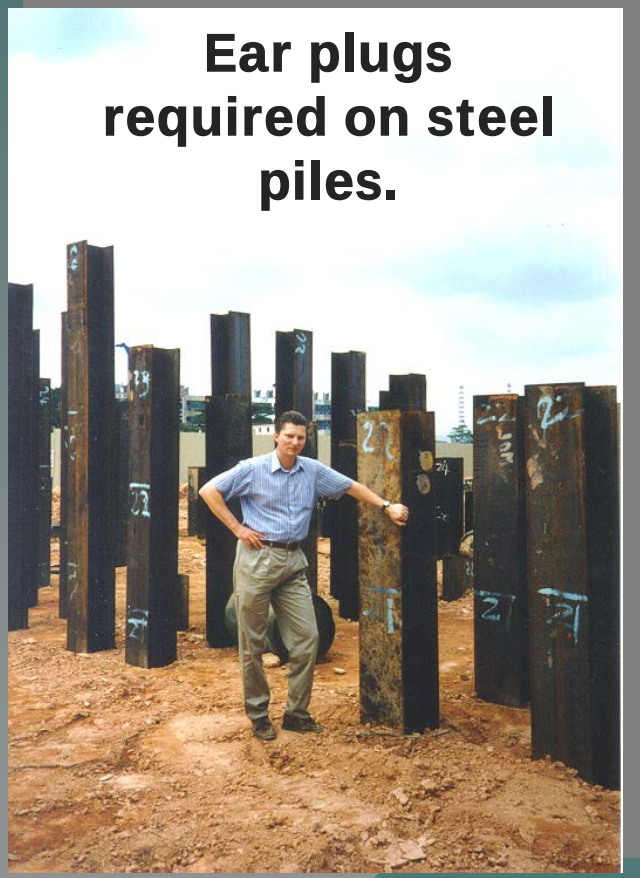
Junttan in box leads

European style leads in China with Chinese water cooled diesel

Pile type

Pile type is the major factor because the pile can be the source of the noise.

Concrete piles make far less noise. Cushion a factor.



Steel piles transmit vibrations. Noise is a line source.

Pile type-continued

Tests show that wood and concrete piles make less noise than steel piles, such as H-beams, pipe, or sheet piles. This is due mainly to the lack of a wood cushion material. If steel piles were driven with a wood cushion the noise level would be greatly reduced.

Pile type-continued

Tests comparing D62 with no sound reduction technology created less noise than Junttan HHK9a with latest sound reduction technology available. Why? Noise came from steel pile.

Noise dropped as pile sank into soil.

Junttan on steel pile was louder than D62

APE D62 produced less noise. Energy was slightly lower.

Pile dimensions

Does not matter much on concrete piles.

Makes big difference with steel piles.

Steel piles are the killer. Can be solved.

Noise output will change depending on wall thickness, length, etc.

Some piles vibrate more than others.

Cushion type

Tests show almost no difference between drive cap (hammer) cushion materials.

However, pile cushion, such as the wood cushion on a concrete pile, is a major factor in reducing noise.

Wood cushions on steel piles would make a big difference in noise reduction.

Cushion test

Tests show that steel pile noise is greatly reduced by using a concrete wood cushion. Energy loss is a factor.

Singapore drive cap design makes it easy to use wood cushion on all types of steel piles. Burlap works.

Singapore adapter design adapts round drive cap base to any size pile.

Cushion-continued

In Singapore, pile drivers use burlap bags instead of thick wood cushion when starting piles. Purpose- to drive piles faster. Burlap reduces the noise factor while allowing energy transfer. Crew adds thick wood cushion when driving gets more difficult.

In Singapore, all drive caps are round. Light weight adapters are fabricated to hold wood cushion and center pile in drive cap. See next slide.

Cushion-continued

Twinwood hammer

Notice Singapore adapters for various pile sizes. Round drive cap can fit large piles. Adapter centers piles in large round drive cap. Various adapters are cheaply fabricated. Adapter allows wood cushions on steel piles.

Other noise factors

Energy output of hammer

Type of soils

Rebounding- causing repeated metal contact

Ground surfaces- water, land, buildings

(warning: avoid nice days on water.)

Weather

What has been done?

- Scheduled operating times- peak hours only.
- HUSH system
- Augered cast-in-place piles
- Drilled shafts
- Still worker
- Burlap bags in Singapore
- Extreme engineering experiments

Scheduling times

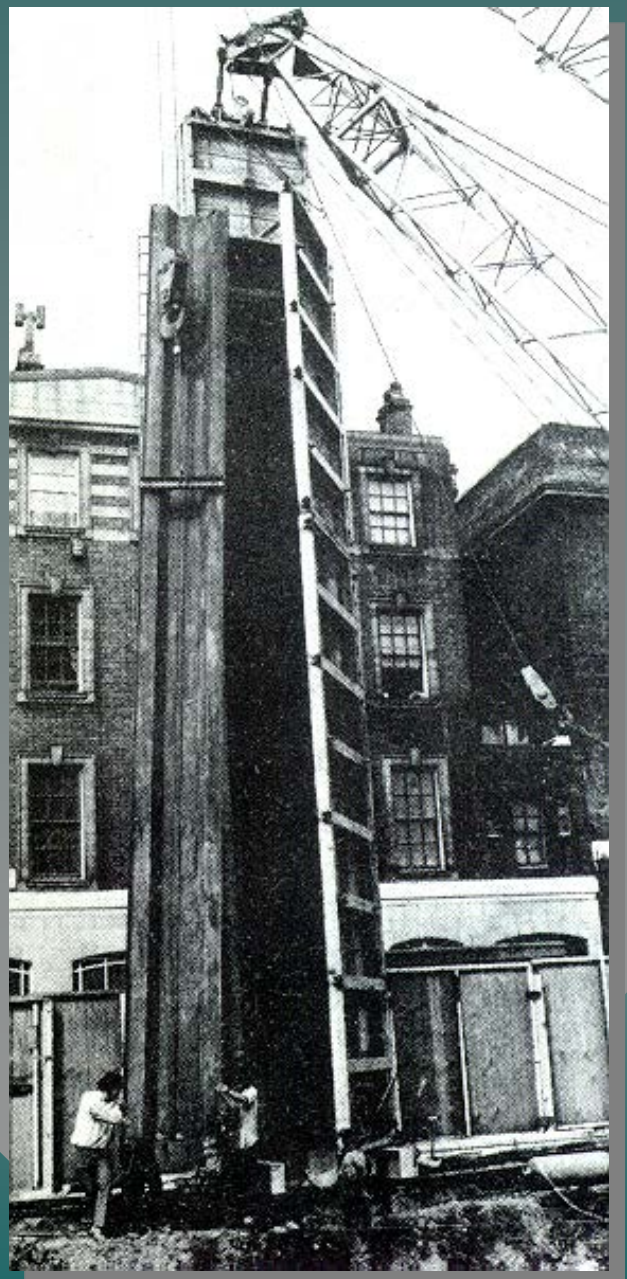
- Drive during day when noise is more acceptable.
- Avoid driving during off peak hours.
- Drive when weather blocks sound waves.
- Know when you make the loudest noise and schedule it to your advantage.

What has been done?

The HUSH system

Consisted of a lead system that completely enclosed the hammer and pile.

Excellent sound reduction.



What has been done?

Augered cast-in-place piles as a alternate foundation

What has been done?

Drilled shafts

What has been done?

Silent pile hammer

This is not an impact hammer.

What has been done?

Burlap bags

- **Past extreme inventions**

Chinese hydraulic press

Oil as a cushion material

Compressed air as a cushion

What is being done now?

- Shielding the diesel hammer.
- Crane suspended sound barrier
- Twinwood enclosed hammer.
- Junttan enclosed hammer with sound reduction foam.
- Burlap bags.
- Plastic piles

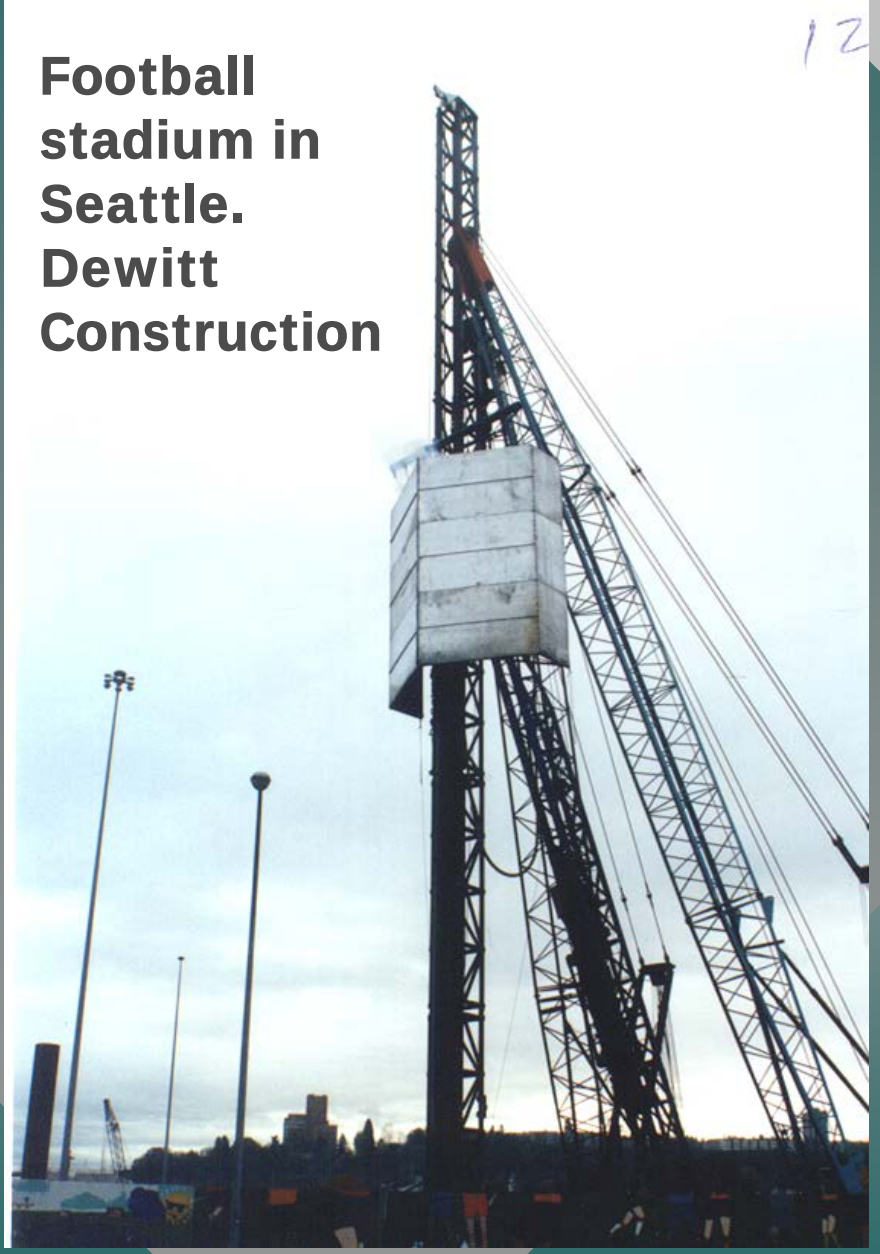
What is being done now? Hammer shielding.

Attempts to shield hammer noise had little effect on test at pier 91 in Seattle. Steel piles were a factor.

Diesel Hammer with Sound Wall

What is being done now?

Hammer shielding.



Football stadium in Seattle. Dewitt Construction

Massive shield had very little effect on noise from D62. Crew reports stated that shield was political not practical.

What to expect in the future.

- A better understanding of what causes the noise will help in the development of better systems to reduce noise.
- Enclosed lead systems using foam pads.
- Drive caps using wood cushion on steel piles.
- Pile rabbits that also serve as sound deadening devices.
- Foam coated piles.
- Plastic or other types of piles designed to reduce noise.
- Continuation of switch to other types of foundations such as augered cast-in-place piles, bored piles, and drilled shafts.

Vibration near concrete

Pile Driving With A Vibratory Driver From or Near Adjacent Structures

The contractor shall not drive piling, with a vibratory driver from an existing structure unless all of the following conditions are met.

1. The existing structure will be demolished within the contract.
2. The existing structure is permanently closed to traffic, and
3. Working drawings are submitted in accordance with Section 6-01.9 and 6-02.3(16), showing the structural adequacy of the existing structure to safely support all of the construction loads.

To minimize the detrimental effects of pile driving vibrations on new concrete less than 28 days old, piles shall not be driven closer to the new concrete than the distance determined from the following formula:

D=C times the square root of E times 10 = C(√E*10)

Where : D= distance in feet

E= rated hammer energy in foot pounds

C= coefficient shown below based on the number of days of curing time

Curing Time (days)	Coefficient (C)	Curing Time (days)	Coefficient (C)
1	0.34	6	0.12
2	0.23	7-9	0.11
3	0.18	10-13	0.10
4	0.15	14-20	0.09
5	0.13	21-28	0.08

This distance may be reduced if approved in writing by the Engineer.