SAND SUPPLY IN SOUTH WALES …. A NEW FACTOR?

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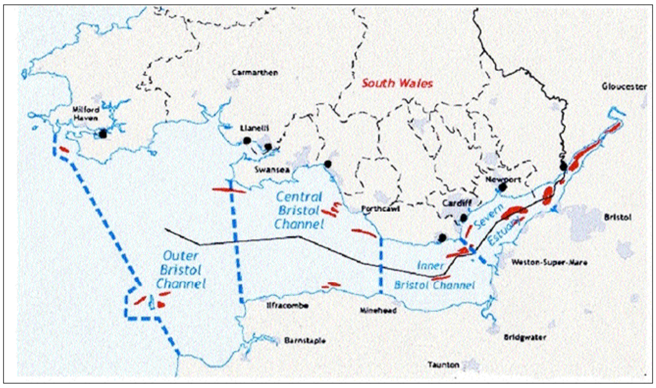
1. SAND RESOURCES IN SOUTH WALES

An inescapable fact is that South Wales has very limited land-based sources of natural sand for concrete manufacture and other building purposes.

1.1. DREDGED SAND

We rely almost exclusively on marine dredged sand - over 90% of the sand used in South Wales comes from the Bristol Channel and Severn Estuary. Whether one thinks this is a good thing or not, one only has to spend a short time on the internet to see the huge opposition to the exploitation of marine resources.

The environmental lobby has now become very respectable and extremely vocal: Dredging has been blamed for such effects as depletion of beaches, coastal erosion, and damage to marine life. There are strong calls for dredging sites to be moved ever westward, in particular away from the banks off the Gower peninsula.



MAIN SANDBANKS AND WHARVES

Although it is unlikely that dredging will be stopped in the foreseeable future, it is the clear policy of the Welsh Assembly Government to discourage long-term exploitation of much of the Eastern Bristol Channel.

1.2. LAND DEPOSITS

At present only a small fraction of the requirement comes from land-based sand pits. While suitable deposits exist in our area, there is equal or even greater opposition to their exploitation compared to marine sources: Most are located in relatively unspoilt rural areas, and extraction usually attracts even less enthusiasm than stone quarries, due to its generally greater impact on the land. Wet processing brings additional environmental challenges in silt disposal and other factors.

ACTIVE SAND PITS

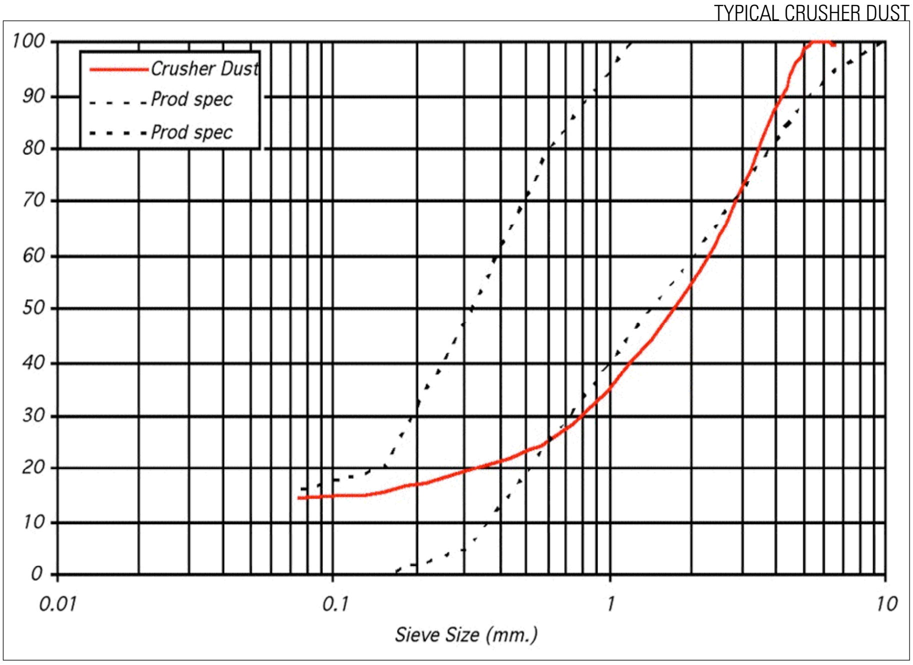
Importation from areas where natural sand is more abundant poses its own problems of cost and additional road traffic.

2. FINE AGGREGATE FROM QUARRIED STONE

2.1. CRUSHED ROCK FINES, OR QUARRY DUST

Quite obviously, if it were possible to replace natural sand, whether marine or land-won, with crushed rock fines, this could help overcome our local shortage. We produce crushed rock fines as an inevitable part of our aggregate production process; it can even be argued that it has cost us more, in power and wear and tear, than the coarser aggregates to do so. And yet in many places, not just here but all round the world, we find there is little or no market for "dust", and we are forced to stockpile it, sometimes even sterilising our own reserves with it.

TYPICAL CRUSHER DUST



Why can we not simply replace some of that scarce and unpopular natural - and expensive - sand with dust and use it for building and concrete?

It is well beyond the scope of this short presentation to go into detail, but the main answers are the twin factors of particle size distribution and particle shape. To generalise, concrete producers require a very specific and consistent gradation in their sand that is not typically satisfied by the fines produced in conventional rock crushing We usually find that the coarser particles are abundant, there is a shortage of material in the crucial 150µm - 1mm range, and an excess of <75µm or filler.

One can argue about the merits of high filler concrete mixes, but the fact remains that to sell crushed rock as sand, it has to look, feel and behave like sand, which means, among other things, controlling the filler content…......

…and the particle shape: Compression crushers - accepted as being the most efficient size reduction equipment, at least in abrasive situations - are not good at producing equidimensional, or sand-like particles, but instead grains are often flaky or elongated, leading to increased surface area (which needs more cement/water to coat it) increased void ratio, and reduced workability.

To add to the difficulty, compression crushers are often unable to produce a consistent gradation as their wear parts deteriorate.

Unprocessed crusher dust is therefore usually regarded as only suitable to be incorporated in a blend with natural sand, and only then if it is of good quality, and cheap enough to make the substitution worthwhile.

2.2. IMPROVED CRUSHING TECHNOLOGY

One of the very few fundamental advances in crushing technology in the twentieth century was the autogenous VSI crusher. Invented by two New Zealanders specifically to overcome the difficulty of producing good particle shape at reasonable cost, this machine allowed significant improvement in the quality of manufactured sand.

These "new" VSI crushers were immediately employed as sand-making machines, as the grain shape produced was superior to any conventional crusher product. The machines were also very good at giving consistent grading regardless of component wear. However, there was a drawback: Typically the fully autogenous VSI's are still unable to deliver sufficient impact energy to create the abundance of particles in the difficult area of the grading described previously. One can increase the rotor speed to some effect, but only at the expense of increasing the percentage of filler produced and the wear cost, and reducing capacity. One solution is to employ a wet process to wash out the fines; however this has a further detrimental effect upon the energy transfer within the crusher, as the coating of water on the feed particles tends to damp the crushing action.

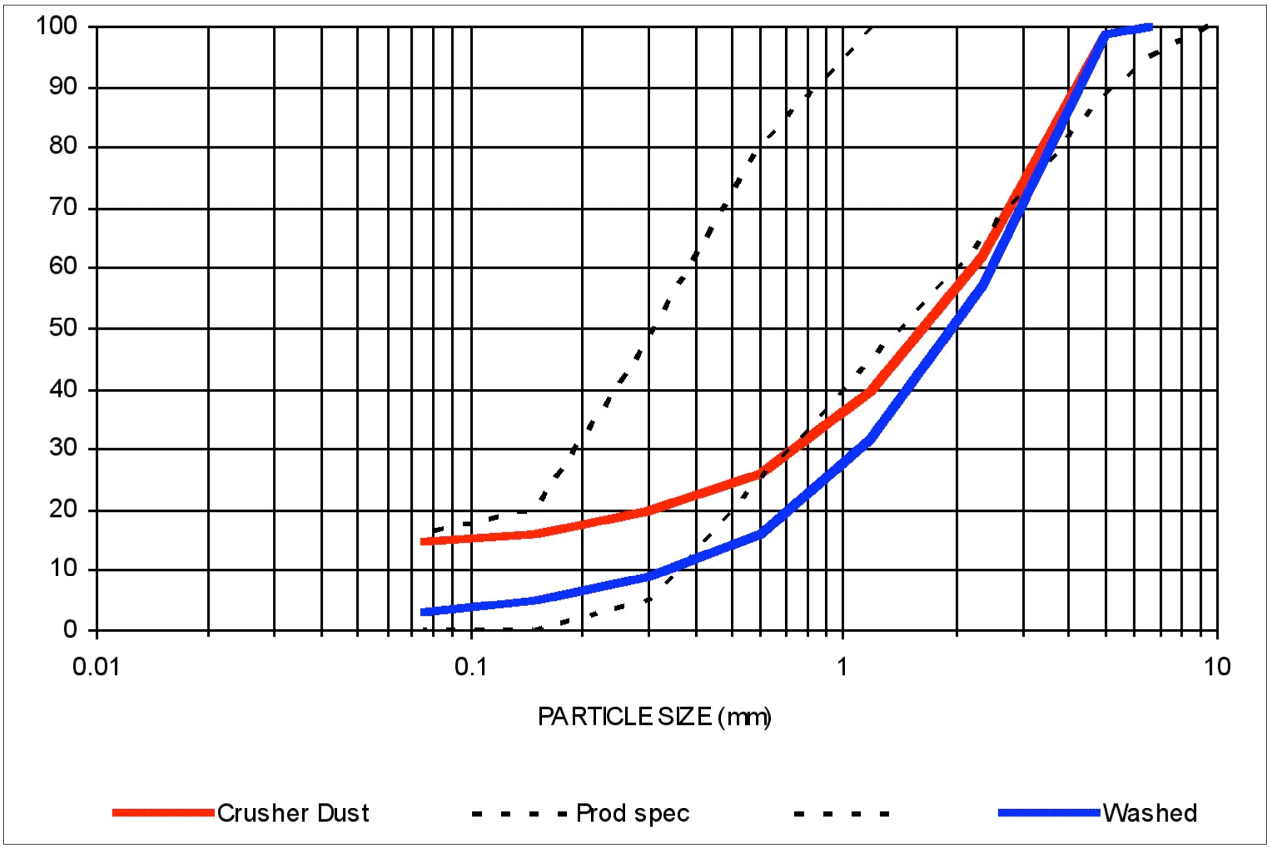
2.3. WET PROCESSING AND CLASSIFICATION

It has become quite commonplace to control the fines content of crushed rock fines using a simple wet classifier, although this then leads to a problem of disposal of the slurry. In most sand and gravel pits, the effluent can be pumped into a worked-out area and left to settle and, hopefully consolidate, with or without the aid of expensive flocculants and so on. In stone quarries we rarely have that luxury, and since we can't let it run away elsewhere, the usual practice is now to install thickening tanks and filter presses, to give us a transportable solid waste that we can deal with.

In some places, the classification system is more sophisticated, and capable of providing multiple products of consistent grading: However, the imbalance of particle sizes derived from conventional crushing has still not been addressed, so the sizes produced in excess still need to be dealt with. Moreover, unless there is a VSI, or possibly a rod mill, in the circuit, it is unlikely that the particle shape will be ideal for use in concrete.

2.4 DRY CLASSIFICATION

To date dry classification systems offered to quarry operators seem only to remove filler from crushed rock fines, without addressing the particle shape or gradation issues - in fact they will make the latter worse, in the same way as merely washing the material. This is probably not the answer to making our product attractive to the market.



3. NEW TECHNOLOGY AND A POSSIBLE SOLUTION

3.1. THE REQUIREMENT

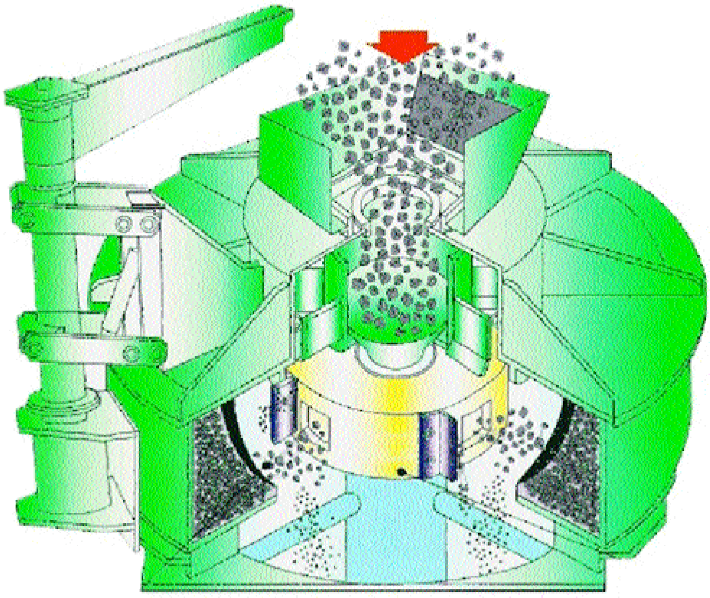
Bearing in mind the shortcomings discussed above, what is wanted can be summarised as follows:

- A dry process to avoid the expense, inconvenience, space requirement, and waste associated with wet processing.
- A process that can take commonly available crushed rock fines or other low-value material as feed.
- A crushing machine that can increase the available grains in the difficult area of the distribution while delivering an excellent particle shape.
- A classification system that can be set to produce a predetermined specification, returning oversize material to the crusher and excess filler to a sealed filtration system for controlled disposal or possible sale.
- Environmentally friendly, with no emissions.
- Low production cost but high added value.

This was approximately the challenge posed to a Japanese quarry plant manufacturer a short while ago: They were faced with a declining domestic quarry industry, the only growth area of which was in sand manufacture, driven by reduced marine, river, and land-based reserves.

3.2. THE SOLUTION

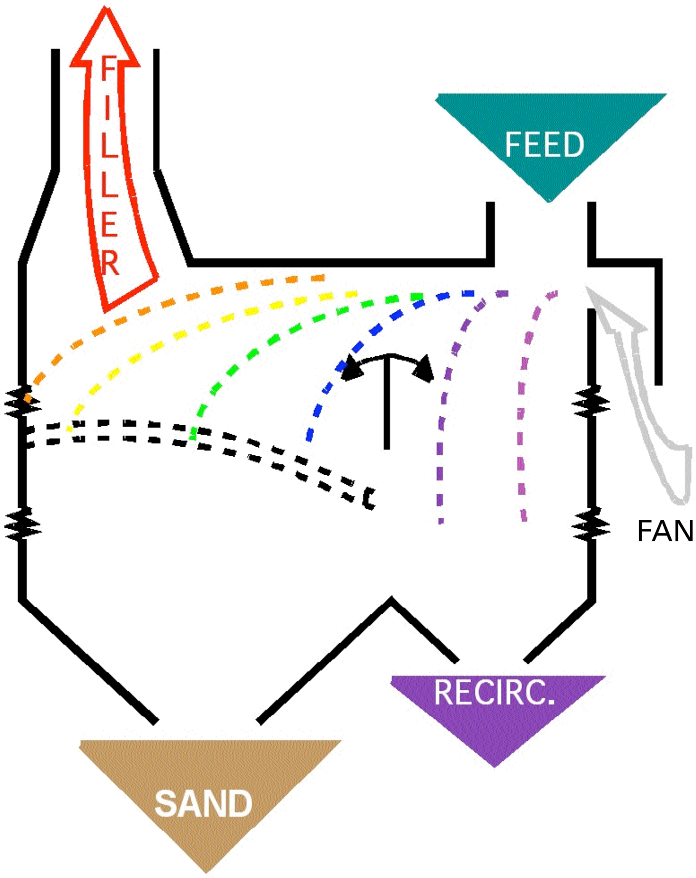
The first stage was to develop a crushing machine that could produce an abundance of the "difficult" sized grains discussed earlier. This was achieved by developing existing autogenous VSI technology to incorporate a milling function, using tungsten carbide impact members and a restriction on the crushing chamber outlet, thus forcing the material into a zone of powerful attrition.



3.2.1. To this was added an air screen, or classifier, from which the oversized grains can be selected and recirculated to the crusher. An additional control allows a proportion of the coarser remaining particles to be recirculated also, in order to control the top size and grading of the product within close tolerances.

3.2.2..The final piece of the puzzle was provided by a bag house dust collector, which removes the unwanted filler.

By altering various parameters, it is possible to produce a consistent sand product to any reasonable specification.



3.3. THE HARDWARE

3.3.1. STRUCTURE

Not unnaturally, the inclusion of a bag house makes the complete plant a substantial item, but the design has been carefully worked out to take up as small a space as possible. Incorporating a bucket elevator means that the whole plant can be arranged vertically on two adjacent steel towers. It only remains to add a feed from the existing quarry plant, and a stock-out conveyor.

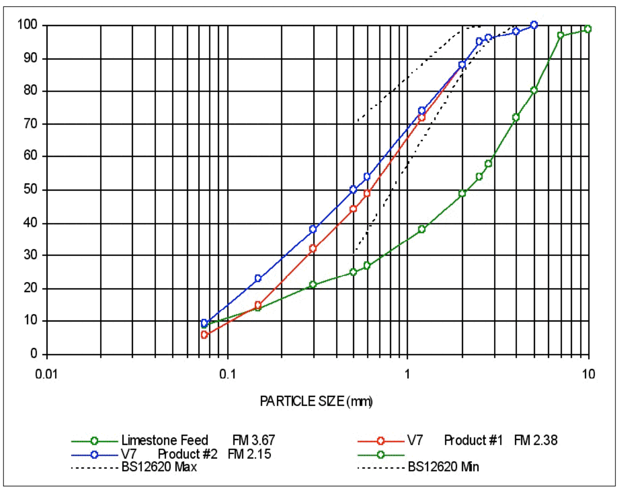
3.3.2. PRODUCT HANDLING

It is usual to include a facility for adding about 3% water to the sand product in order to prevent segregation and to maintain consistency (foreground). The filler is dry powder, and can be removed for sale by tanker, or if it is to be treated as waste, it can be conditioned for transport by dump truck.

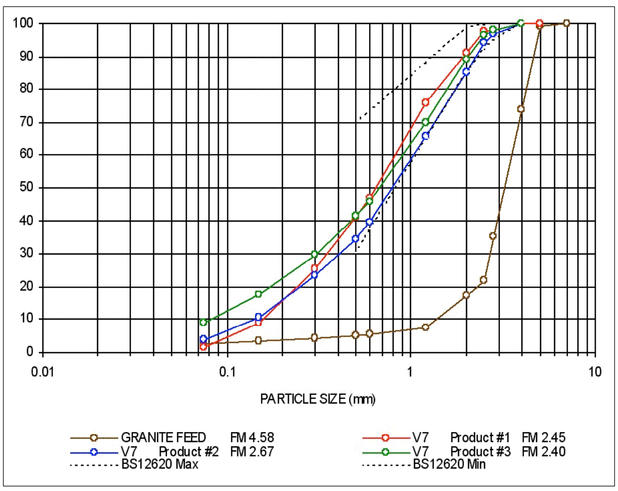
3.4. APPLICATIONS

In Japan there are now approaching fifty of these plants operating successfully in such diverse applications as Andesite, Basalt, Diabase, Incinerator Bottom Ash, Limestone, Nickel Slag, Recycling Concrete, and Sandstone. Below are the results of two recent full-scale tests undertaken on behalf of UK customers, in which bulk samples were shipped to Japan and processed in a test facility.

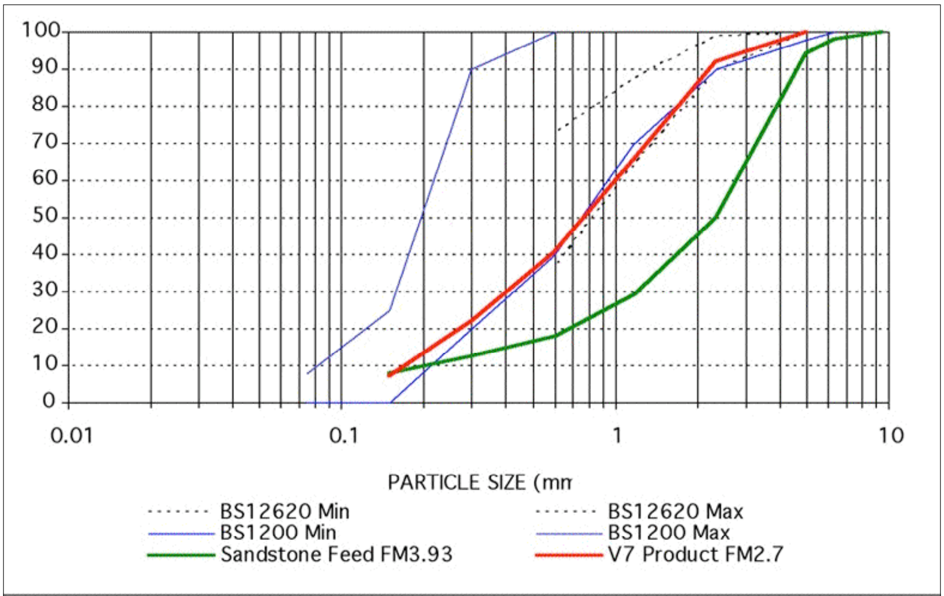
LIMESTONE EXAMPLE

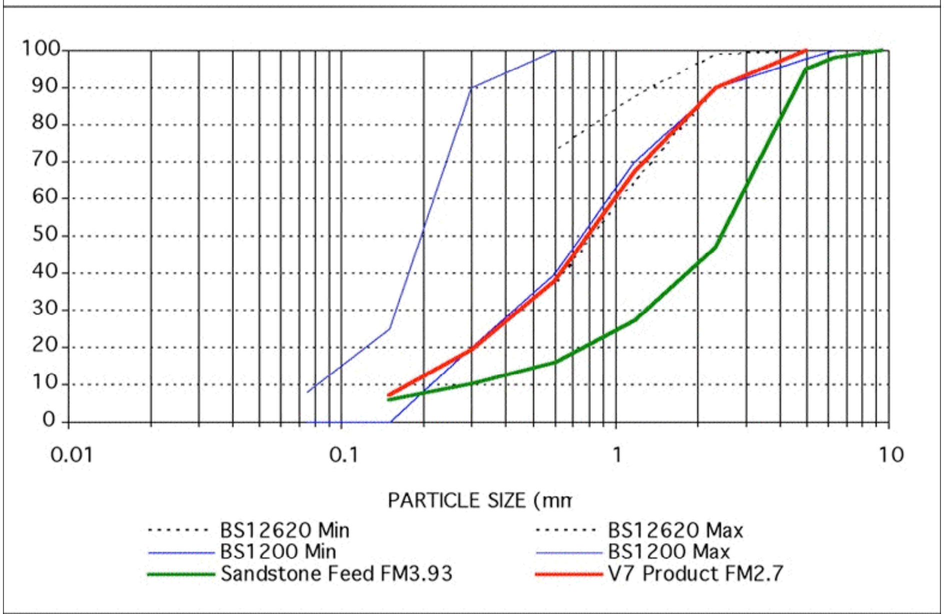


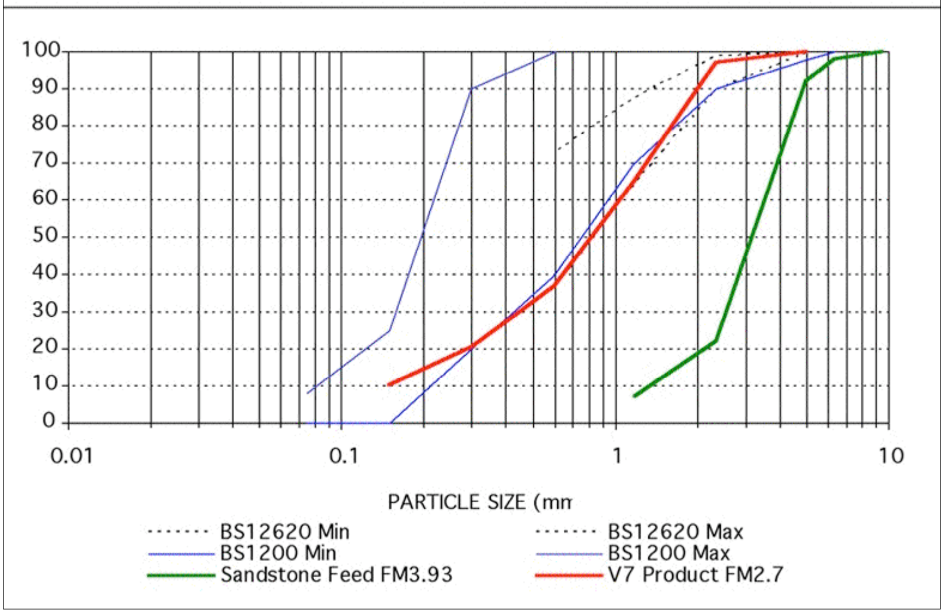
GRANITE EXAMPLE



THREE SANDSTONE EXAMPLES







NOTE: THESE WERE DESIGNED TO MEET THE JAPANESE STANDARD ENVELOPE, THE LIMITS OF WHICH THEY APPROXIMATELY BISECT.

CONCLUSION.

It seems that there is no reason why the gritstone fines of South Wales should not provide a successful feedstock for dry sand-making plants such as that described above. It would clearly be of interest to carry out testing of bulk samples, but in general the main variable tends to be the percentage of filler generated in the process, which in turn is greatly affected by the grading of the feed.

If the sand manufactured in this way is similar to the products already proven, we may expect that it could be used as a substitute for up to 100% of the natural sand in concrete, as is the experience in Japan. No doubt market resistance would arise, but with less justification than applies to existing rock-derived fine aggregate.

Certainly it would be very advantageous at a number of sites in South Wales to increase the utilisation of quarry dust, even if a proportion of material remains as unsaleable filler (although the Japanese seem to be developing new uses for this too), and if extraction of natural sands is curtailed as expected over the next few years, then the industry will have little choice but to embrace such technology as this to make up the shortfall.

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The author's working life has always been concentrated around mining and quarrying, with intermittent attempts to escape, but always he seems to come back to breaking rocks in one form or another, thus fulfilling the prophecies of his elders and betters nearly fifty years ago. He now lives in Pembrokeshire and earns his living as a freelance provider of services to, mostly, the quarry industry. While he has been involved in such matters as safety systems, CDM projects, and temporary contract supervision, his main interest remains in making big rocks into little rocks.