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Aggregate Production Overview

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Topics

- Virtual Tour
- Aggregate Production Process- Basic steps
- Balancing of Production

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THE AGGREGATE PRODUCTION PROCESS

A Brief Overview

Virtual Quarry Tour

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Potential Product Distributions

- Base Stone (1”-0” in size)
- “Concrete Stone” (1”-0.5”)
- “Asphalt Stone” (0.5”-0.25”)
- “Fines” (0.25”-0”)
- 0-5%= “Tailings”

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The 5 Steps in the Mining Process

1- Drilling
2- Blasting
3- Loading
4- Hauling
5- Dumping

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1-Drilling

- Blast pattern is designed and drilled to accomplish the desired end results- 1st opportunity to control product distribution

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2-Blasting

- The Blast Pattern is loaded with explosives and detonated according to the design to maximize the breaking of the stone while minimizing the impact to neighbors and the production of unwanted products
- Very similar to construction blasting but larger in scale and the goal is higher fragmentation

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3-Loading

- Loading the material out
  - Rubber tire loaders
  - Shovels or Excavators

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4-Hauling

- Typically Ridged frame trucks haul the material out of the pit to the dump site

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5- Dumping

- Now the work begins!

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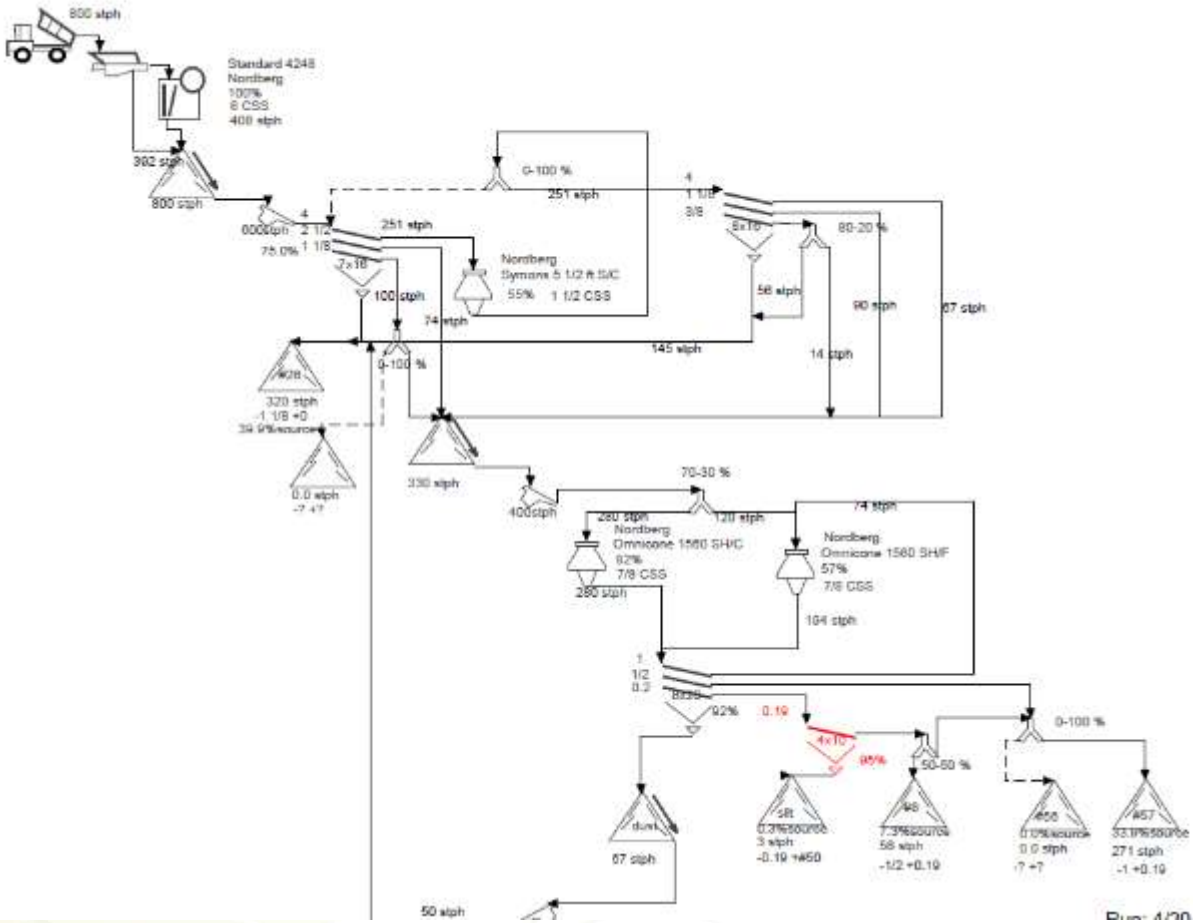
Processing of the Stone



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Processing

- Primary Crushing
- Secondary Crushing
- Tertiary Crushing
- Specialty processes

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Primary Crushing

- Main objective is to make material into conveyable size- typically 6” and smaller-feed for the next step

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Secondary Crushing

6” Rock is the start- 2 products generally produced-Base/21A- Feed for the next step

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Tertiary Crushing

Secondary 4”-1” Material is crushed and screened usually producing 3 products or more that are 1” and smaller

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Specialty Processes

- Air or Water Classifying
- Pug Mill for CTA or Custom Mixes
- Washing/Rinsing

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Distribution of Production

- Geology greatly dictates the product ratios/splits
- The plant makes 3-4 products- this can be adjust to an extent
- A mix is often needed for the next step in the process
- Producing for only one product creates huge inefficiencies in the process.
- Large waste piles can dramatically limit the stone available in a location

QUARRY PRODUCTS FOR CONSTRUCTION PROJECTS

Key Takeaways

- Design with and specify the products normally made by the local quarries
- "Underutilized" products may help with lowering costs
  - *These are often fine products and base*

NORMAL/TYPICAL PRODUCTS

Why Use the Normal Products?

- Crushing plants are set up to make a defined set of products for a defined set of customers
  - *Typically state DOT products*
- New products require plant setup changes
  - *May not be able to produce normal products while in the new setup*
  - *Bad for existing customers*
- May co-generate odd or non-spec products in the new setup
- All leads to increased downtime, need for extra hours, excess product, increased cost
  - *Producers will have to charge more for special products, or*
  - *May choose not to quote at all*

Vulcan Materials Company

Sizes of Open-Graded Coarse Aggregates

Va. Size	Amounts Finer Than Each Laboratory Sieve (Square Openings) (% by Weight)														
No.	4 in.	3 1/2 in.	3 in.	2 1/2 in.	2 in.	1 1/2 in.	1 in.	3/4 in.	1/2 in.	3/8 in.	No. 4	No. 8	No. 16	No. 50	No. 100
1	Min. 100	90–100		25–60		Max. 15		Max. 5							
2			Min. 100	90–100	35–70	Max. 15		Max. 5							
3				Min. 100	90–100	35–70	0–15		Max. 5						
357				Min. 100	95–100		35–70		10–30		Max. 5				
5						Min. 100	90–100	20–55	Max. 10	Max. 5					
56						Min. 100	90–100	40–85	10–40	Max. 15	Max. 5				
57						Min. 100	95–100		25–60		Max. 10	Max. 5			
67							Min. 100	90–100		20–55	Max. 10	Max. 5			
68							Min. 100	90–100		30–65	5–25	Max. 10	Max. 5		
7								Min. 100	90–100	40–70	Max. 15	Max. 5			
78								Min. 100	90–100	40–75	5–25	Max. 10	Max. 5		
8									Min. 100	85–100	10–30	Max. 10	Max. 5		
8P									Min. 100	75–100	5–30	Max. 5			
9										Min. 100	85–100	10–40	Max. 10	Max. 5	
10										Min. 100	85–100				10–30

Typical Products

- Coarse aggregate specifications similar from state to state
- Rip Rap specifications vary greatly
- Aggregate base specifications vary

- Better to use local/DOT specifications

Typical Products

#57

#67

#8

Base (21A or 21B)

Typical Products

Dry Screenings

Manufactured Sand (aka Washed Screenings)

- Typically passing #4
- Dry screenings have high passing #200 (10 to 20%)
- Man sand has low passing #200 (2 to 7%)

Typical Products

50 lb to 150 lb

VDOT Class I

150 lb to 500 lb

VDOT Class II

500 lb to 1500 lb

VDOT Class III

25 lb to 100 lb

VDOT Class AI

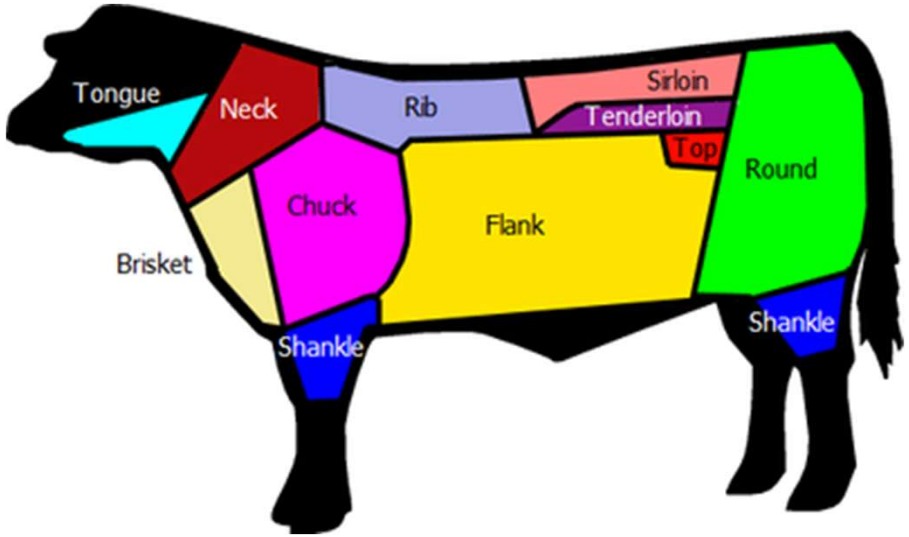
Typical Products

- Design with typical products as much as possible
- If the design calls for something very specific, try to match it to a typical product
- All of this will save money and time
- Involve the quarry early in the design phase

UNDERUTILIZED PRODUCTS

Construction Aggregates

- Like the beef industry
- Multiple cuts of beef are made
- Can't make only tenderloin
- Someone has to buy the other cuts
- Otherwise, the tenderloin would be un-affordable



Construction Aggregates

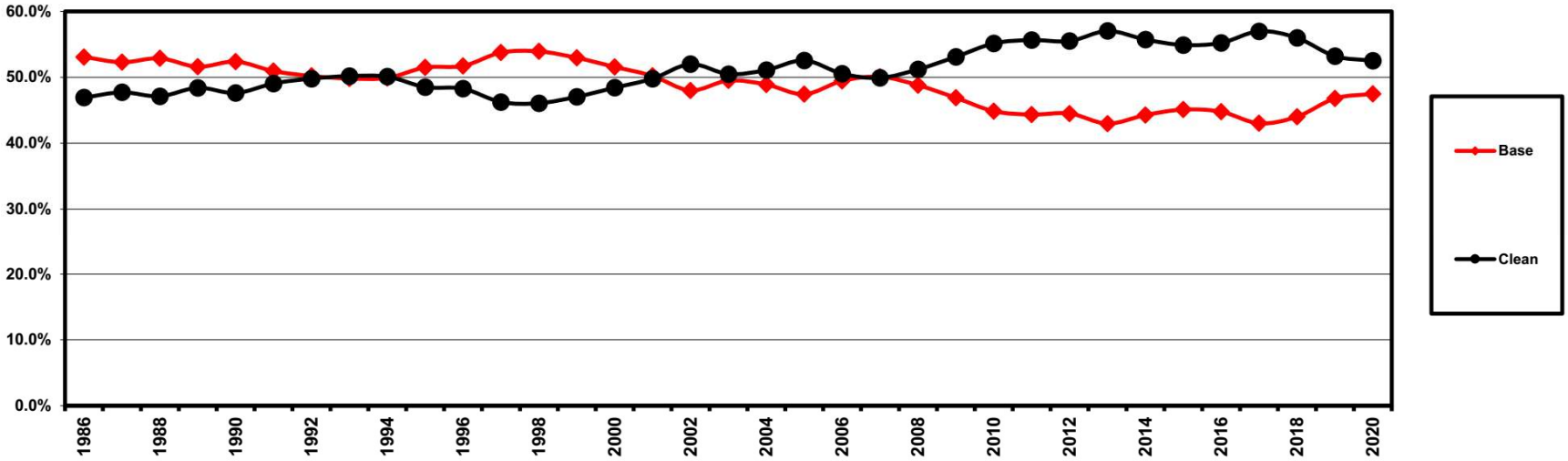
- Construction aggregates are the same way

- When we crush stone, we make approximately the following:
  - *35% coarse aggregate*
  - *20% fine aggregate*
  - *45% aggregate base*
  - *This varies by quarry and each particular geology*

Aggregate Base

- Some pavement designs try to reduce or remove aggregate base
  - *Full depth asphalt*
  - *Full depth reclamation*
  - *Pervious pavements*
- Have seen a decline in base sales over time
- VDOT recognizes aggregate base as an integral part of pavement and requires its use

Aggregate Base & Clean Stone Sales in NC



Dry Screenings & Manufactured Sand

- Dry Screenings and Manufactured Sand make excellent fill
- Classified as sandy soil
- Structural fill
  - *MSE Walls*
  - *High angle of internal friction (above 35°)*

Quarry Fine Aggregate as Fill

	Dry Screenings	Manufactured Sand
LL	NV	NV
PL	NP	NP
PI	NP	NP
USCS Class	SM	SP-SM
AASHTO Class	A-1-b	A-1-b

Max Dry Dens, pcf	124.5	115.7
Opt Moist, %	11.9	12.8

Avg Permeability, cm/sec	1.2×10^{-3}	1.0×10^{-2}
Avg Permeability, ft/day	3.5	12.8

Friction Angle	43.7	41.2

Sample values for one source. Values will vary by source.

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Pond Fines

- Very fine aggregate
- Dust washed from coarse aggregate and from manufactured sand
- Placed in settling ponds
- “Dipped” out, then allowed to drain in stockpile

Pond Fines

- Rock Dust
  - *Non plastic*
  - *Good bearing capacity*
  - *Soil Classification*
    - AASHTO: A-4
    - USCS: ML
  - *Relatively impermeable*

Example of Pond Fines Analysis	
Passing #10	99
Passing #40	99
Passing # 200	79
Liquid Limit	22
Plasticity Index	NP
Standard Proctor	108.7 pcf at 16.4%
Permeability	$< 7x10^{-5}$ cm/s

Pond Fines

- Good Strength Properties
- California Bearing Ratio
  - *Typically 15 to 20*
- Friction Angle
  - *Typically 34° or higher*

How Can Aggregate Producers Help with Design-Build?

- Get us involved early
- We can help designers understand what is locally available
  - *Saves time and redesign later on if the project is designed around what's available*
- We can often provide less expensive options
  - *Particularly on mass fill projects*