Sand and Gravel Quarries of Western WA

A Quit Graben your Horst Production

By
Kelly H.
Roger S.
Jeff T.
Puget Sound – A little perspective

• Stretches from Anacortes to Olympia (more or less)
• Is a fjord (fee-YOURD). Meaning a long, narrow inlet with steep sides, created in a valley carved by glacial activity.
• Part of a larger physiographical structure termed the Puget Trough
Larger Features

- Puget trough, subfeature of the Pacific Border Province.
- Encompasses almost all of North America's Pacific coast.
- Part of the larger Pacific Mountain system.
- Also known as the Western Cordillera.
- Covers much of North America.
Wisconsin Glaciation

• Last Glacial Period: began about 110,000 years ago (ybp = years before present), ended 10,000 to 15,000 ybp.
• Maximum extent occurred about 18,000 ybp

• Vashon Glaciation
  • Advanced into Washington about 18,000 years ago
  • Receded 10 – 12,000 years ago
Vashon vs Wisconsin Glaciation

Max extent of Vashon Glaciation

Olympia

Seattle

Wisconsin Glaciation
Extent of Glacial Advance

13,000 years ago

Present day

Seattle

Olympia

Maury Island

Dupont

http://duff.geology.washington.edu/mbbrg/mbbrg/areas/Puget_Lobe/index.html
Reconstructing the last (Vashon) continental glaciation of the Puget Lowland

Ralph Haugerud,
Harvey Greenburg

Sometime around 20,000 calendar years before present (ybp), ice from the Coast Mountains of British Columbia began filling the Fraser Lowland. The Puget Lobe of the ice sheet reached the US border after 19,000 ybp. Seattle about 17,600 ybp, and its farthest south extent (just south of Olympia) at about 16,900 ybp. The ice front then retreated even more rapidly than it advanced, and Seattle was ice-free by about 16,400 ybp. By about 15,000 ybp the ice front was again back at the border.
Where to find rocks

Where to find rocks

Specifically anywhere.

And here.

Sand and gravel is important for engineering purposes.

Useful for sand and gravel to

Lilliwauk.

Sunglaham to

North and North

Sand and gravel is

important from

WWW.ci.dupont.wa.us/files/library/f6d6cacc6577be3-o.pdf
Where to find rocks

• Basically any where around here.

• Sand and gravel is abundant from Bellingham to Olympia and North Bend to Lilliwaup.

• For sand and gravel to be useful for engineering purposes size IS important.
Fig. 4.4 Curves of erosion and deposition for uniform material. Erosion velocity shown as a band. [Redrawn from Hjulstrom (1935).]
Glacier Northwest Mine, Dupont WA

http://www.ci.dupont.wa.us/files/library/7f935eba98ef7cef_o.pdf
Why Dupont and Maury Island?

• Thin layer of till $\rightarrow$ easy to get sand and gravel
• The sand and gravel are clean
Physical Properties

Absoprtion, Porosity, and Permeability
Surface Texture
Strength and Elasticity
Density and Specific Gravity
Aggregate Voids
Hardness
Particle Shape
Coatings
Undesirable Physical Components
Surface Texture

Cement bond
  Smooth
  Rough

Workability
  Rough requires more asphalt cement
  Rough requires more water Portland Cement

Grip
  Resistance to wear to maintain
  Limestone wears easily
  Marble, Basalt have good resistance to wear/smoothing
Absorption, Porosity, and Permeability

Pore characteristics
  Size
  Number
  Interconnection pores

- Affect the strength of the aggregate, abrasion resistance, surface texture, specific gravity, bonding capabilities, and resistance to freezing and thawing.
- Absorption relates to the particle's ability to take in a liquid.
- Porosity is a ratio of the volume of the pores to the total volume of the particle.
- Permeability refers to the particle's ability to allow liquids to pass through. If the rock pores are not connected, a rock may have high porosity and low permeability.
Strength and Elasticity

Strength
- Resistance of an aggregate to tensile and compressive forces

Elasticity
- Ability of material to deform
- Resistance to freeze/thaw cycle

Want both properties to maximize durability of the composite material.
Density and Specific Gravity

Indication of Porosity and Voids
absorption of asphalt or Portland cement paste

Resistance to freeze/thaw damage
Hardness

Resistance to abrasion and degradation
Soft aggregate-wears easily
Hard aggregate resists wear
Particle Shape

Crushed and rough aggregate

Workability
Require more asphalt and PCC to coat the surface and make the mix workable.

Strength
Greater interlock when consolidated
Greater friction
Particle Shape

Smooth and round aggregate

Workability
- Less asphalt and PCC to coat the surface
- Makes the mix more workable.

Strength
- Reduced friction and interlock.
Coatings

Mineral deposits
Dust formed by crushing and handling.
May affect bond strength
Washing is required to remove coatings
Undesirable Physical Components

- Structurally weak particles
- Clay
- Flat or elongated shape
- Organic matter
Chemical Properties

Reactions

Portland Cement Concrete

Reactive Aggregate-Sodium Chloride
General Characteristics:
Compacted Aggregates

Base or Sub-base
Without Cementing agent
PCC-rigid pavement sub-base used to:
Improve drainage,
Protect a material that is susceptible to frost.
Gradation is important to form solid base
Asphalt-flexible pavement sub-base is used to:
Carry the load
Provide Strength to transmit load
Gradation and stability
General Characteristics: Aggregate for Hot Mix Asphalt

Five Aggregate requirements for HMA:

1) Strong, tough and durable
2) The ability to be crushed into bulky particles, without many flaky particles, slivers or pieces that are thin and elongated
3) Low porosity
4) Low permeability
5) Correct particle size and gradation for the type of pavement
General Characteristics:
Aggregate for Portland Cement
Concrete

Much more variation in requirements due to different uses:
Roads
Bridges
Buildings
Canoes
Aggregate for Portland Cement Concrete

Factors to consider:

1) The size and interconnection of voids
2) The texture of the particles
3) The gradation of the coarse and fine aggregates
4) The mineral composition of the particles
5) The shape
6) Abrasion resistance
7) Water absorption
Economics of Aggregates

• Market
  – Demand
  – Supply
  – Customers

• Future of Local Aggregate Industry
  – Repairs to aging buildings & roads
  – New construction projects
  – Growing cities
Demand of Gravel

- Always a demand
  - Highway 18 / 1-5 renovation projects
  - Currently 3 new proposed mining operations in WA
  - Housing developments
  - Building blocks of nearly all construction
  - Billion dollar industry!

- Economic Expansion = Gravel Demand ↑
Local Supply of Gravel

• ENDLESS!
  – Puget Sound is naturally blessed
    • Particularly south-sound prehistoric deltas
  – DuPont pit the size of downtown Tacoma?
    • $[387 + 187(?)]$ acres x $[80]$ ft deep

• Transportation
  – Trucks
  – Barges (1 barge = 186 trucks)
Gravel Controversy

• **Environmental Concerns**
  – Destroying natural landscape
  – Groundwater contamination
  – Noise pollution

• **Quarry Opposition**
  – Land owners
  – Local Environmental groups
Problems with the Controversy

• Creating Artificial Shortage
  – Demand doesn’t lower
  – Thus, prices increase

• VERY Difficult to Mine New Quarries
  – Every project causes local outcry
  – Propositions get locked in the courts
The Future of Aggregates

• Here to Stay
  – Everlasting industry
  – Always a market
  – Always a demand
  – Always a local supply(?)

Anything that generates more projects is good for our industry....
Sources and Resources

http://en.wikipedia.org/wiki/Last_glacial_period

http://www.tubbs.com/gravel/gravel.htm

http://www.washington.edu/burkemuseum/geo_history_wa/

http://www.washington.edu/burkemuseum/geo_history_wa/Cascade%20Episode.htm

http://www.pugetsoundkeeper.org/about-puget-sound/geology-folder

http://en.wikipedia.org/wiki/Pacific_Border_province

http://seattlepi.nwsoure.com/local/6420ap_wa_gravel.html

http://www.djc.com/special/concrete97/10024308.htm