Raw Material Stockpile Management

Team 9 – Eagle Materials & Texas Lehigh Cement Company

Team Members: Aditya Vijendran, Raece Oakeson, Sergio Monge, Jack Perrotta, Matthew Novreske

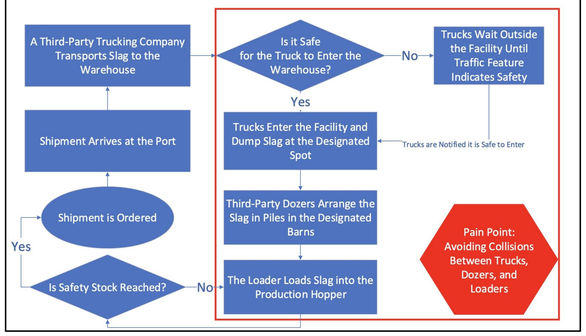
Faculty Mentor: Mario Ventresca

Background

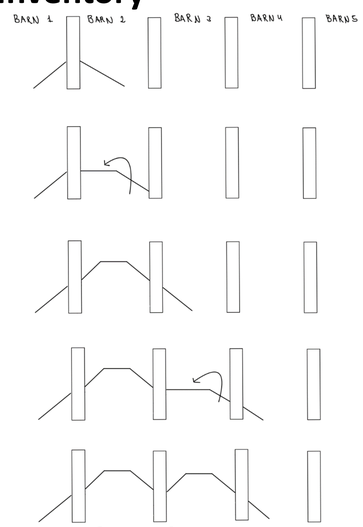
Texas Lehigh Cement Company is a partner of raw materials giant Eagle Materials founded in 1978 and based out of Texas. They are currently a leading supplier across the state for multiple classes of oil well and residential purpose cements. A recent pivot to ground granulated blast furnace slag as the base of manufactured cement mixes demands high-capacity storage to house the international shipments of raw material.

Problem Statement

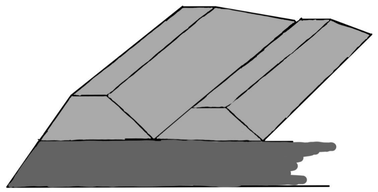
The construction of a new cement plant in Houston, Texas expecting its first shipment in March of 2024 is facing logistical challenges caused by two entrances/exit points within the warehouse. Inventory alignment challenges are presented by the need to house roughly 55,000 short tons of the raw material cement base, slag. Additionally, the storage of the warehouse must ensure easy access for loaders while maintaining the prioritization of old inventory before it exceeds its 4–5-month shelf life.



Inventory

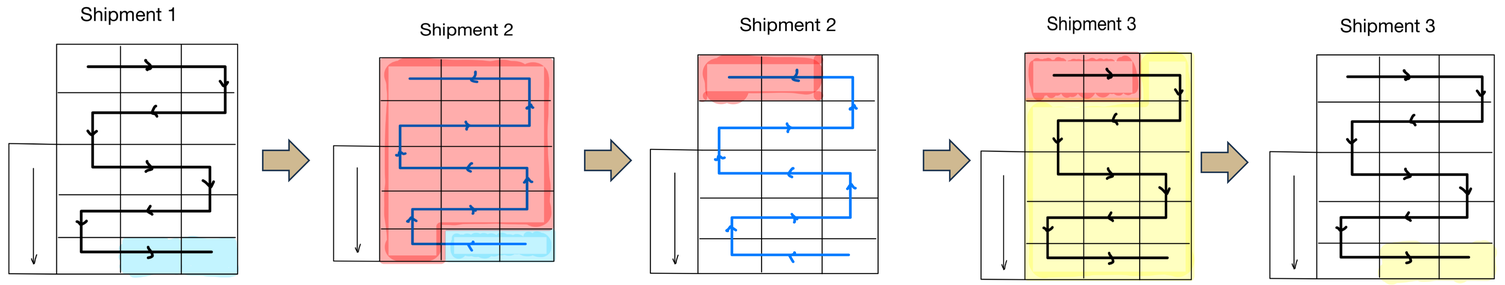


Slag stacking process inside warehouse



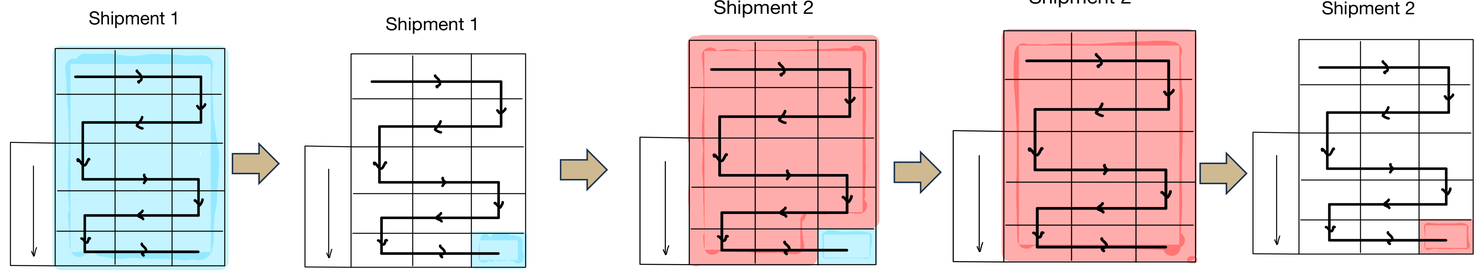
Geometry of slag pile inside warehouse

Scenario #1:



- Loader follows path of arrows
- Loader reverses route
- Shipment 2 trucks dump inventory
- Remaining inventory is stored outside
- Loader continues reversed route until 2 boxes left
- Loader goes back to original route
- Shipment 3 trucks dump inventory
- Loader follows original path
- Process is repeated

Scenario #2:



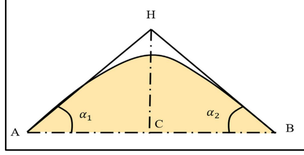
- Loader follows path of arrows
- Loader continues until one box left
- Loader continues on blue box until it's over
- Loader goes back to original path once trucks dump inventory
- Loader follows original path
- Process is repeated

Shipment 1 Shipment 2 Shipment 3

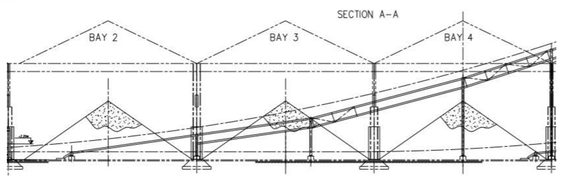
Capacity Calculations

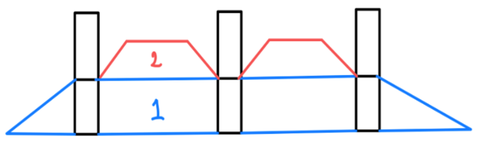
Base Layer

Barn 2		
Width	80	ft
Length	268	ft
Height	14	ft
Spillover (B1)	30	ft
Angle of Repose	35	deg
Climb Distance	19.994	ft
Sloped Area (Base)	1599.526	ft^2
Sloped Area (Side)	2879.146	ft^2
Sloped Area (Corners)	0	ft^2
Tabletop Area	21281.328	ft^2
Sloped Volume	31350.705	ft^3
Tabletop Volume	297938.590	ft^3
Total Barn Volume	329289.295	ft^3
Column Volume	336	ft^3
Volume Lost	2240	ft^3
Total Barn Volume	327049.295	ft^3
GBFS Density	79.596	lb/ft^3
Total Barn Capacity	13015.908	tons
Total Volume	991274.068	
Total Quantity	39450.725	tons

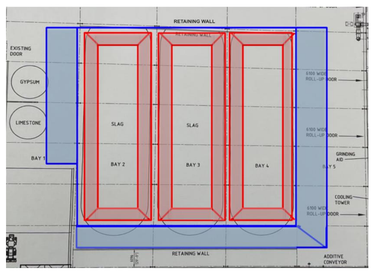


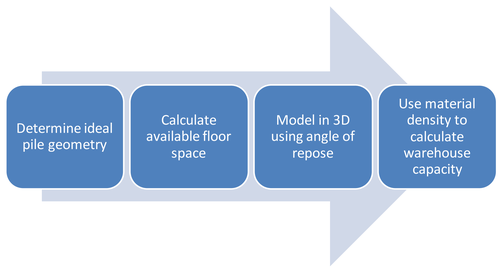
After some experimentation the group landed on a two-tiered shape seen below with a flat-topped base pile extending across all three barns allocated for storage, and additional trapezoidal piles across the length of each individual barn on top. This allows for maximal raw material storage both beneath and above the concrete shielding surrounding warehouse support columns.





Capacity calculations revolved around first solving the quantity of slag held in the base layer, and then calculating additional capacity achieved through the secondary pile. For the base layer, basic dimension of each barn such as length, width, height (minding the concrete shielding), and allocated spillover. Using the provided angle of repose for GBFS, horizontal distance to achieve selected pile height allows a fully dimensioned 3D geometry to be created. From there, basic area and volume calculations are used to produce available space in cubic feet for each individual barn. Following a quick subtraction of the occupied space by the warehouse support columns the final volume figure can be combined with Texas Lehigh's provided material density number to establish the total tonnage each layer contains.





Total Box Capacity Map

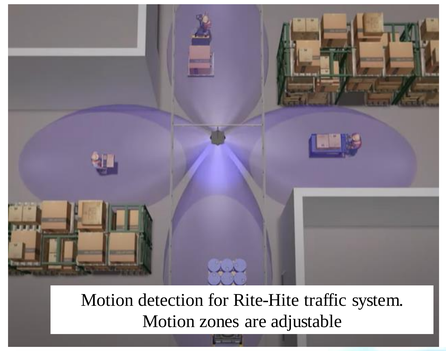
	Barn 1	Barn 2	Barn 3
Box 1	3340.40	3006.05	3474.26
Box 2	3191.72	2857.37	3325.58
Box 3	3191.72	2857.37	3325.58
Box 4	2656.75	2857.37	3325.58
Box 5	3920.01	4209.79	4886.12
Total Tonnage	16300.60	15787.93	18337.11

Total Truck Load Map

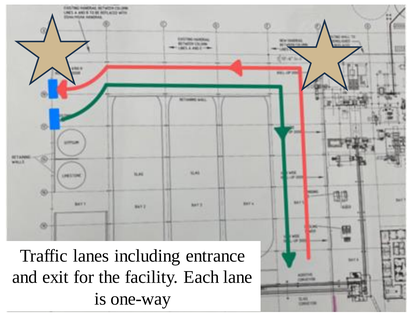
	Barn 1	Barn 2	Barn 3
Box 1	133.62	120.24	138.97
Box 2	127.67	114.29	133.02
Box 3	127.67	114.29	133.02
Box 4	106.27	114.29	133.02
Box 5	156.80	168.39	195.44
Total Trucks	652.02	631.52	733.48

Traffic Safety

Example traffic light system for two locations in the warehouse



Motion detection for Rite-Hite traffic system. Motion zones are adjustable



Traffic lanes including entrance and exit for the facility. Each lane is one-way

Zone warning lights for loader