Manufactured Sand

Aggregate (crushed rock, gravel, and sand) is an essential resource for the construction sector, housing, transport infrastructure and climate change adaption. Due to unprecedented levels of construction and infrastructure development activity, there is growing demand for aggregate which is in short supply in many parts of New Zealand. Where resources are scarce or consenting time frames impact supply, it is important to utilise quarry products effectively.

Sand is currently the second most used raw material on the planet, it is used across several sectors, is easy to obtain and suitable for many purposes. The demand for its use in construction, microchips, glass and in cosmetics has been rapidly increasing with the increase of urbanisation and it is becoming less readily available because of this growth, and the closure of unsustainable sand extraction operations in many parts of the world.

The use of manufactured sand, while a suitable alternative to natural sand, is a less used product type within all industries. Manufactured sand is generated through the crushing or grinding and screening of rock products, and therefore uses rock that can be used for other purposes such as concrete and asphalt aggregates, roadbases, armour rock, etc. The produced sand can be washed and sieved to remove any fine particles or impurities. It can range in size but typically passes through 7mm or 5mm screens.

The reported amount of rock, sand, and gravel extracted from quarries in New Zealand, is typically around 30 million tonnes annually (refer Figure 1). Reporting is voluntary and each year between 40%-75% of quarries submit data. The estimated total production for 2021 is 45 million tonnes. The amount of natural sand extracted for industry is typically around 3 million tonnes per annum.

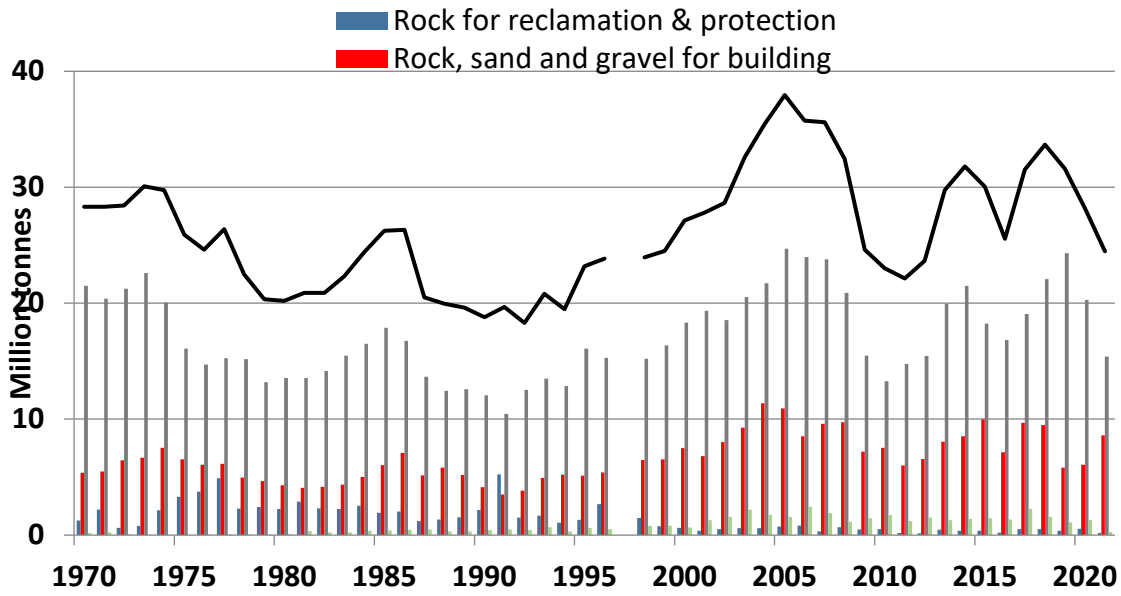

Figure 1: New Zealand Rock, Sand and Gravel Production 1970 – 2021

International Literature

Internationally, aggregate demand is expected to recover to pre-Covid levels of 44 billion tonnes per annum by 2030 because of growing population, urbanisation, and a return to economic growth in China and India. There is a concern among experts internationally in the availability of natural sands in the future. According to some forecasts, buildable sand may run out as early as the first half of this century. It also causes issues for aquatic habitats and affects groundwater recharge. Sand extraction from quarries exists on large scales internationally with the USA quarrying almost 50 times what New Zealand extracts on average per annum. There have been significant issues associated with the extraction of sand around the world. Illegal mining from riverbeds has posed severe threats to environments.

Sand extraction, like all quarrying can have an impact on the natural environment around it, and therefore the quarry industry works collaboratively with iwi, local communities and councils to provide positive environmental impact and meet legal requirements of environmentally sustainable operations. Sand and gravel extraction has a positive impact on the risk to communities surrounding active river systems. Removal of aggregates can allow for engineered or channelised flow, reducing risk of flooding on neighbouring land.

To keep up with the building sector expansion, manufactured sand is being used to supplement the supply of natural sand. There is a rapidly growing market for manufactured sand as the building sector continues to expand. Some researchers expect the global manufactured sand market will grow at a compound annual growth rate of 17% between 2020 and 2028.

Manufactured Sand Properties

General properties:

- It is a well graded product that maintains the source properties of the rock.
- It does not contain organic and soluble compound that affects the setting time and properties of cement; thus, the required strength of concrete can be maintained.
- It does not have the presence of impurities such as clay, dust, and silt coatings, or have increase water requirement as in the case of river sand which impair bond between cement paste and aggregate. Thus, increased quality and durability of concrete.
- It can undergo shaping during manufacture which allows for aggregate interlock and consistent compaction in asphalt and aids workability in concrete.

The physical and mineralogical processes of natural sand and manufactured sand differ which can have effect on concrete and asphalt products, that should be considered during the design phase.

Advantages

There are several potential advantages that the use of manufactured sand has over natural sand sourced from rivers, these are outlined below:

- Higher compressive and flexural strength
- Consistency in grading allows better quality control
- Has less impurities, such as clay, dust, or silt
- Quality assurance can be increased by on site production
- Physical and chemical properties can withstand harsh climate conditions
- Consistent shape aids compaction/density requirements

The strength of concrete has been found to improve due to the better consistency of shape, texture, and gradation of the fines. Since there are less impurities, such as clay or dust, the sand produces a better quality of concrete.

Disadvantages

Some customers find workability impacted by the increase in manufactured sand in concrete mixes. The decrease in workability can lead to more cement and water requirements thereby increasing cost. The decrease in workability is a function of the crushing and screening process and fragmentation of the source rock. Proper process to produce a fit for purpose manufactured sand requires a greater level of energy intensity.

Manufactured sand uses the same source rock used to produce quality aggregates for concrete, sealing and asphalt. It therefore needs to return at least the same value to the quarry as it will deplete source rock at the quarry.

Conclusion

Nationwide, the most pressing issue facing the aggregates industry, is the diminishing availability of consented aggregate and sand resource relative to demand.

Manufactured sand is used internationally. Crushing and screening practice here in New Zealand has produced significant amounts of manufactured sand which has found a home in asphalt, roading base and concrete. Historically we have had sufficient natural sand (river, beach, land based alluvial and seabed extraction) resources which has been supplemented by production of manufactured sand to meet market demand. However, as these natural resources diminish, the industry is investing in more intensive manufacturing processes to fill the gap.

Brookby Quarry, in Auckland, will be commissioning a manufactured sand plant in mid-2024 and a number of technologies are available to produce this product. If financially viable, it is common for lead times of 5-10 years before any meaningful production would be available. This requires significant financial investment and could add 20-30% to the cost of sand on top of any additional transport costs, however there are downstream savings due to the quality of manufactured sand compared to river sourced sand.