



QUALITY ASSURANCE TESTING OF EXTRUDED CONCRETE

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Extruded concrete for kerb and channel work is supplied as a semi-dry material with zero or very low slump since the material is subject to high intensity vibration and must be self-supporting after extrusion.

Quality assurance of this type of concrete requires extra attention during testing as the material has significant differences to standard structural concrete.

Specific guidance for extruded concrete is not covered in New Zealand Standards, while local guidelines produced by NZRMCA in 2005 rely on AS 2876 even though this document is not cited in NZ standards. Typically kerb concrete is specified in terms of strength grade, but quality assurance can be complicated due to the following:

- Testing for strength is done at the concrete plant before final adjustment with water on site to achieve the correct consistence for extrusion (this water addition is small otherwise concrete sampled at the plant cannot be adequately compacted).
- Compaction of cylinders at the plant requires extra compaction using vibrating tables or ramming with larger diameter (e.g. 32 mm) rebar or modified Proctor hammer.

- Site testing of concrete is occasionally done and requires special attention to ensure full compaction is achieved as per plant-based testing.
- Some projects specify core testing of kerb concrete that requires precise sampling and correct testing to produce a reliable indication of in-situ strength.

The quality of kerbing concrete is a combination of strength and dimensional stability and optimum moisture content may differ for these two properties. Strength will be highest when concrete is on the point of slumping since the benefits of improved compaction usually outweigh the increase in water/cement ratio. In contrast, good dimensional control of extruded concrete may occur with concrete that is slightly drier although compaction efficiency is slightly reduced (e.g. air contents of 4-6 percent compared with 2 percent for well compacted concrete). A relatively narrow range of moisture content is therefore possible for kerbing as shown in Figure 1 below.

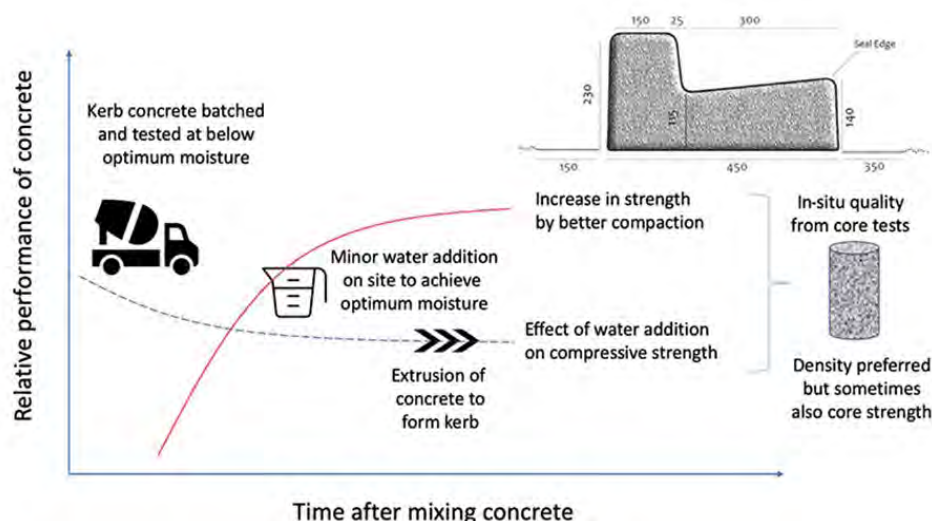


Figure 1: Schematic of the process of batching and extrusion of concrete

Table 1: Recommended kerb concrete proportions and typical strength performance

Mix Type	Road type application	Cement content (kg/m ³)	Water/cement ratio	Plant strength (MPa) Air – 2%	In situ strength (MPa) Air – 6%
A	Motorway	280	0.55	40	32
B	Arterial	260	0.60	35	28
C	Residential	240	0.65	30	24

N.B. predicted strengths derived from modified Abrams law for GP cement while 1% extra air reduces strength by 5%

Measured strengths from plant and in-situ testing will vary, which is shown in Table 1 using recommended kerb mix proportions for different road applications. This analysis assumes a water demand of 155 L/m³, which is an average value that will vary depending on materials and mix designs around New Zealand. Predicted strengths assume good construction practice in terms of curing concrete that can have a significant effect on compressive strength.

TESTING METHODOLOGY FOR CONCRETE SUPPLIERS

Concrete supplied to projects using extruded concrete will have batch and test records that confirm mix proportions and performance in terms of density and strength. Technicians undertaking this testing must ensure that concrete is at the correct consistence when sampled and have appropriate equipment to ensure a reasonable level of compaction. Quality assurance of kerbing concrete supply includes the following activities:

- Cement contents should comply with the prescriptive limits given in Table 1 and must be within 1 percent of the target value to comply with NZS 3104.
- Consistence level is assessed by taking a handful of
- concrete using protective gloves and by balling and shaking the fresh material, the level of cohesion and workability can then be assessed.
- A representative sample is then extracted from the concrete mixer in the normal manner specified in NZS 3112 Part 1.
- Concrete is compacted in standard cylinders using either a vibration or rodding/hammering where the energy used in compaction is significantly higher than used for standard concrete (e.g. double vibration time or ramming more than 30 blows per layer).
- Storage of concrete cylinders follows standard practice and the visual appearance and hardened density of test specimens should be checked after demoulding to confirm compaction.
- Testing for compressive strength is undertaken at 7 and 28-days is the standard manner outlined in NZS 3112 Part 2.
- Site testing may also be undertaken after final water addition by the kerbing contractor, and it is important that cylinder compaction produces dense concrete consistent with that achieved during plant testing.

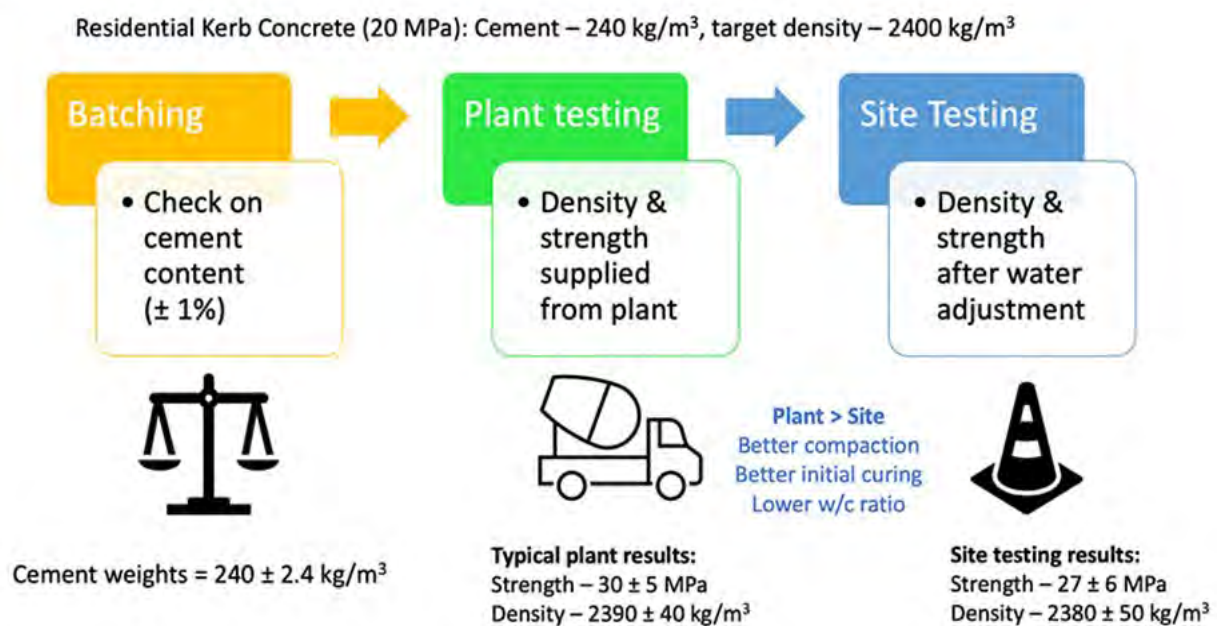


Figure 2: Typical range of results from quality assurance of residential kerb concrete supply



Image: Powell Kerbing Ltd.

Construction of new developments requires a significant amount of extruded concrete for kerbs, channels and median barriers.

Anecdotal evidence suggests that concrete plants that regularly supply kerb concrete usually develop the skill to sample the material at the correct consistence and fully compact the concrete (e.g. cylinders when demoulded appear normal without excess porosity or low density). Concrete plants that only occasionally supply kerb concrete often do not always have this expertise, which may lead to poor density and strength results and require core testing of in-situ concrete.

Reducing the amount of in-situ testing requires good quality assurance of concrete supply. This is shown in Figure 2 for a kerbing project of 20 MPa residential concrete. Note that testing of kerb concrete on site is not commonly undertaken but it is possible if requested. While this is more difficult to undertake, quality assurance on site using cylinder testing may help avoid core testing of kerbing, which is often found to be unreliable.

CONCLUSIONS

Construction of new developments requires a significant amount of extruded concrete for kerbs, channels and median barriers. This type of concrete is periodically the source of disputes regarding the quality of the concrete

in the field. Invariably the issue is difficult to resolve since test records from concrete suppliers may differ from those obtained from core testing on site. The lower strength found from core tests is due to several factors that include higher water content, incomplete compaction, less effective curing in the field and in particular the higher variability associated with core testing. Concrete suppliers cannot resolve these site issues but should ensure that they provide reliable quality assurance for kerb concrete supplied to projects. It is particularly important that non-standard compaction processes are understood by technicians undertaking this testing.

REFERENCES

- New Zealand Ready Mixed Concrete Association. (2005). *Special concrete guidelines: Kerb and channel machine placed concrete*. Wellington, New Zealand.
- Standards Australia. (2000). *AS 2876: 2000 Concrete kerbs and channels (gutters) - Manually or machine placed*. Sydney, Australia.

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