OZINGA®

April 20, 2019

Mr. Scott Smith, P.E.
Consulting Engineers, Inc.
123 Ledgehearth Square
Atlanta, GA 55544

RE: Concrete Pavement Design Proposal
The Book Worm Parking Lot

Mr. Smith:

Ozinga is pleased to provide this concrete pavement design proposal for the above mentioned project. Specific information used to develop this concrete paving design was gathered from the Geotechnical Engineering Report dated October 14, 2018 and other information provided by the design team. If the information provided is updated or changed, Ozinga will need to review our recommendations for applicability. Please contact us if you desire further assistance regarding this project.

Sincerely,
Ozinga

Ryan Cialdella
VP, Research & Development

Concrete Pavement Design Proposal
The Book Worm Parking Lot

Summary

Project Description

A ± 43,000 S.F. retail book store will be constructed along with associated parking and access areas. The site is currently undeveloped and is covered with pasture grass.

Subgrade Foundation Soils

According to the Geotechnical Report provided by Geotechnical Company, the soils were found to be sandy with rock. There was a layer of organic peat material encountered at approximately two feet below the surface, which is to be removed and replaced with structural fill per the project geotechnical report. It should be noted that predominate on-site soils consisting of sand and rock (or similar borrow sources) are suitable and acceptable for structural fill.

Traffic Conditions

According to the Pavement Design Calculations attached to the Geotechnical Report, the Standard Duty pavement is to be designed for two ESALs per day. Assuming 2.5 ESALs per truck, the Average Daily Truck Traffic (ADTT) for standard duty is one truck per day.

For Heavy Duty areas, the pavement is to be designed for 15 ESALs per day. Assuming 2.5 ESALs per truck, the ADTT for heavy duty is six trucks per day.

Proposed Asphalt Surfaced Pavement (from Engineering Plans and Geotechnical Report)

Standard Duty:	
HMAC Surface Course	1.5 inches
Asphalt Base Course	1.5 inches
Limerock Subbase	6.0 inches
Stabilized Subgrade	

Heavy Duty:	
HMAC Surface Course	1.5 inches
Asphalt Binder	1.5 inches
Limerock Subbase	6.0 inches
Stabilized Subgrade	12.0 inches

Proposed Concrete Surfaced Pavement (from Engineering Plans and Geotechnical Report)

Standard Duty:	
Portland Cement Concrete Thickness (500 psi)	5.0 inches
Limerock Base	6.0 inches
Additional Base (Free Draining Stabilized Subbase)	4.0 inches
Compacted Subgrade	12.0 inches
Maximum Joint Spacing	12.0 feet
Concrete Curb and Gutter	Required
Heavy Duty:	
Portland Cement Concrete Thickness (500psi)	6.0 inches
Limerock Base	6.0 inches
Additional Base (Free Draining Stabilized Subbase)	4.0 inches
Compacted Subgrade	12.0 inches
Maximum Joint Spacing	12.0 feet
Concrete Curb and Gutter	Required

Proposed Concrete Surfaced Pavement Recommendation (from ACI 330R-08)

Standard Duty:	
Portland Cement Concrete Thickness (500 psi)	5.0 inches
Limerock Base	None
Stabilized Subgrade	None
Compacted Subgrade	12.0 inches
Maximum Joint Spacing	12.5 feet
Concrete Curb and Gutter	Contraction: Not Required
Dowel Bars	Construction: Not Required
Heavy Duty:	
Portland Cement Concrete Thickness (500 psi)	5.5 inches
Limerock Base	4.0 inches
Stabilized Subgrade (minimum 3% cement)	6.0 inches (may be placed in lieu of limerock)
Compacted Subgrade	12.0 inches
Maximum Joint Spacing	12.5 feet
Concrete Curb and Gutter	Required
Dowel Bars	Contraction: Not Required
	Construction: Not Required

Detailed Report

Project Description

A ± 43,000 S.F. retail book store will be constructed along with associated parking and access areas. The site is currently undeveloped and is covered with pasture grass.

Subgrade Pavement Foundation Soils

In order to develop a concrete pavement section, testing must be conducted in order to determine the existing soil type and strengths. The ACI design procedure uses design tables grouped according to subgrade strength. According to the Geotechnical Report provided by Geotechnical Company, the soils were found to be sandy with rock. There was a layer of organic peat material encountered at approximately 2 feet below the surface, which is to be removed and replaced with structural fill per the project geotechnical report. It should be noted that predominate on-site soils consisting of sand and rock (or similar borrow sources) are suitable and acceptable for structural fill.

According to the Pavement Design Calculations attached to the Geotechnical Report, a subgrade reaction modulus of 100 psi/in should be used for the pavement design. NRMCA will use this value as the basis of design for the ACI 330 procedure. The subgrade must be properly prepared with uniform compaction. In general, a granular subbase is not a necessary layer in the concrete section where truck volumes are below 200 ADTT and speeds are slow. A granular subbase or subgrade stabilization may be recommended if pumping or erosion is likely to occur due to heavy loads traveling across the concrete joints and the pavement is constructed in a wet environment.

Asphalt Surfaced Pavement Recommendation (from Geotechnical Report)

The following inputs were used to determine the pavement cross sections contained in the plans and Geotechnical Report:

Standard Duty:	
Design Period	20 years
Daily ESAL	2
Estimated ADTT(Average Daily Truck Traffic)*	1 truck per day
Heavy Duty:	
Design Period	20 years
Daily ESAL	15
Estimated ADTT (Average Daily Truck Traffic)	6 trucks per day

* * Assuming 2.5 ESAL/truck

Additionally, the chosen level of reliability was 85% and the initial and terminal serviceability were 4.2 and 2.0, respectively. The recommended asphalt and concrete surfaced pavement cross sections as detailed in the geotechnical report are shown as follows:

Recommended Cross Sections from Geotechnical Engineering Report

Pavement Layer	Standard Duty Thickness (inches)	Heavy Duty Thickness (inches)
HMAC Surface Course	1.5	1.5
Asphalt Base Course	1.5	2.5
Limerock Base	6.0	6.0
Stabilized Subgrade	12.0	12.0

Pavement Layer	Standard Duty Thickness (inches)	Heavy Duty Thickness (inches)
Portland Cement Surface Course	5.0	6.0
Limerock Base	6.0	6.0
Drainable Base Course	4.0	4.0
Stabilized Subgrade	0.0	0.0

Proposed Concrete Surfaced Pavement Recommendation (from NRMCA Analysis of ACI 330R-08)
Reliability – 95%, Service Life – 20 years

Site Area and Traffic: Per quantities taken from the Site Plans, the parking lot has approximately 67,465 SF of pavement with light duty designation. Using the ACI Table 3.3 for defining traffic categories, the typical traffic loading for a light duty pavement corresponds to Traffic Category A. There is approximately 18,500 SF of pavement with a heavy duty pavement designation. The traffic expected on the heavy duty section is a small number of standard garbage type vehicles and an occasional delivery truck. Therefore, the designation for this area is Traffic Category A.

Aggregate or Stabilized Subbase/Subgrade: Due to the low truck traffic volume, a granular base is not required or recommended for the standard duty design. However, due to the wet environment, shallow ground-water table, and the erosion susceptible (sandy) soil, it is recommended to stabilize the soil under the heavy duty pavement section with a minimum of 3% cement. Another suitable option is use of 4" of recycled concrete, asphalt, or lime rock base from the existing site materials in lieu of stabilized subgrade.

Pavement Strength: Based upon the traffic loading category, environmental conditions, and the subgrade strength, the recommended minimum concrete flexural strength is 500 psi for the Standard and Heavy Duty areas.

Pavement Thickness: Standard Duty: Entering Table 3.4 from ACI 330 for a modulus of subgrade reaction value of 100 psi/in., a traffic category of A (ADTT = 1), and a modulus of rupture value of 500 psi, the resulting minimum recommended concrete pavement thickness is 5.0 inches (see below).

Heavy Duty: Entering Table 3.4 from ACI 330 for a modulus of subgrade reaction value of 100 psi/in., a traffic category of A (ADTT = 10), and a modulus of rupture value of 500 psi, the resulting minimum recommended concrete pavement thickness is 5.5 inches (see below).

Table 3.4—Twenty-year design thickness recommendations, in. (no dowels)

		k = 500 psi/in. (CBR = 50; R = 86)				k = 400 psi/in. (CBR = 38; R = 80)				k = 300 psi/in. (CBR =26; R = 67)			
	MOR, psi:	650	600	550	500	650	600	550	500	650	600	550	500
Traffic category*	A (ADTT =1)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.5
	A (ADTT = 10)	4.0	4.0	4.0	4.5	4.0	4.0	4.5	4.5	4.0	4.5	4.5	4.5
	B (ADTT = 25)	4.0	4.5	4.5	5.0	4.5	4.5	5.0	5.5	4.5	4.5	5.0	5.5
	B (ADTT = 300)	5.0	5.0	5.5	5.5	5.0	5.0	5.5	5.5	5.0	5.5	5.5	6.0
	C (ADTT = 100)	5.0	5.0	5.5	5.5	5.0	5.5	5.5	6.0	5.5	5.5	6.0	6.0
	C (ADTT = 300)	5.0	5.5	5.5	6.0	5.5	5.5	6.0	6.0	5.5	6.0	6.0	6.5
	C (ADTT = 700)	5.5	5.5	6.0	6.0	5.5	5.5	6.0	6.5	5.5	6.0	6.5	6.5
	D (ADTT = 700)†	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
		k = 200 psi/in. (CBR = 10; R = 48)				k = 100 psi/in. (CBR = 3; R = 18)				k = 50 psi/in. (CBR = 2; R = 5)			
	MOR, psi:	650	600	550	500	650	600	550	500	650	600	550	500
Traffic category*	A (ADTT =1)	4.0	4.0	4.0	4.5	4.0	4.5	4.5	5.0	4.5	5.0	5.0	5.5
	A (ADTT = 10)	4.5	4.5	5.0	5.0	4.5	5.0	5.0	5.5	5.0	5.5	5.5	6.0
	B (ADTT = 25)	5.0	5.0	5.5	6.0	5.5	5.5	6.0	6.0	6.0	6.0	6.5	7.0
	B (ADTT = 300)	5.5	5.5	6.0	6.5	6.0	6.0	6.5	7.0	6.5	7.0	7.0	7.5
	C (ADTT = 100)	5.5	6.0	6.0	6.5	6.0	6.5	6.5	7.0	6.5	7.0	7.5	7.5
	C (ADTT = 300)	6.0	6.0	6.5	6.5	6.5	6.5	7.0	7.5	7.0	7.5	7.5	8.0
	C (ADTT = 700)	6.0	6.5	6.5	7.0	6.5	7.0	7.0	7.5	7.0	7.5	8.0	8.5
	D (ADTT = 700)†	7.0	7.0	7.0	7.0	8.0	8.0	8.0	8.0	9.0	9.0	9.0	9.0

*ADTT = average daily truck traffic. Trucks are defined as vehicles with at least six wheels; excludes panel trucks, pickup trucks, and other four-wheel vehicles. Refer to Appendix A.
k = modulus of subgrade reaction; CBR = California bearing ratio; R = resistance value; and MOR = modulus of rupture.
†Thickness of Category D (only) can be reduced by 1.0 in. (25 mm) if dowels are used at all transverse joints (that is, joints located perpendicular to direction of traffic).
Note: 1 in. = 25.4 mm; 1 psi = 0.0069 MPa; and 1 psi/in. = 0.27 MPa/m.

ACI 330 Table 3.4: 20 Year Design Thickness Recommendations

Dowels and Tie Bars: Due to the light truck traffic loading and the section thickness being less than 7 inches, it is not recommended that steel round dowels at either the contraction (sawcut) or construction joints be incorporated into the Standard Duty design. Load transfer between the slabs will be carried by keeping the joint spacing close and using aggregate interlock.

Tie bars should be used as stated in section 3.8.3 of ACI 330R-08 to tie the first longitudinal joint from the pavement edge where no edge restraints exist. Tie bar dimensions shall be in accordance with Table 3.7.

Joint Spacing and Sealing: A proper jointing plan is integral to the overall long-term performance of the concrete pavement. A jointing plan should be designed in accordance with ACI 330R-08.

The following chart provides the maximum joint spacing and is recommended to be 12.5 feet for Standard and Heavy Duty in either direction with the length to width not exceeding 1.25 in areas of the parking lot with irregular slabs. Please note that these are maximum joint dimensions and the preferred joint spacing for both Standard and Heavy Duty designs may be somewhat less than the stated maximums for added reliability.

According to Section 5.7.1 of ACI 330, typically, joints produced using conventional processes are made within 4 to 12 hours after the slab has been finished in an area—4 hours in hot weather to 12 hours in cold weather.

Neither contraction nor construction joints are required to be sealed.

Table 3.5—Spacing between joints

Pavement thickness, in. (mm)	Maximum spacing, ft (m)
4, 4.5 (100, 113)	10 (3.0)
5, 5.5 (125, 140)	12.5 (3.8)
6 or greater (150 or greater)	15 (4.5)

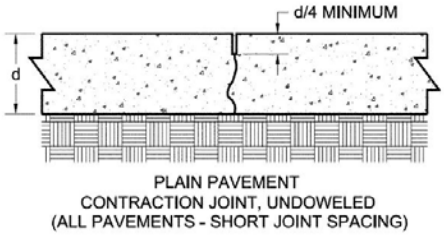
Pavement Design Summary: The recommended pavement cross section as determined by ACI 330R-08 and construction details are as follows:

Standard Duty:	
Portland Cement Concrete Thickness (500 psi)	5.0 inches
Limerock Base	None
Stabilized Subgrade	None
Compacted Subgrade	12.0 inches
Maximum Joint Spacing	Required[1]
Concrete Curb and Gutter	Contraction: Not Required
Dowel Bars	Construction: Not Required
Heavy Duty:	
Portland Cement Concrete Thickness (500 psi)	5.5 inches
Limerock Base	4.0 inches
OR	
Stabilized Subgrade (minimum 3% cement)	6.0 inches (may be placed in lieu of limerock base)
Compacted Subgrade	12.0 inches
Maximum Joint Spacing	12.5 feet
Concrete Curb and Gutter	Required[1]
Dowel Bars	Contraction: Not Required
	Construction: Not Required

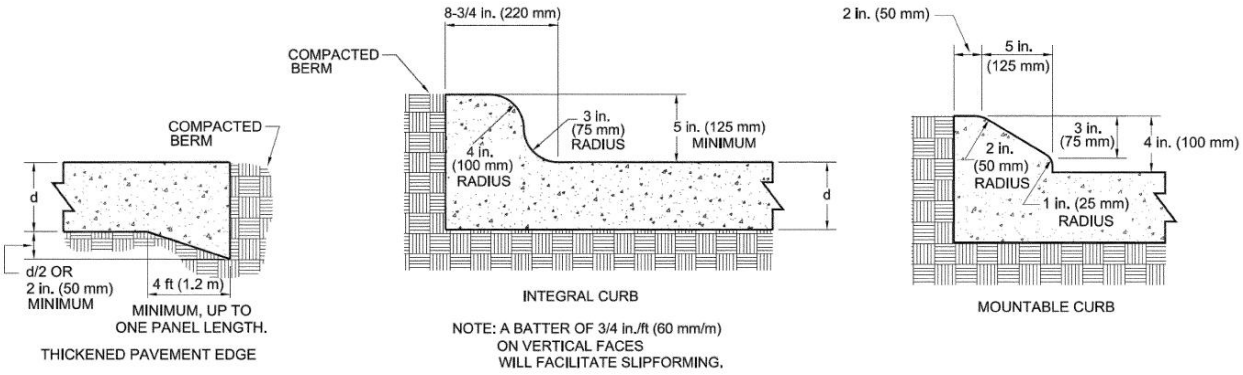
[1] May be integral or placed independently

Suggested Concrete Pavement Details

The following joint detail is recommended for the proposed pavement cross section:



The suggested curb details are shown below. Curbs and gutters may be formed monolithically with the pavement at the same thickness or may be poured independently. If placed independently, the curb and gutter should be tied to the pavement to reduce separation.



Concrete Sustainability

As transportation professionals and owners/operators continue to look for ways to lessen the environmental impact of streets, roads, and highways the use of concrete as been proven over time to achieve these goals. Attached is a publication produced by NRMCA entitled *CSR03 - Sustainability of Concrete Pavements* that demonstrates the many ways that the use of concrete can achieve the important goals of lowering environmental impacts of pavements.

Disclaimer

The information contained herein is provided for use by professional personnel who are competent to evaluate the significance and limitations of the information provided and who will accept total responsibility for the application of this information. The project Engineer of Record shall be responsible for the review and acceptance of the design recommendations. The recommendations reflect the judgment of the National Ready Mixed Concrete Association (NRMCA) and NRMCA believes the recommendations are accurate. However, NRMCA makes no representations or warranties concerning the fitness of this information for any particular application or installation and DISCLAIMS any and all RESPONSIBILITY and LIABILITY for the accuracy of and the application of the information provided to the full extent of the law.