Experience with Dry Engineered Sand Solutions

An overview of Luck Stone Corporation’s investigations and advances in producing quality engineered sands from quarried rock. Click here for more information about Metso's dry separation technology.

More than twenty years ago Luck Stone Corporation, one of the largest, family-owned and operated aggregates companies in the USA and is one of the largest producers of crushed stone, embarked on a sequenced investigation to satisfy demand for a dry asphalt sand product that would avoid the environmental concerns inherent in wet systems. The solution to dry asphalt sand processing also led them to applications for production of their own design for dry engineered concrete sand.

Requirement for a dry solution

In 1989, Luck Stone’s Northern Virginia sales staff requested a manufactured sand product to provide their asphalt customers. Engineered sand specifications for concrete in the USA are controlled by the American Society for Testing and Materials (ASTM) through C33 and are significantly different to most other countries in the world. Manufactured sand for use in asphalt in Virginia, Luck Stone’s primary market, is generally considered as material passing 6.3mm (1/4 inch) screen. However the real asphalt issue was and is the excess minus 75μm (200 mesh) which was desired to be less than 7% passing 75μm (200 mesh).

Because most "screenings" have significantly more material passing 75μm (200 mesh), a process to remove this excess material was undertaken. Luck Stone had routinely employed a wet process to remove this excess 75μm (200 mesh) material, but concerns with space and the environmental aspects of this process pointed to the desirability of a dry processing system.

Although consideration was given to the wet process, Luck Stone did not believe it would be the best solution. As a result, in 1990 they began an investigation into dry alternatives to de-watering with a classifying screw.
The search begins

As with many aggregate producers, Luck Stone was faced with a dilemma. How could they produce asphalt sand without the associated problems of a wet process? They didn’t want to sacrifice aggregate stockpile space to locate de-watering ponds nor did they want to process or produce wet material during freezing weather. They also didn’t want the environmental concerns that are inherent with ponds, wet fines containment and water or slimes disposal.

The challenge of finding a dry solution was given to Luck Stone’s Chief Engineer, Bob Stansell, since deceased, who considered and tested several options.

Dry fine screening

Luck Stone began their investigation with a suggestion from their Leesburg plant manager. He suggested they investigate a multi-deck screen which had previously been demonstrated to him. The desired result with this type of screen would be realized if it could remove a sufficient amount of minus 75μm (200 mesh) material by either screening or air sweeping to meet a gradation of less than 5% passing the 75μm (200 mesh).

After several days of testing and subsequent evaluation, Luck Stone concluded this particular screen would not be suited to dry separation at a cut point below 300μm (50 mesh). They determined that this screening unit would not be effective in the production of a final product due to its moisture sensitivity and their inability to control the weather.

Fluid-bed dryer

Luck Stone next investigated a fluid-bed style dryer. This process would have the advantage of being able to remove moisture at the same time the ultrafines were being removed. The equipment included a slightly inclined vibrating pan with many small holes throughout. This arrangement allows heated air to pass through the material both drying and removing the ultrafines.

This process offered excellent control regarding the cut-point and eliminated the moisture problem associated with damp feed. The results were favourable with good levels of control and predicted consistency.

However, several areas of concern pre-empted Luck Stone’s favourable view of this equipment’s performance. Even though it provided excellent results they determined the capital required to install such a system would be excessive.

Their concern extended to the higher maintenance considerations of this process due to abrasion and complex burner requirements. The added processing cost to provide the necessary energy for drying was also a detriment for this process. Their final concern was the safety of such a system to operate unattended with the balance of the automated circuit.

Luck Stone determined to continue their search for a better process, although the fluid-bed dryer was superior in providing a good, clean and consistent product.

A new direction

During a market lull, with decreased demand for an asphalt sand, the intensity of this investigation was somewhat abated as Luck Stone turned to other pressing issues. During this time they began a serious study of the in-process screenings moisture content. The study was conducted over a six month period and found an average moisture level of 1.5%. This was due primarily to water added at the crusher for dust control.

Also noteworthy during this period was the installation of dust collectors on the circuit.
minimizing the need for water addition at the crushers. These results encouraged Mr Stansell to investigate a type of air classifier he had installed some 20 years prior. He had not seriously considered this air classifier since his previous experience had shown it to wear rapidly, even in limestone. Other concerns were sensitivity to feed moisture, similar to other fine separation equipment.

Continuing his investigation, Mr Stansell discovered that the company responsible for this particular classifier – the Gravitational Inertial Classifier – was actively marketing this process for dry engineered sands. He also discovered that they had overcome his concern with wear by the utilization of ceramic liners.

Above: Ceramic liners last for years even in highly abrasive applications.

Metso Static Classifier Solutions

The technology that Luck Stone investigated has recently been purchased by Metso. It is one of three separate static (no moving parts) classifier types offered dependant on the separation required by the process.

Gravitational Classifiers produce 0.15-1.65mm (12/100 mesh) separations and are suitable for coarse industrial mineral solutions. Centrifugal Classifiers produce 0.02-0.15mm (100/600 mesh) separations and are suitable for industrial mineral, mining, fly ash and cement applications. These classifiers exploit centrifugal forces to produce very fine separations.

Gravitational Inertial Classifiers produce 0.063-0.3mm (50/230 mesh) separations and are highly suitable for precise engineered sand applications. Adjustable airflow controls the amount of ultrafines retained as product and recirculating air scrubs the coarse product before it exits.

The Gravitational Inertial Classifier’s main applications are in the production of quality engineered sands from quarried rock. The classifier utilizes air flow, gravity, and directional changes to achieve very accurate and adjustable material separations.

The ultrafine retention is controlled by the adjustment of the primary to secondary air ratio. Tailoring the amount of ultrafines in the product offers quality sand production with minimum waste.
**Static yet accurate**

The Gravitational Inertial classifier offers a versatile option that can fit into multiple quarrying solutions. It is highly accurate and adjustable and has the ability to remove just the ultrafines that need to be removed, which maximizes both productivity and sand quality.

These classifiers also have exceptionally low operating costs as they have no moving parts and ceramic lining throughout. This means that no adjustment for wear is required and abrasive feeds have little influence on operating costs with ceramic liners lasting for years even in highly abrasive applications.

The intelligent design of the classifier also effectively utilizes the air movement which minimizes the power requirement.

**Luck Stone’s experience at the Leesburg Plant**

Luck Stone submitted test samples for evaluation with the Gravitational Inertial Classifier in the autumn of 1992. Based on the initial tests, as well as an on-site visit of the testing facilities, the design process was initiated to include a Gravitational Inertial Classifier at Luck Stone’s Leesburg, Virginia plant.

During the design process a structure to support a dual AC22.5GI was built. A single unit, installed in 1993, absorbed the existing 60 tons/hr of the 2mm (10 mesh) screenings produced by a Nordberg 5 1/2 foot short head cone. With the addition of a new HP300 to the circuit in 1994 the increased feed tonnages required the installation of the second AC22.5GI unit to give a combined throughput of 120tph.

A single conveyor from the circuit feeds both units by use of a splitter at the head pulley discharge. After passing through the classifiers, the finished asphalt sand product falls through a mixer where water is added for dust control and keeps the product homogenous. This air-scrubbed sand product is then conveyed to a stacker for outside storage.

The Sand Plant Fines (SPF) is the minus 75μm (200 mesh) that has been removed from the classifiers and is separated from the air by the dust collector, and then stored in a 350 ton silo. Draft for both the dust collector and the dual AC22.5GI classifiers is provided by a single 75KW (100 HP) system fan. The system operates under negative pressure so fugitive dust is not a problem.

**Product characteristics and uses**

The final classifier product (air-scrubbed screenings) provides a more desirable material for the asphalt producer. Limiting the moisture in this dry process limits the amount of energy required by the asphalt producer to remove the moisture. This results in cost savings for the asphalt producer. Removing water also leads to added savings because these plants become more productive as they retain stone for less time. This allows the full design tons per hour to run through the plant.

An important question Luck Stone asked themselves when considering this process was what could be done with the generated ultrafines. They determined that they could be blended back into the base product without any detrimental effects. A handling system to do so was designed into the plant layout. Although these fines range over 90% passing the 75μm (200 mesh), their impact upon the base quality is limited due to the differences in comparative volumes. Because these fines are easy to handle, a system for loading them directly into trucks was included in the design.

**A new challenge – engineered concrete sand**

Today Luck Stone employs air classification technology at the majority of their plants and
have also adapted its use to make engineered concrete sand.

Several years after the successful production of asphalt sand with their air classifiers, Luck Stone began to investigate a replacement crushed stone product for natural sand in the concrete or ready-mix market. This pursuit continues after over a decade of effort and has resulting in the production of high performing crushed fine aggregate for use in concrete.

Production of engineered concrete sand is much more difficult in the USA compared with other parts of the world due to the tight regulatory specifications from ASTM. The ASTM C33 specifications are designed for natural sands with little accommodation for manufactured sands in the envelope. For this reason, achieving specification with engineered concrete sand in the USA is a difficult task. It is also the case that most concrete customers in the US are only experienced with natural sands and thus very resistant to engineered concrete sand technologies.

Research based approach

Luck Stone started their research into this area with the International Center for Aggregates Research (ICAR), a joint operation of The University of Texas at Austin and Texas A&M University dedicated to aggregate research. The goal of one of ICAR’s projects – ICAR Project 102 – was to prove that engineered sands can and do compete technically with natural sands and demonstrate that high percentages of minus 75μm (200 mesh) are feasible in Portland Cement Concrete (PCC).

The results from this research proved that higher percentages of minus 75μm (200 mesh) are not detrimental to the quality of engineered sand and does in fact have advantages over natural sand. The results showed that processing with a Barmac VSI produced excellent texture and shape in the engineered sand.

From research to reality

Luck Stone carried out multiple trials of local natural sands against that produced in each of their quarry sites. The best engineered sand results were from crushing diabase (trap rock) at their Goose Creek site. They purchased a Barmac B9100 VSI for Goose Creek in 1998 as they could foresee the increasing request for shaped aggregate and the possibility of producing quality engineered sand from this site. After the Barmac VSI’s installation, the site produced a ‘high fines’ engineered sand with 14% passing 75μm (200 mesh). Luck Stone initiated the Aggregates Research Institute (ARI) to help establish the quality of the engineered sand.

During this period, Luck Stone branded the engineered sand as ADVANTA® Concrete Sand. However, due to the higher-than-ASTM-C33-allowed minus 75μm (200 mesh) compared to natural sand, it proved difficult to gain acceptance for this engineered sand with customers. To try and encourage acceptance of ADVANTA® Sand, Luck Stone decided that blending with natural sand to decrease the minus 200 would allow their customers to establish confidence in the new sand.

Blends were produced by mixing the ADVANTA® Concrete Sand with natural sand from Luck Stone’s Caroline pit. Customers were generally still resistant to the new sand. In order to encourage the use of the ADVANTA® Concrete Sand Luck Stone specified its use on a major construction project at their Goose Creek plant. As a result of this work and the performance of the concrete during finishing customers began to use the material in mixes for low risk uses. The blended sand was eventually accepted by customers but blending costs proved to be high due to the cost of transportation of natural sand.
Above: Luck Stone’s dual AC22.5GI classifier was installed in 2005 and is fed with crushed sand from a Barmac B9100 VSI.

**Controlling the ultrafines to produce 100% engineered concrete sand**

Luck Stone decided they needed to reduce the amount of minus 75μm (200 mesh) present in ADVANTA® Concrete Sand for customers to accept a 100% engineered sand. A dual AC22.5GI air classifier was installed at Goose Creek in 2005 to control the minus 75μm (200 mesh), creating an improved ADVANTA® Concrete Sand to meet their customers’ needs.

After several years Luck Stone determined to advance the concrete sand strategy to other production plants where markets were present. To do this, they decided the best solution was to conduct large scale testing using a portable Barmac B6100 VSI, screen and a transportable Gravitational Inertial air classifier to prove the viability with Luck Stone’s customers. By changing the Barmac VSI’s rotor speed they were able to adapt the different mineralogies of the stone to perform similar to the natural sands in the same area.

The portable plant was installed at Luck Stone’s quarry sites and then fed with sufficient material to produce 1,000-1,500 tons of ADVANTA® Concrete Sand for the specific
customers to try at full production through their ready-mix plants. They would feed it fresh screenings to shape them and then de-dust them to provide enough test material for their customers to conduct full scale production testing as a means to determine real time production benefits outside of a laboratory setting. After completion of experimentation, this transportable test plant is now producing ADVANTA® Concrete Sand consistently at one of Luck Stone’s plants.

With the success of the trials, a decision was made to establish ADVANTA® Concrete Sand production at the Goose Creek, Virginia location. This decision was based on both market demand and location geology. The dual AC22.5GI was installed in 2005 and is fed with crushed sand from the Barmac B9100. The dual AC22.5GI air classifier processes up to 100tph of sand producing both ADVANTA® Concrete Sand as well as Mineral Filler Supplement (used in Hot Mix Asphalt; specifically SMA) from the -200 mesh.

**Conclusion**

Several of the Luck Stone plants are producing ADVANTA® Concrete Sand today and the strategy is to continue introducing this product to their concrete customers. This is a testament to Luck Stone’s tenacity and foresight in introducing ADVANTA® Concrete Sand in spite of the difficulties from both customer resistance to change and unfavourable ASTM specifications.

In 2010 Metso purchased the Buell air classification technology from Fisher-Klosterman Inc. Metso intends building on the success that this long established air classification technology has had in the USA. It is being offered along with existing Metso technologies to create highly efficient and adjustable solutions to engineered sand production globally.

*Click here for more information about Metso's dry separation technology.*