Environmental Aspects of Modular Paving in Elevated Landscapes

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Abstract :

Changing demographics, urbanisation, climate change and planning policies have seen the significant growth in more densely populated developments. Traditionally, with densely populated developments design issues such as storm water storage, impermeable hard landscaping, parking spaces and reduced biodiversity are often prevalent. However, over the last 10 years we are seeing a coordinated growth of designed roofscapes or elevated landscapes. Unlike conventional hard landscaping, the roofscape developmentrequires more input at the design, construction and maintenance stages to consider logistics, buildability, positive environmental impact and life span of the pavement. This paper will discuss all these attributes looking at both the design and construction of these elevated pavements and how we, as an industry, can begin to recognise the rapidly growing and often overlooked sector of Roofscaping.

Key Words : Landscaping; Roofscaping; Attenuation; Pedestal; stabiliser; Logistics;

1. Introdouction

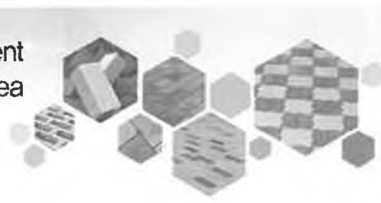
Thelater part of the 20th centruary and early 21st century have been credited with the growth of urbanisation, changing the dynamics and demographics of our worldwide cities. As technology has moved at a pace the ever changing demands imposed upon designers within our urban landscape has also changed and our knowledge of the impact which we have had on the landscape, has developed. One could call it the perfect storm. The changing environmental impacts, developing commercial realisation and necessity, coupled with social and demographic changes have all met and amalgamated, requiring modern planners, developers and designers to reconsider how our urban areas work. It has long been cited that future sustainable prosperity will depend upon cities being able to attract citizens to an environment where they can thrive.

The decrease in the overall rate of population growth means that the citiy of the futurecannot rely upon the growth in numbers to drive succesful prosperity growth, but will need to create environments where people are attracted to the lifestyle a connibation has to offer with the benefits of associated "well-being"not only for the individual but also for the community as a whole. By the year 2050 it is estimated that 90% of the worlds population will live in a city of 100, 000 or more. In addition to this, within the period of the next 15 to 20 years, the aging global population (60 years plus) are set to become the consumer group pushing global consumption growth (51% of urban consumption growth in dveloped countries) and subsequent economic prosperity. With these demographic changes and the demands associated with their expectations, it stands to reason that future developments will be required (and wish) to provide ammenities akin to this generation. Additionally, as the communities evolve and developments are

created, the urban landscape will become increasinglydependant upon innovative solutions to be able to deal with the aspects of an aging population, more densely occupied environments, and changing climatic conditions brought about through issues created by these shifts. All of these apparent issues may be effectively improved within the roofspace of the urban environment. For many years we have seen how the inclusion "green roofs"within a project are the growing solution to improving urban bio-diverisity, reducing surface water run-off, reducing solar gain and wear on the building fabric. Indeed, local government in the UK are collectively considering the use of "green roofs" as a planning tool to reduce the effects climate change and the movement in demographics mentioned earlier. The London Plan actively encourages green roofs and walls on every new development and retrofit wherever possible in Greater London. The so-called Metro-Mayors are actively championing this planning tool, and we are beginning to see up-take from some of the UK statutory authorities as well, for example, those responsible for the collection, cleansing, discharge and distribution of our water. In a 2015, Thames Water embarked upon a project to provide in excess of 200,000sqm of "green space"within its catchment area, to remove parts of London form the very real risk of flooding. Within this exercise they were considering roads, hardstandings, new developments and roofspace. All with the aim of reducing the amount of surface area which discharges in to metropolitan combined sewers. We have learnt from our development of permable landscape pavements over the last fifteen to twenty years, that storm activity, climate change and modern development has had an impact on the way that we manage water and rainfall activity. It is unquestionable that the premise of the permeable pavement, having a structural and aesthetic surface which can store, rather than shed water, is now a mainstream solution used by designers for their SUDs permformance requirements. It is therefore a natural progression for modular pavements to become a major part of the building fabric, an elevated landscape, and all the assocated benefits which may be created.

2. The Market Place

There are a significant number of benefits from considering developing the roofs space. This is to not only to include the living green roof, (whose market has grown significantly in the last 10 to 15 years in the UK from circa 200 000 sqm in 2007 installed to around 1 000 000sqm in 2018), but also areas of hard "roofscaping". In the last 10 years the skyline of London, for example, and repeated worldwide, has changed significantly incorporating balconies, terraces and podiums (area tools) as a designers choice. The use of these area tools have, until recently, remained largely the domain of the roofing contractor offering grey characterless environments for airconditioning units, fall arrest and HVAC equipment. The following information is based upon the UK market, but the proportions will be similar for other countries. The flat roofing marketing the UK is estimated at cicra 20million sqm per annum. Around 15million sqm of these roofs are considered to be bonded, non ballested roofing systems where the membrane is bonded or mechanically fixed to the building structure. The balance of roofs are considered to be "ballested"roofs, where there is usually a mass, in excess of 35kg/m^2 placed above the memrbane to secure the insulation. This ballesting can take the form of paving, soft landscaping (greenroofs and more intensive structures), pebbles and other amenity surfaces such as running tracks and sports pitches. This market place is set to grow.



The drivers behind the growth are as follows:-

- Reduced space for development
- More demand for anemity areas
- Proven health benefits
- Commercial recovery
- Environmental Benefits

With the changing population demographic and demand for housing within urban area, thereis an increase in the number of dwellings per development. This leads to more innovative solutions for parking (rooftop parking), social interaction (attractive landscaping), mobility and health. There is a growing body of evidence which shows that our health is directly related to companionship, stress-less areas, greener environments and fitness. With less development space and the commercial pressure to make a return, the use of a hard "roofscaped"area addresses these issues without removing valuable land area from the footprint of the building space.

3. Modular Paving in Roofscaping

There are a number of signifcant benefits from employing modular paving within the roofspace structure To understand these, it is important to appreciate the applications where it will be utilised. With all the examples below one shouldconsider modular paving against other surfacing materials such as resin bound aggregates, bituminous surfaces and other monolithic pavement sturctures. The questions of building movement, expansion joints, pavement elasticity and buildability should always be compared. In a majority of instances the most effective rooftop solution for a hardlandscaped area will be modular paving, either laid traditionally or upon pedestals. When laid traditionally, and not designed specifically as a permeable pavement, (for example a traffiked podium deck) it is important to consider the role of water within the pavement sturcture at rooftop level. At ground level, all too often on large paving projects, laid upon an impermeable structure (not including the bedding layer) water plays a large role in the possible failure of the pavement. It isnecessary to understand how water will either be removed from the sublayers ore prevented from entering the sublayers and becoming trapped to cause subsequent damage. The choice of bedding layer is important to prevent the migration of fine materials with the passage of moisture; a drainage layer which drains but does not flex under traffic to cause the loss of jointing and bedding materials, or; joints which remain stable and impermeable with the application of an joint stabiliser designed to stop water pentration. Alternatively, specialised modular paving systems have been developed for vehiclular traffic which can be used hand in hand with thermal performance products, drainage materials and provide a durable hardwearing surface.

3.1 Stormwater Management

"Water will become the defining factor in the future of our cities.." Diana Budds

The opportunity to create a permeable roofscape as part of the SUDs plan is being increasingly explored. The benefits of vegetaed landscapes are already widely discussed, in terms of water storage, evapoitranspiration and dissipation. Consider that the typical green roof (comprising of 20mm drainage board, 50mm substrate, sedum mat) offers circa 40-65% by volume of water

storage depnding upon its composition. A paved constuction, with the modular paving units installed upon pedestals and directly laid upon the roof consturction, can increase this figure to levels of 80-90% volumetric storage capacity. This creates a more effective permeable pavement, based on retention capacity, than a ground level solution, when one considers storage capacity and the import/export of fill/waste materials. A typical ground level permeable pavement will have a storage layer of 150mm thick at 30% void. A 50mm void ceated by pedestals with a modular paved surface will create the same capacity, with no requirement to import specialised fill materials for the roofspace. Increasingly, we are seeing discharge requirements of less than 5l/s/ha for a given storm duration (often 1 in 100 years plus 20% storage capacity) for new developments to meet thier planning requirements. Often to achieve this, one would have to consider large sub-surface storage tanks on an inner city site, where the use of permeable pavements are not possible due to the lack of surrounding space. This is market place where modular paving would not be previously considered. The advent of blue roofs to work in conjunction with ground level solutions such as permeable paving and rooftop solutions such as green roofs, offers desginers considerable scope for their stormwater solutions. Over the coming years, water scarcity will becomemore apparent as demand grows, from a growing population. The use of greywater recycling systems are already mainstream and indeed some planning authorities are only accepting new developments with a suitable water re-use plan. The ability to create a permeable roofscape with modular paving capturing, attenuating and returning the stormwater is significant and easily achieveable. The use of modular paving over and above other surface materials offers a direct access for water capture and a low maintenance pavement.

3.2 Accessible Pavements

"Developed retiring and elderly .....generate 51% of urban consumption growth"McKinsey Global Institute

The improvement in building thermal performance has necessitated designers to increase the thickness of insulation on roofs, amongst other areas. In practice this has increased the height between the constructed floor/roof slab and the threshold of any access point. Access to roof space has historicall been provided to gain access for leakages, maintenance and other occurances. The items previously highlighted have driven a change to more accessible roofspace. The performance and development of the pedestals support paving has imrpvoed significantly enabling ramps and level thresholds to be easily created with modular paving systems. It is true to say that this has always been the case with bound materials, however simplicity of modular simply supported paving and its constructability offers added advantages during construction and throughout the lifespan of the pavement. This, coupled with the aesthetics of modular paving enable designers to create rooscapes of outstanding beauty. Given that it is predicted that the 60+ generation will drive consumption over the next 15 years, it is important the developments with this consumer group in mind, are considered with bright, attractive and accessible roofspaces, to encourage the citizens to make full use of the potential these areas offer.Additionally, this consideration will provide areas which are accessible to everybody, with level thresholds, limted concerns over ponding and slippage and excellent drainage.



3.3 Utility Pavements

The discussion has focused upon the exception roofscapes which can be created. However, there is a hige requirement for safe walkways at rooftop level for the maintenance and upkeep of the building. This will be even more important as roofspace becomes part of the SUDs solution in the future. Cloud based water management systems will ensure that no roof becomes "waterlogged", but access will be required for maintenance of the drainage outlets and other associated areas. With roof operations, everything should be designed to be removeable by a suitably skilled workforce. For example, the cost of removing a bound surface to reach a waterproofing leak is considerably more expensive than removing some simply support paving units. However, this needs to be balanced against the ease of removal and mindless vandelism. Thought would also have to be given to exposure of the roof membrane, weather conditions, and access to name but a few items

4. Conclusion

The roofing and associated marketplace performs on the basis of reducing risk to all stakeholders of the building or development. As part of the waterproof integrity for a structure, warenties and guarentees are offered to provide confidence to the building user and developer. Unlike the groundlevel landscaping industry, the perceived degree of risk when installing a roofscape is higher. There are a number of items which will need to be considered to reduce this perception, such as:-

- trades are working at height,
- materials and logistics not only need to be delivered to often restricted sites, but also to the laying face which may be many metres above ground level
- the installer will be laying upon a waterproofed structure
- building movement and temperature control
- constructability (access, egress, storage, safety and maintenance)
- packaging and waste
- structural integrity
- project management

As an industry, there is a rightful and necessaryplace for modular paving in the development of the roofscape. Innovative solutions which address the items above and assist the long term performnce of the waterproofing and building structure will gain in popularity with desginers. The roofspace is often on the critical path of a project with the need to begin the internal fit out of a building. The simplicity of modular paving, the flexibility of its structure to adapt with building movement and the ability to create inspiring surfaces uniquely places modular paving as the solution of choice. Modular paving offers other additional benefits to the construction and development of roofscapes. We have seen rooftype classification being undertaken in cities as diverse as Rotterdam, London, Chicago, Singapore, Seoul and Sydney. What was collectively termed as a green roof 10 years ago is now being described as red for living, working and recreation, blue for stormwater management, yellow for renewable energy and green for nature and bio-diversity.Modular paving is uniqiuely positioned to be able to assit witin all of these colour coded environments. We are seeing the market increase for developments which incorporate podium decks, terraces and balconies, making full use of not only the horizontal, but also the

vertical space, and this increase is driven by reduced availability of land to build sprawling developments. There are specialist manufacturers who have developed systems which go together to provide seemless warranties, easily constructed solutions, prevent water penetration, or encourage water penetration, alreadyoperating within this market place very successfully. It is not a market where there is a one solution fits all methodology, but it is a growing market which we should have a better understanding of and encourage development into. In the words of a form mayor of London, Mr Ken Livingstone our "most under-used asset is just above our heads"

Acknowledgements

With special thanks for their help and support to : Profesor John Knapton, Mr Paul Heerkens Zoontjens BV, Mr Paul Lamparter Resiblock Ltd

References

[1] Heerkens P.; Bringing Buildings to Life, Glasgow University, Glasgow, July 2008.
[2] Karen Liu, Designing Green Roofs for Stormwater Management, @Greenroofs.com, November 2015 1st Published Construction Canada 10th April 2015
[3] Diana Budds, 7 Trends That Augur The Future of Urban Design, Fast Company, 27th December 2017
[4] McKinsey Global Institute,Urban World: The Global Consumers To Watch, April 2016
[5] Mayor of London, Living Roofs and Walls: Technical Document supporting London Plan Policy, February 2008