

27 February 2019

Mr Shayne Elstob – Chief Operating Officer

McCallum Bros Limited
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Rosebank
Auckland 1348

Dear Shayne

Sand for Concrete Manufacture in the Auckland Market

You have asked me to provide a brief history and comment on certain technical aspects concerning the use of marine sourced sand for concrete manufacture in the greater Auckland market and neighbouring regions.

Historical Background

The predominant sand used for concrete manufacture in the Auckland Region has been coastal sand for at least 100 years. The two main dredging sources are near Pakiri on the East Coast and the Kaipara Harbour on the West Coast. At various times Waikato sourced sands have been used, sometimes blended with coastal sand. Waikato sands used in concrete are not preferred; they have several disadvantages and are less economic compared to coastal sand. Dune sand from Tomarata, west of Wellsford was also used intermittently 15 to 20 years ago.

Coastal Sand Characteristics.

The main minerals in both West Coast and East Coast sands are Quartz and Feldspar; the proportions of each can vary depending on the source. The most important aspect is that these minerals are inert and are proven to be non-reactive to the alkalis in cement; this is very important for the long-term durability of buildings and structures.

Coastal sand for ready mixed concrete manufacture in Auckland is always blended with crushed rock fines which provides an ideal combination that has low water demand, good workability, finishing properties and pumpability. The typical proportions of crushed rock fines are 60% to 40% of coastal sand with the combined fine fraction being approximately 50% of the total coarse and fine aggregate volume.

Other desirable characteristics of coastal sand is that it is very clean, has consistent grading, good particle shape, is strong and durable and contains very few ultra-fine particles. These characteristics greatly reduces the risk of early plastic shrinkage or long-term drying shrinkage

cracking issues. The only negative property of Coastal sand is that it contains chlorides and weaker shell fragments. However, in my 40+ years of involvement in the concrete industry regular chloride testing of coastal sand has always given very low or below the test detection limit results. There has never been an instance where chloride levels have been anywhere near the maximum limits of NZS 3109 and NZS 3101 for building and construction. Likewise, shell fragments in sand due to their relatively low abundance do not appear to have any negative affect on concrete strength or durability.

Tomarata (landbased) sand is very similar in grading and composition to offshore coastal sand which is to be expected because it is very near to Pakiri. The most notable difference is that Tomarata sand is more weathered with a distinct yellow/orange colour and contains more silt sized particles which can give problems in concrete if not controlled to a low level.

Waikato Sand Characteristics

Waikato concrete sands are coarser in particle size distribution compared to coastal sand. They contain various minerals of volcanic origin that are highly reactive to the cement alkalis in concrete. Over the years, there have been several reported cases of Alkali Silica Reaction (ASR) causing significant damage to structure directly related to the use of Waikato sand in concrete. The concrete production standard (NZS 3104:2003) places a maximum limit of 2.5kg/m³ of total alkali in concrete when potentially reactive aggregate or sand is used. This is very challenging for the concrete mix designer as it becomes very difficult to produce higher strength concrete mixes typically used for important infrastructure projects, high rise construction and marine structures. As the alkali levels in the locally available cements are constantly variable there is always an element of ASR risk when using Waikato sands.

Most Waikato sands at their source contain a variable pumice proportion which needs to be separated out from the denser more durable sand particles. If the pumice content of concrete sand is more than approximately 2% by weight concrete strength can be significantly reduced. Due to the coarser particle size distribution of Waikato sand it requires a greater proportion of sand to crushed rock fines compared to when coastal sand is used. Typically, this is 40% crushed rock fines to 60% sand to achieve a blend of suitable fineness for concrete.

Economics of Concrete using Coastal Sand Vs Waikato Sand in Auckland.

My comments in this discussion are limited to the technical aspects of concrete, however there are significant differences in road transport cartage distance between both sands the dredging and shipping costs of coastal sand is a major component of the sand cost.

The main economic advantage using coastal sand compared to Waikato Sand is that significantly less cement is required to produce the same strength concrete. This quantity can vary depending on the other raw materials and admixtures used; typically, a 20kg to 40kg cement reduction. Not only is making concrete using less cement more economic it is an environmentally responsible means to reduce CO2 emissions. The main reason for the difference in cement content is that Waikato sands are coarser which requires a greater ratio of sand to crushed rock fines to produce a blend an optimum blend. The resulting blend has more voids in comparison to a marine sand which has a slightly higher water demand which requires more cement to produce the same strength.

Discussion

I have first-hand experience of a trial with a major concrete producer to introduce Waikato sand in concrete to the Auckland market. The trial product was not well received and concrete placers much preferred the workability and finishing characteristics of Coastal sand concrete.

In other countries where natural sands have been depleted or are off limits to extract there has been a move to using manufactured sands. Manufactured sand is made from crushed rock requiring expensive quarry plant and a high degree of processing. Regardless natural sand is always superior to manufactured sand and few countries have been able to successfully use 100% manufactured sand for the fines in the mix and a proportion of natural sand is almost always required.

Conclusion

There are many factors to consider in the evaluation of sand mining methods including the environment, sustainability and the benefits of a proven product essential for construction growth.

Coastal sand is an important valuable resource for concrete manufacture in the Auckland region. It has a proven track record over many decades and completely removes the risk of ASR susceptibility when used in conjunction with the other available concrete aggregate materials from local quarries. Coastal sand is the preferred sand of choice for the Auckland concrete market and superior to any other alternatives

Yours sincerely

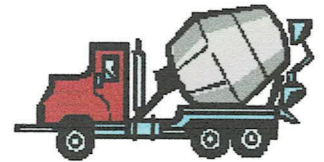


Brett Beatson
NZCE (Civil) REA

Beacon

Technical Services Limited

Company Profile



Beacon Technical Services Limited was established in February 2002 as a consultancy business primarily focussed on providing technical support services to the ready mixed concrete, quarrying and construction industries.

The core business is fulfilling the role of Plant Engineer to Ready Mixed Concrete producers throughout New Zealand and the Pacific Islands. The focus being to work closely with customers to establish and maintain quality control systems and procedures in order to achieve Plant Audit status under the Plant Audit Scheme operated by Concrete New Zealand.

This work involves aggregate and sand evaluation for use in concrete, concrete mix design, and statistical analysis of concrete test results, advice on compliance with audit requirements, concrete troubleshooting, concrete advice, research and development.

Principal – Brett Beatson

Prior to establishing Beacon Technical Services, I worked for 21 years at W Stevenson and Sons Limited in Auckland. The most recent position held was Technical Manager of Stevenson Concrete. Prior to this I held the roles of Technical Operations Manager and manager of the Civil Engineering Laboratories Division.

I have a wide range of experience in the field of construction and building materials testing ranging from earthworks, quarrying, roading construction, concrete and concrete products.

Qualifications:

NZCE (Civil), REA

London City & Guilds Concrete Technology Parts 1&2

Industry Affiliations:

Member of Concrete New Zealand

Member the Technical Committee Concrete New Zealand, Readymix Sector

Member of Concrete New Zealand, Learned Society