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CVE504

QUESTION ONE

1. Define flexural strength

Flexural strength can be defined as the stress in a material just before it yields in flexural test.

1. A group of four piles supports a 450 x 450 mm rectangular column which transmits an ultimate axial load of 4000 kN. If the pile diameter is 500 mm spaced at 1350 mm Centre - Centre, design the pile cap using fcu =30N/mm2, fy=410N/mm2.

1350

450

450

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Ø | 300 | 350 | 400 | 450 | 500 | 550 | 600 | 700 |
| Cap depth (mm) | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1400 | 1800 |

$$∅=500$$

Depth of pile cap = 1100mm

d-h-cover-ɤ

d= 1100 – 100 – 25 = 975

space c=$\frac{1}{2}x space$

=$\frac{1}{2}x 1350=675mm$

=$critical section=\frac{1}{5}\*500=100mm$

$$a^{1}= \frac{1350-450}{2}=450$$

$$\frac{500}{2}=250mm$$

D = 250 – 100 = 150mm

Design for reinforcement

$$As= \frac{Nl}{4d\*0.87fy}$$

$$= \frac{4000\* 10^{3}\*675}{4\*975\*0.87\*410}$$

$$=1940.87 mm^{2}$$

Total area = $2As =3881.74 mm^{2}$

Provide Y25 @ 250 c/c

Shear capacity

Shear along critical section

$$v= \frac{p}{2}=\frac{4000}{2}=2000KN$$

$$v\_{BD}= v. \frac{av}{bd}$$

$$= \frac{2000\*350}{2\*975}=359KN$$

$$c= 0.12k(100pfcu)^{\frac{1}{3}}\geq (0.035k^{1.5} fcu)^{0.5}$$

$$k=1+ \sqrt{\frac{200}{d}}=1+ \sqrt{\frac{200}{975} }=1.45$$

$$VRD.C= 0.12\*1.45(100\*0.0026\*30)^{\frac{1}{3}}\geq (0.035\*1.45^{1.5}30)^{0.5}$$

$$0.35\geq 0.33 OK$$

$$\frac{0.35\*2150\*975}{1000\*1000}=0.73\geq VRD.C$$

QUESTION TWO

2a. A cantilever retaining wall has angle of friction 450 and supports a granular materials of saturated density of 1820kg/m3. Check the stability of the wall and determine the overturning and restrained moments. Assume 30-410N/mm3 grade of concrete.

Coefficient of active pressure = $\frac{1-sinθ}{1+sinθ}= \frac{1-sin45}{1+sin45}$

=0.17

$$stability pa=KaPgH$$

$$=0.17\*1820\*10\*5.1\*10^{-3}$$

$$=15.78kN/m^{2}$$

$$horizontal force= \frac{1}{2}PaH$$

$$=\frac{1}{2}\*15.78\*5.1$$

$$=40.24kN$$

$$load due to surcharge KaSl=0.17\*12=2.04kN / m^{2}$$

$$horizontal force due to surcharge H=PaH$$

$$=2.04\*5.1$$

$$=10.404kN$$

Vertical load

$$Vwall= \frac{1}{2}\left(a+b\right)h$$

$$= \frac{1}{2}\left(0.3+0.4\right)\*4.5\*24$$

$$=37.8kN$$

$$Vearth= \frac{1}{2}\left(a+b\right)\*h\*saturated density$$

$$=\frac{1}{2}\left(2.4+2.8\right)\*4.5\*1820\*10\*10^{-3}$$

$$=200.66kN$$

$$Vbase=3.8+0.6+24$$

$$=54.7kN$$

$$Vtotal=37.8+200.66+54.71=293.17kN$$

Variable load

$$Vc=d.Sl$$

$$=24\*12$$

$$=28.8kN / m$$

Overturning moment

$$Mo=γfHk\frac{H}{3}+γfH3\frac{H}{2}$$

$$Mo=1.1\*40.24\*\frac{5.1}{3}+1.5\*10.24\*\frac{5.1}{2}$$

$$=115.4kNm$$

Restricting moment

$$Mr=\left[\left(37.8\*1.2\right)+\left(54.7\*1.9\right)+\left(200.66\*2.5\right)\*0.9\right]$$

$$=585.85kNm$$

2b. Give reasons for the following; (a) Bored piles are enlarged at base (b) Precast piles must be reinforced and design to resist bending moment.

Bored piles are enlarged at base so that they have larger bearing capacity and resistance to uplift.

Precast piles must be reinforced to withstand the impact of the driving hammer and designed to resist bending moment caused by lifting and stacking.

QUESTION THREE

3a. Write a well detailed explanation of the construction procedure including materials used, tests on soil bearing capacity, pile length etc. during the construction of Fajuyi Park Bridge, Ado-Ekiti.

Construction of bridge

Materials used

Reinforced concrete: Reinforced concrete (RC) (also called reinforced cement concrete or RCC) is a composite material in which concrete's relatively low tensile strength and ductility are counteracted by the inclusion of reinforcement having higher tensile strength or ductility.

prestressed concrete: Pre*-*stressedconcrete is a form of concrete where initial compression is given in the concrete before applying the external load so that stress from external loads are counteracted in the desired way during the service period. This initial compression is introduced by high strength steel wire or alloys (called ‘tendon’) located in the concrete section.

Steel

Soil bearing capacity

It is the ratio of force per unit area required to penetrate a soil mass with standard circular piston at the rate of 1.25 mm/min. to that required for the corresponding penetration of a standard material. The California Bearing Ratio Test (CBR Test) is a penetration test developed by California State Highway Department (U.S.A.) for evaluating the bearing capacity of subgrade soil for design of flexible pavement.

CBR Test Procedure:

* Normally 3 specimens each of about 7 kg must be compacted so that their compacted densities range from 95% to 100% generally with 10, 30 and 65 blows.
* Weigh of empty mould
* Add water to the first specimen (compact it in five layer by giving 10 blows per layer)
* After compaction, remove the collar and level the surface.
* Take sample for determination of moisture content.
* Weight of mould + compacted specimen.
* Take other samples and apply different blows and repeat the whole process.
* Remove the mould from the tank and allow water to drain.
* Then place the specimen under the penetration piston and place surcharge load of 10lb.
* Apply the load and note the penetration load values.
* Draw the graphs between the penetration (in) and penetration load (in) and find the value of CBR.
* Draw the graph between the %age CBR and Dry Density, and find CBR at required degree of compaction.

Bridge elements

Substructure: foundation of the bridge (piles)

Superstructure: pier, abutment, pile cap and slab

Substructure: Piles

A concrete pile maybe precast, prestressed, cast in place or composite construction. Prestressed piles are formed by tensioning high strength steel prestress cables, and casting the concrete about the cable. When the concrete hardens, the prestress cables are cut, with the tension force in the cables now producing compressive stress in the concrete pile. It is common to higher-strength concrete (35 to 55 MPa) in prestressed piles because of the large initial compressive stresses from prestressing. Max length: 10 - 15 m for precast, 20 - 30 m for prestressed. Optimum length 10 - 12 m for precast. 18 - 25m prestressed.

Realization of the pile

* Preparation of the site
* Preparation of the reinforcement
* Arrangement of pile reinforcement and enclosing with the formwork
* Pouring concrete into the formwork
* Removal of formwork after drying

Superstructure

Realization of pier and abutment

* Pier is a vertical bridge element which is used to transfer load from the deck to the pile and then to the ground
* Abutment is a vertical bridge element used to support lateral pressure at the end of the bridge.
* Prepare the reinforcement
* Enclose the reinforcement and cast
* Remove the formwork after drying

Realization of slab deck

* Slab deck is a horizontal bridge element where vehicle move
* After the removal the removal of formwork for piers and abutment, placement of formwork for slab and arrangement of reinforcement should be done
* Casting and appropriate surface finishes should be done.

3b. If a Bridge structure is to be located within Afe Babalola University, suggest a likely location and justify your assertion.

Across Ureje river connecting Afe Babalola university and ABUAD farm behind staff quarters.

A bridge is a structure which spans between vertical alignment (rivers, terrains) used to transport goods and services from one place to another.

QUESTION FOUR

4a). Differentiate between HA and HB loading system.

HA represents normal traffic while HB represents very heavy abnormal loads

4b). Give a mathematical definition of active and passive pressure acting on a retaining wall.

$$active pressure=\frac{1-\sin(θ)}{1+\sin(θ)}$$

$$passive pressure=\frac{1+\sin(θ)}{1-\sin(θ)}$$