

structural analysis - red square

Much of Red Square is built on top of the Central Plaza Parking garage. This garage is built out of concrete post and beam construction. Portions of the plaza in front of the Suzzallo Library and Gerberding are built on top of unexcavated subgrade and the remainder of the plaza is constructed above the basements Kane Hall and the Odegaard Library. Because of this unique situation, there are a number of structural constraints associated with potential future development on the plaza including:

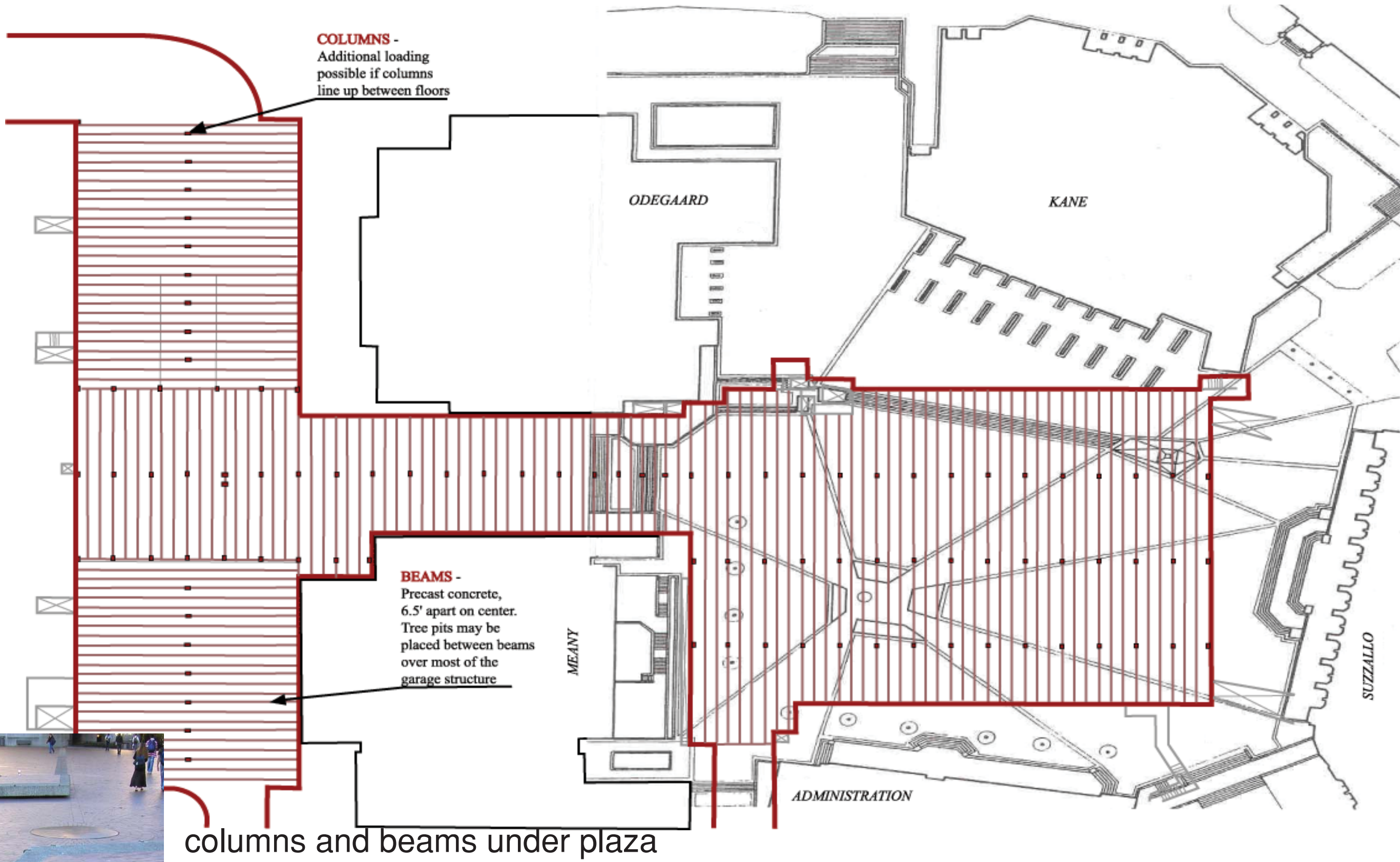
- limited live load capacity of the parking garage roof
- constraints on alteration of grade due to the shallow depth from plaza grade to the top of the roof slab
- potential difficulty in structural anchoring on top of the parking structure
- sensitivity of penetrating the waterproof membrane on top of the parking garage roof

existing conditions and construction strategies

The columns in the parking garage supporting Red Square form 20'X60' bays and the beams which span these 60' bays are spaced approximately 6 - 1/2' O.C. providing ample structural integrity to support the weight of vehicles on the plaza above.

The brick paving is set upon a 1/4" bed of sand which sits above a 1-1/2" asphaltic concrete membrane. Below this is a coal tar membrane: penetration of this membrane is undesirable. Any punctures in this membrane must be meticulously patched in order to ensure a waterproof seal is maintained.

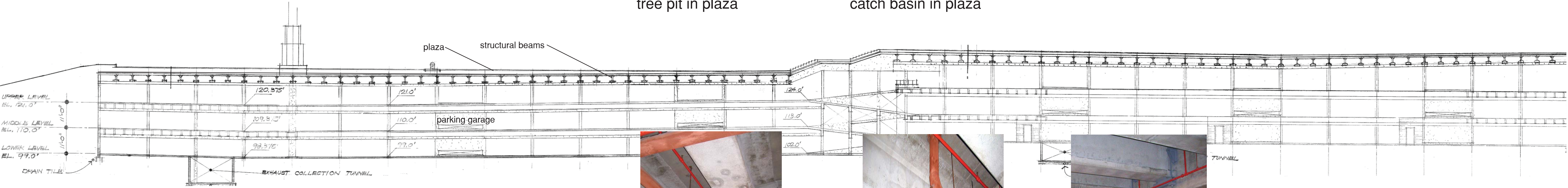
Concrete tree pits were built between the beams and similarly constructed additional planters can be added if desired.



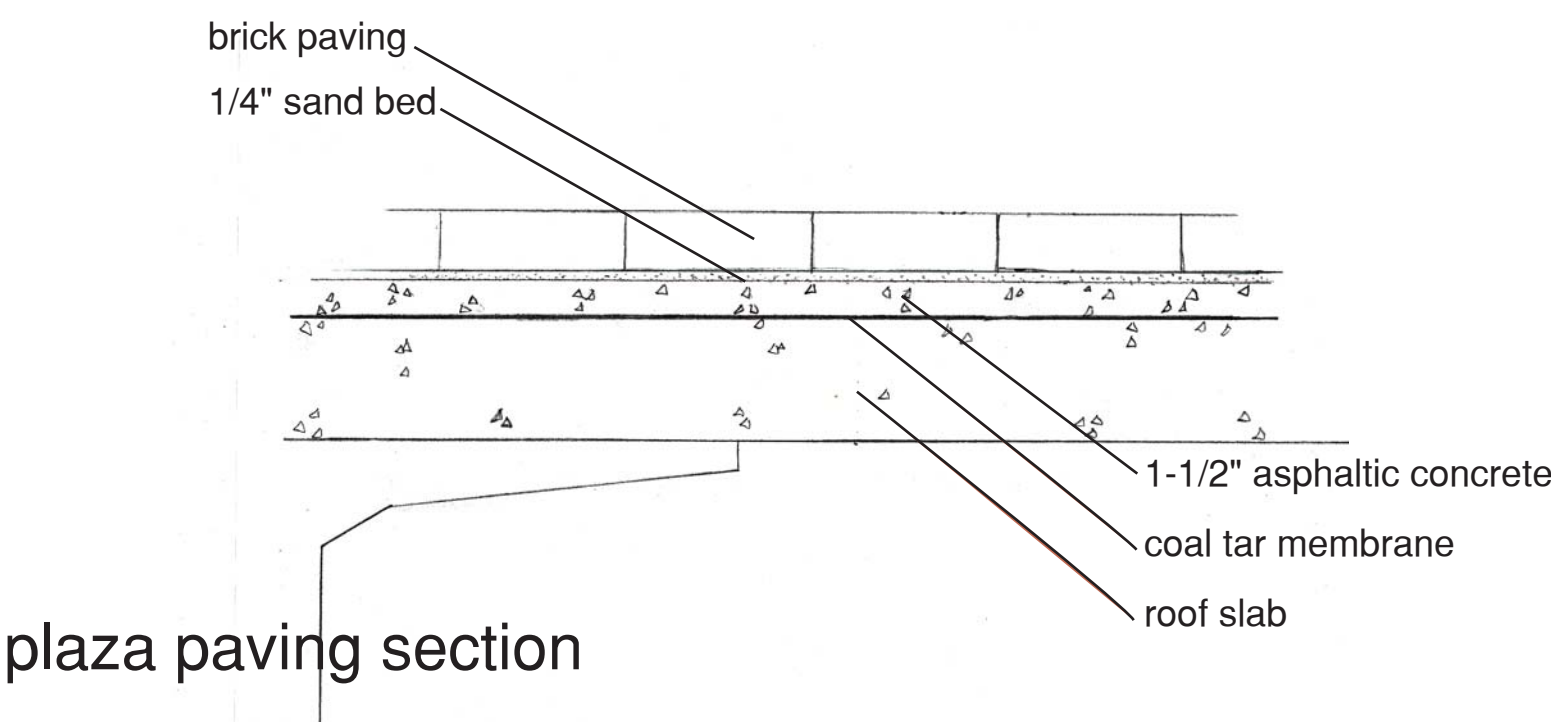
tree pit in plaza



catch basin in plaza



red square/parking garage cross section



plaza paving section



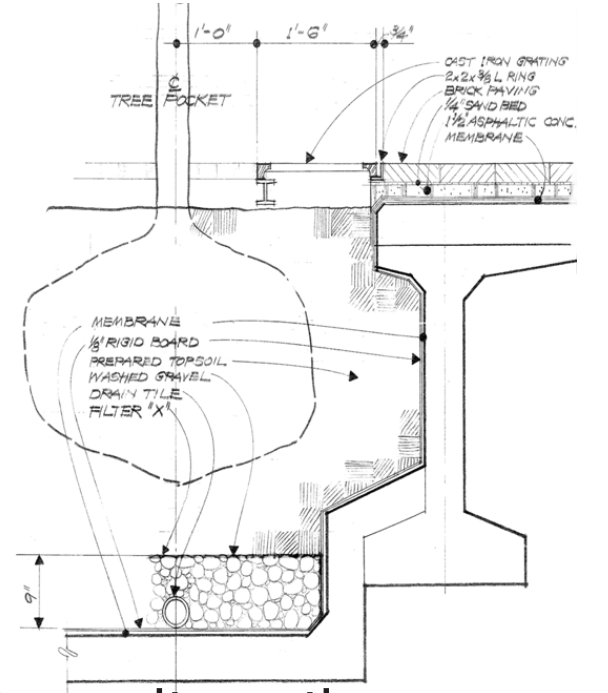
tree pit in garage



drainlines in garage



concrete columns and beams



tree pit section

lightweight building technologies and strategies

Because of the constraints associated with building on top of the parking garage, it may be necessary to explore different lightweight building technologies in order for a design to meet the live load capacity restrictions. Here is a brief introduction to some strategies that may help in developing feasible design possibilities for Red Square.

geofoam

Geofoam is the generic term for any type of synthetic, closed-cell foam material that is used on or in the ground. The most commonly used geofoam by far is an expanded polystyrene (EPS). EPS can be molded into large blocks or panels with the quality, durability and environmental friendliness sufficient for permanent in-ground use. It has been used in a wide range of landscape applications where live load restrictions were a consideration and could be effectively used to lighten the load of proposed interventions in Red Square. With a density of 1-2 lbs/cubic foot, geofoam is ~1% the density of standard fill.

Information obtained from: R Control Systems Website on 10/10/05



geofoam used as lightweight fill in a rooftop application



here geofoam reduces the lateral pressure on a concrete retaining wall



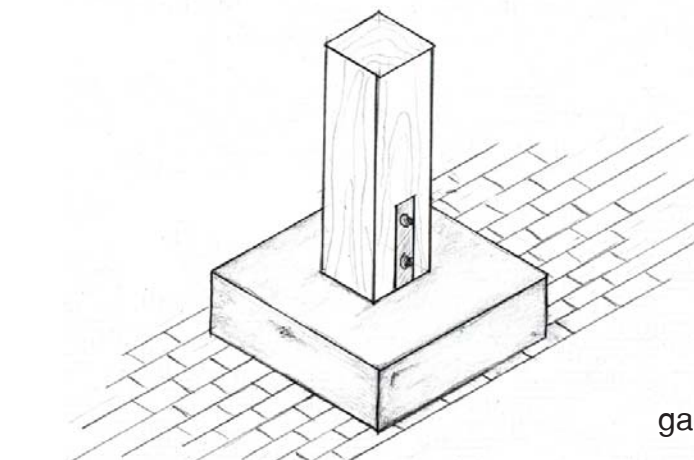
geofoam was used to elevate this plaza grade in a limited live load situation

roof top anchoring strategies

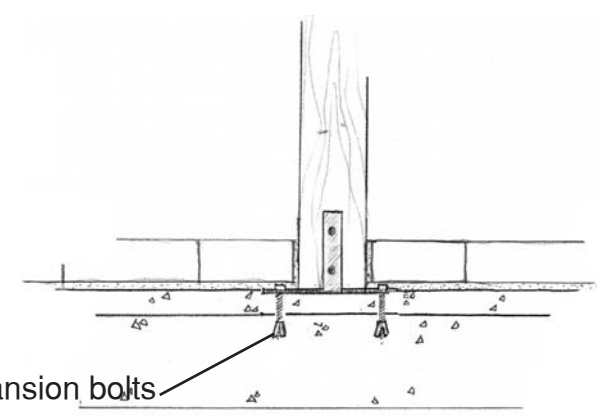
The roof slab beneath the plaza paving is topped with a coal tar waterproof membrane, thus anchoring into the slab or to the beams below is complicated but possible. Possible anchoring strategies are conceptually illustrated here.

Spread footings: spread footings are one easy way to stabilize structures on the plaza because they can be placed directly upon the ex. brick. They are not however appropriate for many applications.

Concrete Anchors: Bolting structures to the roof slab beneath the plaza is another anchoring strategy. However in order to bolt to this concrete slab the waterproof membrane must be penetrated. This penetration must be sealed appropriately.



spread footings



anchoring to roof slab

alternative concrete technologies

lightweight concrete - There exist many lightweight concrete blends ranging in weight from 35 to 115 pound per cubic foot. The compressive strength is typically not as great as ordinary concrete, but it weathers well. It requires less need for structural steel reinforcement, and has smaller foundation requirements. However it can cost more than typical concrete and may shrink more upon drying.

Information obtained from: greenhomebuilding.com on 10/10/05



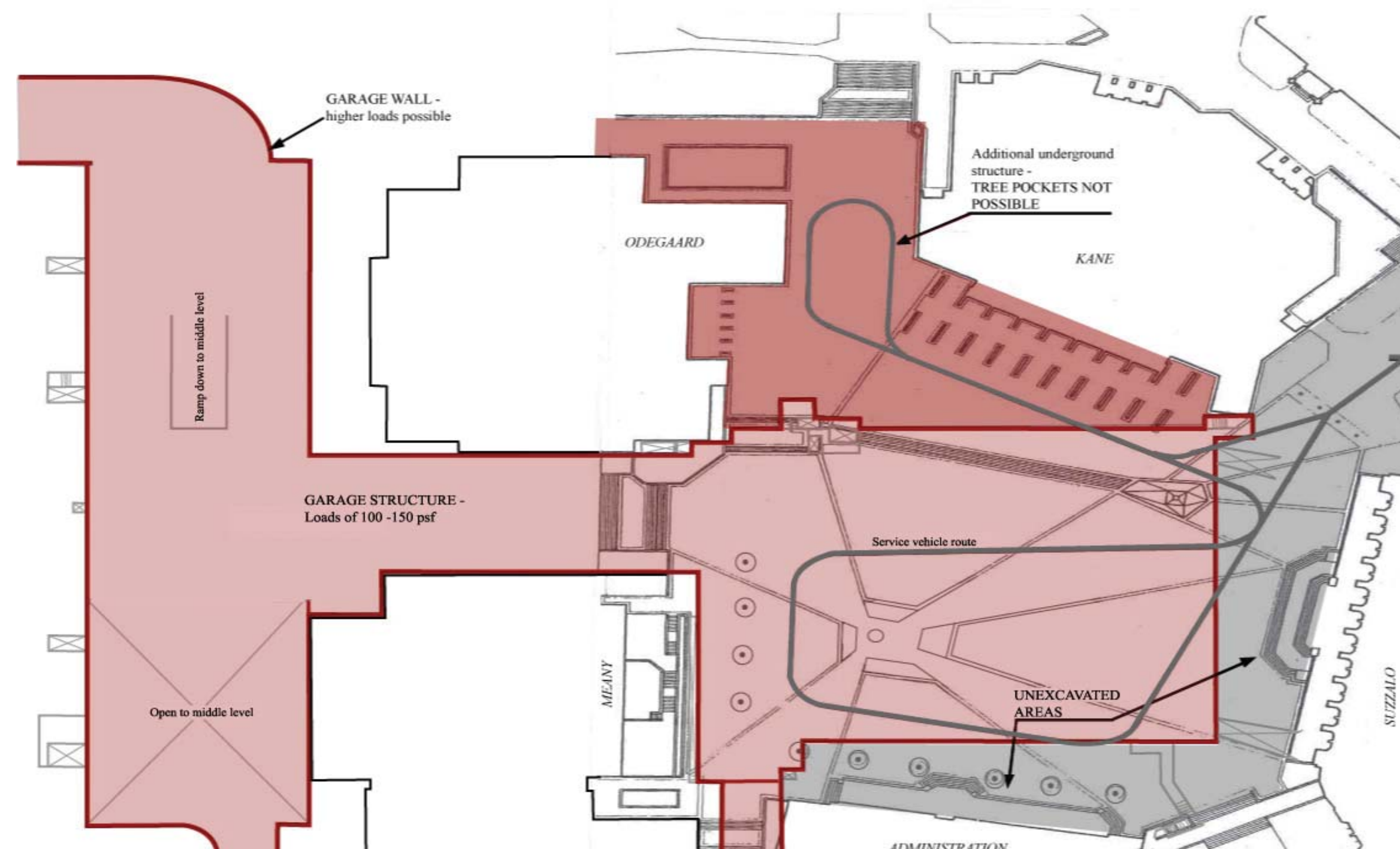
a unique home constructed of lightweight concrete

autoclaved aerated concrete - ACC ACC is about one-fourth the weight of conventional concrete and is available in blocks, wall and roof panels, lintels, and floor slabs. Each of these products can be manufactured in a range of sizes depending on specific applications, allowing for maximum efficiency and flexibility in construction but is typically significantly more expensive than traditional concrete.

Information obtained from: http://www.cement.org/basics/concreteproducts_acc.asp on 10/11/05



modular ACC blocks



allowable live load zone map - pounds/square ft.



structural layout - top floor of parking garage

lightweight soil blends

Due to the live load restrictions of the parking garage beneath Red Square, the growing medium used in design interventions will likely have to be thin in profile while achieving an ideal balance of both drainage and retentive properties.

Lightweight soil blends used often in green-roof applications include a granular mineral mixture with a low organic content and such components as: Perlite, vermiculite, encapsulated polystyrene, coconut fibers, crushed lava, peat, and common components such as typical sand and aggregates.

Precedents:

The Xero Flora greenroof system installed on Ford's industrial complex contains an ultra thin 2 cm substrate profile which severely limits viable planting options but is extremely lightweight. On the opposite end of the spectrum, the Soldier Field project in Chicago where a 5.5 acre park was built on top of a parking structure has multiple engineered soil blends with profiles that range from 6-30".



nutrient rich/lightweight topsoil



vermiculite

perlite