The Contrast analysis of BRT road and platform section

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Abstract. Asphalt concrete has been widely used in various fields, and now most of the urban roads have taken asphalt concrete pavement. Because of the way of channelization and the braking force of the vehicle, the road surface of the special road needs to bear greater shear stress, so the road section and the section of the platform usually adopt different pavement structures. In this paper, two kinds of pavement structures are numerically simulated, and the deformation and stress of two kinds of pavement structures under vehicle loading are compared and analyzed.

1. Introduction
As a result of economic development, the number of vehicles in urban areas has increased dramatically. It is easy to cause urban traffic congestion, and BRT has also been used in more and more cities. BRT channelized traffic is more likely to damage Asphalt Concrete Pavements, this paper mainly analyzes the state of the vehicle when the brake is stopped, and compares the stress and deformation of the road structure and the pavement structure. Most of the existing road design methods in China still simplify the vehicle load to static load and assumed to be constant[1]. In the specification[2], the single axial load of 100KN is adopted as the standard axle load, and the ground pressure of the tire is 0.7mpa. The equivalent circle diameter D of single wheel transmission surface is 21.3cm, and the center distance between two wheels is 1.5D.

2. Material and Methods

2.1 Model size and material parameters
Analysis of the data used from the Hubei Province Yichang City Gezhou dam first company, the structure of the road and the structure of the station are shown in table 1 and table 2.

| Material                     | Thickness (cm) | Elastic Modulus (MPa) | Poisson's ratio | Density (g/cm³) |
|------------------------------|----------------|-----------------------|-----------------|-----------------|
| Upper layer SMA-13 type SBS modified asphalt concrete | 4              | 1400                  | 0.35            | 2.46            |
### Table 1 Traffic section road structure and parameters.

| Traffic section    | Road structure and parameters                                      | Thickness(cm) | Elastic Modulus(MPa) | Poisson's ratio | Density(g/cm³) |
|--------------------|---------------------------------------------------------------------|---------------|----------------------|-----------------|---------------|
| **Middle layer**   | AC-16C medium grained asphalt concrete                              | 6             | 1200                 | 0.35            | 2.469         |
| **Lower layer**    | ATB-25 type asphalt stabilized macadam base                          | 8             | 1000                 | 0.3             | 2.493         |
| **Upper base**     | Cement stabilized grading gravel base (The representative value of unconfined compressive strength for 7 days is 3 ~ 4.0MPa) | 18            | 700                  | 0.25            | 2.419         |
| **Middle base**    | Cement stabilized grading gravel base (The representative value of unconfined compressive strength for 7 days is 2.5 ~ 3.0MPa) | 18            | 700                  | 0.25            | 2.414         |
| **Lower base**     | Cement stabilized grading gravel base (The representative value of unconfined compressive strength for 7 days is 2.0 ~ 2.5MPa) | 18            | 700                  | 0.25            | 2.409         |
| **Subbase**        | Grading gravel base                                                  | 15            | 300                  | 0.35            | 2.24          |
| **Subgrade**       |                                                                     | 600           | 40                   | 0.4             | 1.8           |

### Table 2 Platform section structure and parameters.

| Platform section    | Material                              | Thickness(cm) | Elastic Modulus(MPa) | Poisson's ratio | Density(g/cm³) |
|---------------------|---------------------------------------|---------------|----------------------|-----------------|---------------|
| **Layer**           | Black C35 reinforced concrete faceplate| 28            | 31500                | 0.2             | 2.43          |
|                     | Cement stabilized grading gravel base (The representative value of unconfined compressive strength for 7 days is 3 ~ 4.0MPa) | 26            | 700                  | 0.25            | 2.419         |
| **Middle base**     | Cement stabilized grading gravel base (The representative value of unconfined compressive strength for 7 days is 2.0 ~ 2.5MPa) | 18            | 700                  | 0.25            | 2.409         |
| **Lower base**      | Grading gravel base                   | 15            | 300                  | 0.35            | 2.24          |
| **Subbase**         |                                      | 600           | 40                   | 0.4             | 1.8           |

The road surface can be considered as an infinite plane, the length and width of the model are 600cm.

#### 2.2 Load

In the design of the road, double circle vertical load is usually adopted. In fact, the contact surface between the tire and the ground is approximately elliptical. Because of the inconvenience of calculation, the contact area of the ellipse is rarely used [3]. The actual contact area between the tire and the road surface is roughly composed of a rectangle and two semicircles [4], it is approximated as a rectangle in calculation[5], as shown in the figure 1.
In the formula above: $F$ is single wheel load, 25KN; $p$ is tire pressure, 0.7MPa.

The horizontal load acting on the surface of a road; multiplied by the vertical load on the wheel and the coefficient of friction between the wheel and the road.

$$q = f \times p.$$  \hspace{1cm} (2)

In the formula above: $q$ is the horizontal load; $f$ is the coefficient of friction.

Refer to "urban road design code" and measured data, When the driver in the case of mental preparation shift and braking, the horizontal force coefficient $f$ is 0.2; when the emergency braking is taken, the $f$ takes 0.5[6]. Consider the most unfavorable conditions, $f$ take 0.5.

2.3 Boundary conditions

The pavement structure model adopts linear elastic solid185 unit, The contact state between the asphalt layer and the semi rigid layer is completely continuous and completely smooth, and all the layers are completely continuous. The boundary conditions are as follows: the bottom surface is completely fixed, there is no X direction displacement between the left and the right, and there is no displacement in the direction of Y. The mesh is shown in Figure 2 and Figure 3.
3. Finite element simulation results

3.1 deformations
Since the load is applied once, the resulting deformation is smaller, the results are shown in Figure 4 and Figure 5.

![Figure 4](image1.png)
(a) Horizontal section

![Figure 4](image2.png)
(b) Vertical section

Figure.4 Traffic road deformation contour.

![Figure 5](image3.png)
(a) Horizontal section

![Figure 5](image4.png)
(b) Vertical section

Figure.5 Platform section deformation contour.
3.2 Stress

![Traffic road stress contour](image1)
(a) Horizontal section  
(b) Vertical section

**Figure 6** Traffic road stress contour.

![Platform section stress contour](image2)
(a) Horizontal section  
(b) Vertical section

**Figure 7** Platform section stress contour.

**Table 3** Stress and deformation calculation results.

| Structure | Maximum deformation (mm) | Maximum stress (MPa) |
|-----------|--------------------------|----------------------|
| Road      | 0.052487                 | 0.26322              |
| Platform  | 0.050213                 | 0.3481               |

4. Conclusions

In this paper, the finite element model of pavement structure is established, and the stress and deformation results are compared. The conclusions are as follows:

1. From Fig. 4 and Fig. 5, it can be seen that the deformation of the surface layer to the base layer and the bottom layer basically shows a linear change, and the maximum deformation occurs at the center of the contact surface between the wheel and the ground.

2. By comparing the stress and strain contour maps, it is found that the deformation and stress are not the regular relationship, and stress mutation occurs due to stratification of pavement structure.

3. In the opposite direction of the road, the below road deformation is larger. Because of the different materials used in the surface layer, the deformation of the platform section is less than that of the traffic section, and the influence of the deformation depth is roughly the same.
5. References

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