

Stone – Back to Basics

# LIMESTONE

*The recent Stone & Tile Awards are proof that the use of stone is a competitive fashion industry with different stone types coming in and out of favour. Limestone is currently in vogue partly due to its subtle tonality and the broad palette of neutral greys and browns which this stone type offers. This versatile and highly variable stone type is used as thin tiles, large format cladding, ashlar construction and statuary – what is it, what makes it so versatile and how can we choose a good quality stone?*

*Above: Limestone cladding, in King Street, Sydney*

*Below: Producing thin limestone slabs under the gang saw.*



## Limestone & Marble Formation

Although marble and limestone are both predominantly composed of calcium carbonate their physical properties and structure can be quite different. Limestone is a sedimentary stone type mainly formed by the deposition of small fragments of marine organisms such as coral, shells and other marine organisms along with smaller amounts of other 'contaminant minerals' such as sand grains and clay.

After deposition the sediment undergoes a process called diagenesis which involves de-watering, compaction and cementation through the pressure applied by overlaying sediment resulting in the formation of limestone rock. The pressure applied can also cause some chemical changes such as the conversion of shell fragments into calcite and the formation of stylolites (discussed in more detail later). The type of sediment laid down and the conditions of formation (e.g. amount of pressure applied) can vary greatly leading to a significant change in the density and strength of the stone formed.

Marble is a rock composed of a mosaic of calcite and/or dolomite crystals. Like limestone it is composed predominantly of calcium carbonate but in this case the minerals have undergone metamorphism through exposure to high pressure by deep burial within the earth or applied forces through tectonic movement. Some marble deposits are formed through high temperatures from contact with molten rock intrusions.

Put simply, the formation of limestone and marble can be considered a 'generational change' as both rock types are formed from similar types of sedimentary deposits with marble metamorphosing from limestone with higher heat and pressure.

## Is it Marble or Limestone?

There are many limestone types on the market that are sold as marble and it can be difficult to tell the difference when viewing a polished tile. In a commercial sense, limestone and marble appear to be differentiated by the level of polish which can be achieved. If the stone can achieve a high polish then it is usually sold as a marble, if not, it is likely to be sold as limestone.

In trying to determine if a stone is a limestone or marble the keyword to remember is 'metamorphosis'. As marble is a metamorphic rock all shell and coral fragments are converted into calcite crystals usually removing any trace of the original structure. The fracture face of a marble tile will usually be 'sugary' with uniform grain size while a limestone may show remnants of the original sediment.

Here's a quick rule for telling the two stone types apart - if you can see shell fragments it's probably limestone. If the stone breaks with a consistent sugary fracture it's probably marble.

## Appearance

Limestone is typically white to tan in colour although there are darker colours on the market such as Jura Grey and Nero Marquina. The stone can be produced in a range of finishes such as polished, honed, sawn, tumbled and grit blasted making it suitable for a wide range of locations. The degree of polish that can be achieved depends on the grain size and density of the stone.





*Decay of high density limestone due to unstable stylolites.*



*Intricately carved limestone capitals*

As limestone is formed from sediment, stone types that have variability in the bedding sediment or large fossil fragments are more likely to display changes in appearance and strength when slabbed in different orientations.

### Use

Limestone would have to be the most versatile stone type. With the hundreds of limestone types available there are products that are soft and fine-grained and suitable for carving into intricate statuary, other limestone materials have very high durability and are suitable for use in aggressive locations such as pool coping and external facades. Dense limestone is a popular product for processing into thin tiles for floor tiles and wall cladding. The low processing cost of limestone has allowed it to be used in block form for construction of homes.

### Design Considerations

As limestone is composed of calcium carbonate it will be etched by acidic substances such as wine, soft drinks and some liquid soaps. It is important to note that the application of an impregnating sealer will not prevent etching as they do not protect the surface of the stone. Dark coloured limestone is particularly vulnerable as the etching usually produces a contrasting bleached appearance. If the stone is likely to be exposed to acids the use of a honed or matt surface will make etching less conspicuous.

Sedimentary rocks such as sandstone and limestone can lose significant strength when wet. It is important that this strength loss is taken into account when determining load bearing requirements.

Limestone has a relatively low abrasion resistance compared to granite. Textured or coarse honed finishes that may be applied to increase the slip resistance can become polished in high traffic areas which can affect the slip rating.

### Stylolites

Stylolites are vein-like features that are typically seen as fine lines that zigzag across that surface of the stone. The stylolite represents an interface where soluble minerals have been removed by pressure dissolution. Less soluble minerals such as clay and pyrite remain at the interface and become concentrated at the interface which highlights the stylolite. Most stylolites are formed in a plane that is sub-parallel to the bedding although in some circumstances they can develop perpendicular to bedding.

The stylolites may be considered as benign features that add to the character of the stone but it is important to remember that they are three dimensional structures that sometimes contain clays that are unstable when wet. As floor tiles are exposed to frequent wetting and drying cycles during cleaning, the use of stone containing unstable stylolites can lead to significant decay as clay within the stylolite causes small pieces of the tile surface to become detached. The use of water to clean stone should always be kept to a minimum.

### Testing and Specification of Limestone

Standard specification ASTM C568 provides a guide to the selection of limestone dimension stone suitable for general building and structural purposes. The standard provides separate requirements



*Initial processing of a limestone block*

for low, medium and high density limestone. The physical requirements for this specification are given in Table 1.

The specification of any dimension stone should be based on location, design and engineering considerations specific to the intended use. The specification states a minimum strength requirement which requires the determination of both dried and soaked strength. It is also important to note that the strength results are likely to vary significantly with bedding orientation.

Water absorption and modulus of rupture are the key performance indicators for this stone and should be evaluated closely throughout the project supply phase to ensure adequate performance in service.

### In Summary

Limestone is a highly versatile stone type which is available in a wide range of colours and textures and suitable for nearly all locations. Taking note of the following points will assist you in the selection of the right stone for the job and its maintenance well into the future:

- Stylolites should be thoroughly evaluated to ensure they are stable and not likely to decay in wet/dry environments.
- Ensure soaked strength results are used to determine load bearing capacity of paving units in wet environments.
- Some loss of slip resistance may occur in high traffic areas and needs to be taken into account.
- As limestone is acid sensitive it is important to clean up spills immediately to avoid permanent staining and etching.
- Minimise the use of water when cleaning. <sup>CS</sup>

Table 1: ASTM C568-08 physical requirements of limestone dimension stone.

Property	Low Density Limestone	Medium Density Limestone	High Density Limestone
Bulk Specific Gravity - min (kg.m <sup>-3</sup> )	1760	2160	2560
Water Absorption – max (% by weight)	12	7.5	3
Modulus of Rupture - min (MPa)	2.9	3.4	6.9
Compressive Strength – min (MPa)	12	28	55
Abrasion Resistance – min (Ha)	10	10	10



Complementary use of high density brown limestone with white marble as a border.

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