Sustainable Engineering & Design: Office Building Foundation and Parking Lot

Caroline Fox
Department of Civil Engineering
Sustainability Capstone

ABSTRACT

There currently exists acommonly used method for foundation design and is the process used in the original design that is being analyzed for sustainable substitutions to the traditional method. Many do not examine the accepted method for foundation design because this method works and leads little room for error. There is also the matter of how it will affect the cost of design and construction. This method is not sustainable and requires large amounts of natural resources to construct.

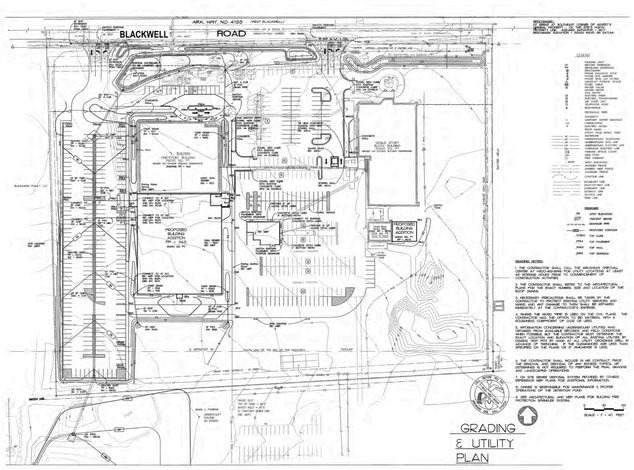
OBJECTIVE

The purpose of this report is to explore low impact development additions to the traditional foundation and site design.

Method:

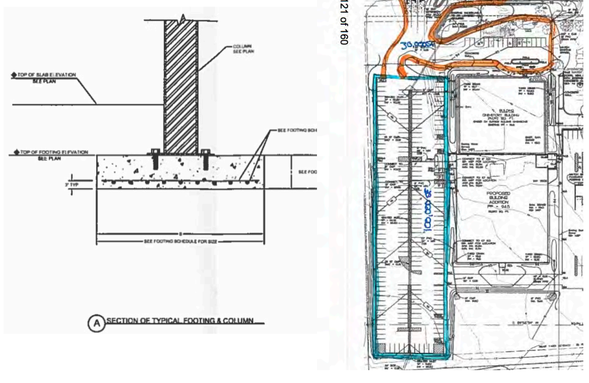
- Develop design of building foundation, cantilever retaining wall, and pavement structure based on traditional methods and materials
- Explore low impact development (LID) practices that could be incorporated into traditional design
- Analyze practicality of LID solutions being implemented into common practice for site design

SITE LAYOUT



FOOTING DESIGN & PARKING LOT

The geeral footing sections and parking lot lay out wer developed during the initial site design. The materials for these designs were analyzed for more sustainable methods.



HIGH-VOLUME FLY ASH RECYCLED-AGGREGATE CONCRETE

Fly ash is a byproduct from burning powdered coal in electric generating power plants. Fly ash can be used to substitute the cement in concrete.

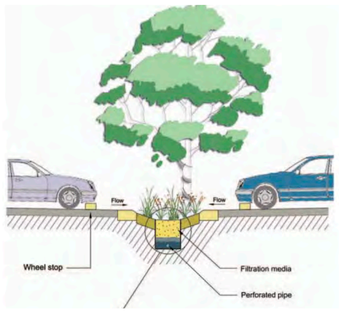
From a study conducted on HVFA-RAC many of the properties are similar to those of traditional concrete. This allows for the use of HVFA-RAC as a suitable sustainable substitute for traditional concrete.

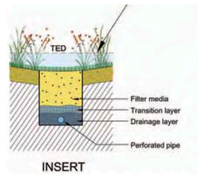
The table below shows the mix design for HVFA-RTAC.

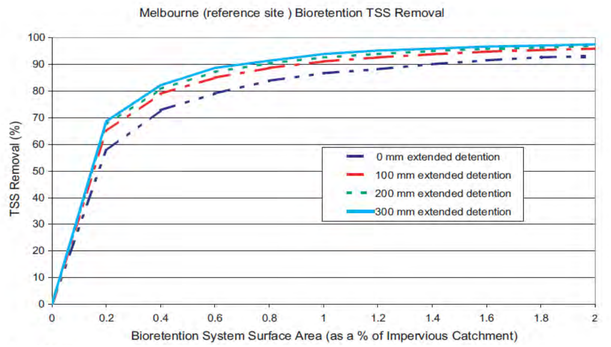
Concrete Mixture		Natural-Aggregate Concrete	RAC	HVFA-RAC
Water		230	230	230
Cement		380	760	380
Fly Ash		-	-	380
Natural Sand		314	-	-
Fine Recycled Fraction		-	-	-
Crushed Aggregate		1338	-	-
Coarse Recycled Fraction		-	1169	1057
Superplasticizer		-	-	6.8
Water/Cement		0.60	0.30	0.60
Water/Binder		0.60	0.30	0.30
Compressive Strength (MPa)	3 days	16	26	20
	28 days	27	31	29
	60 days	32	34	36

BIORETENTION BASINS (RAIN GARDENS)

A bioretention basin (rain garden) is a shallow planted depression designed to retain or detain stormwater before it is infiltrated or discharged downstream. In addition to storing water before it is discharged downstream or infiltrated, vegetation in bioretention basins can trap and remove suspended solids and other pollutants from water.







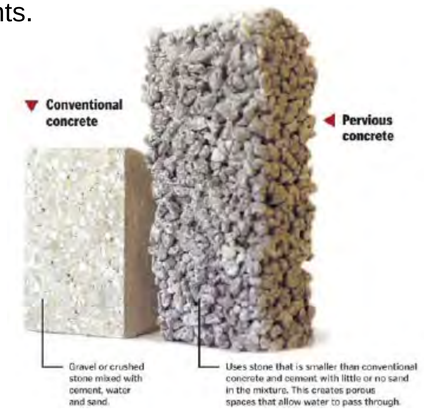
This graph shows the distribution of total suspended solids (TSS) removal with the surface area of bioretention basin.

RECYCLED STEEL

Reinforcing steel bars are already highly recyclable. American Iron and Steel Institute stated that in 2012, the steel recycling rate was at 88 percent. Steel can maintain is structural properties after being repeatedly melted down, reformed, and reused. The steel used in the foundations and retaining wall will be from recycled material and is recyclable at the end of its service life for this project.

PERVIOUS CONCRETE PAVEMENT

A pervious concrete can help is maintain runoff within a parking lot area and also serves as a type of filter for suspended solids and other pollutants.



SUSTAINABILITY

With the current design for the project, the reinforcing steel bars are the only sustainable element to the project. The use of HVFA-RAC, pervious pavement, and bioretention basins only add minor additional calculations for the project design.

These additions would not be an inconvenience to the designer. The purpose of these practices is to minimize the negative effects of development on the environment. In this case, the project will reduce the use of fine aggregates. It will also maintain the natural water runoff pre-development as well as aid in filtering out pollutants before water is send downstream.