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Sustainable use of natural stone as paving material

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Sustainability is not only a matter of choosing durable stone types for a specific application. It is also about the energy consumed during the production, transportation and placing of the stone. It is also about dimensioning and shaping of the stone properly for the actual construction and the stone together with other materials in the construction. This contribution deals with the latter and is a case study on a failed paving construction.

Stone paving is the collective expression for the use of stone slabs, setts and kerbs for exterior paving purposes. There are three European product standards in force; EN 1341, 1342 and 1343 respectively. These standards describe e.g. how to denominate the products, the allowed dimensional tolerances and which technical properties to validate. There is little or no information on the actual usage of these products. Such information has generally to be elaborated by each country.

The standard way of construction for pavements is non-bonded laying of elements in crushed sand/split mixtures. Under special loads and cleaning requirements this traditional, unbound construction method easily fails and a bound construction is needed. The structural integrity of an unbound pavement construction is maintained on the basis of friction and mechanical interlock. Energy from traffic loading enters the structure via the surface course, some of this energy is dissipated within the surface course itself and some is transmitted into the bedding course and thereafter the supporting base layers beneath. There are two structural elements in the surface course, the setts and the jointing medium. The jointing medium has physical properties which are important to consider, such as stiffness modulus, resistance to shear et al, which crucially affect the manner in which the pavement responds to applied loads.
Sufficient friction between the various components is crucial but is not generated and mechanical interlock not exercised without movement of the component parts of the structural model. The unbound paving is not a rigid construction and the various parts of this structural model must be mobilised in order that friction is generated. The paving is therefore also heavily dependant upon the unseen surface finishing of the setts (and slabs). In order to adequately generate friction between the paving element and both bedding and jointing materials the unseen surfaces have to be rough, preferably a cleft or riven surface, to function properly.

There are two distinct categories of setts, shallow setts and full setts, each requiring a different approach:
Shallow setts are those having depth less than width.
Specifying shallow setts makes a more economical use of the raw material used in their manufacture but the pavement construction requires to designed more carefully and there is an upper limit to the level of traffic which can be carried. A concrete base must be provided when specifying shallow setts.

Full setts are those having depth not less than width.
For many centuries the "golden rule" was that setts must be at least as deep as they are wide. The heavier the traffic loading, the deeper the sett in relation to its width. Before the advent of concrete and mortar, when jointing, bedding and supporting base were all unbound, this rule was very necessary. Even with the development of high performance mortars and reinforced concrete for a base, we need to use full setts when the traffic loading exceeds a given maximum.
The deeper the sett in relation to its width, the more the strength of the pavement is taken by the joints between the setts. So, with deep, full setts we can sometimes lay over an unbound or a bituminous base, even for heavy traffic.

As can be seen, these simple rules given above depend on proper definition of the traffic loads. i.e. number of vehicles per day and the weight of them. When the general rules are not followed the stones start to move in an uncontrolled manner. Some cases and one in particular will be detailed in this presentation. The case studies demonstrate the importance of the necessary knowledge needed to build a paving that can cope with the dynamic

and static traffic loads. In addition, it shows the problem that may arise due to a poorly defined border between setts and slabs.