

Article

Experimental Study on Key Techniques for the Construction of High Asphalt Concrete Core Rockfill Dam under Unfavorable Geological Conditions

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Abstract: Asphalt concrete core dams (ACCDs) have been widely constructed in Xinjiang, yet the design of materials and structures has mainly relied on empirical knowledge without substantial theoretical grounding. In this study, we carried out a large-scale relative density test of gravel material in Bamudun dam, studied the compaction characteristics of gravel material, and determined the relative density characteristic index, in order to provide a basis for the subsequent dam material rolling test and construction quality inspection. Furthermore, in order to improve the efficiency of dam construction in narrow valleys, we optimized the connection type between asphalt concrete core wall and bedrock, and proposed a rapid construction method of paving core wall after pouring mass concrete base on bedrock. Finally, we established a three-dimensional finite element model to systematically analyze the stress and deformation patterns of the dam body, core wall, and base of the ACCD at Bamudun. The results show that the maximum compressive stress suffered by the core wall during the full storage period is 1.62 MPa, there is no tensile stress, and the risk of hydraulic splitting is small. The stress and deformation levels of each part are within the safe range. This verifies the rationality of the rapid construction method. The research findings can provide a great theoretical significance and engineering value for the safe design and construction of ACCDs.

Keywords: asphalt concrete core rockfill dams; compaction; narrow valley; earth-rock dam construction



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1. Introduction

Hydraulic asphalt concrete (HAC) is widely used for water barriers in hydraulic engineering, owing to its excellent impermeability and good deformation [1–3]. This trend is evidenced by the construction or planned construction of over 100 asphalt concrete core wall dams in China [4], representing approximately 50% of such dams worldwide, as shown in Table 1. Notable examples include the Yele (125 m), Maopingxi (105 m), Xiabandi (78 m), Guanmaozhou (106 m), and Quxue (174 m) dams [5–7]. The unique geographical and climatic conditions, as well as the availability of high-quality asphalt resources, have contributed to the widespread adoption of asphalt concrete core wall dams in Xinjiang. Notably, the construction of large-scale asphalt concrete core wall dams such as Xiabandi, Kushtayi, and Alagou has stimulated economic development in Xinjiang [8,9]. However, due to their complex geological environment, it is necessary to further study the detailed structure, material design theory, and on-site construction technology of asphalt concrete core wall dams.

Table 1. Typical project of asphalt concrete core wall dams in Xinjiang.

Serial Number	Dam Name	Dam Height (m)	Dam Length (m)	Total Storage (BCM)	Installation (MW)
1	Niya reservoir	131	352	0.422	6
2	Dashimen reservoir	128	205	1.27	60
3	Shimen hydropower station	106	312.5	0.7975	95
4	Wu Yi reservoir	102.5	374	0.968	15
5	Gilgrade reservoir	101.5	345	0.61	20
6	Kushitayi hydropower station	91.1	439	1.59	100
7	Nu'er reservoir	80	740	0.68	62
8	Xiabandi reservoir	78	406	8.67	150
9	Kezigar reservoir	64	355	1.767	5

Xinjiang is home to numerous rivers with abundant sand and gravel resources [10]. In comparison to rockfill dam material, gravel material generally exhibits superior gradation and lower porosity after compaction, resulting in a significantly higher deformation modulus [11,12]. This makes it easier to meet stress and deformation transitions when filling the dam body of concrete face dams [13]. These advantages have led to an increasing preference for gravel material as a damming material for high asphalt concrete core wall dams [14]. However, the discrete gradation of natural gravel often leads to poor gradation and uneven density distribution, posing challenges in terms of permeability during engineering construction. Wu et al. [15] conducted an experimental study on the permeability characteristics of sand–gravel overburden with high fine material content and poor gradation, finding that the permeability coefficient decreases with increasing relative density and the content of particles less than 5 mm. The gradation and particle size of sand–gravel dam fillers determine the contact relationship between particles, which in turn affects its macroscopic mechanical response. Zhao et al. [16] explored the relationship between particle gradation and the basic physical characteristics of the dam filler, identifying three gradation characteristic parameters closely associated with dry density in the gravel filler area and the transition material filler area. These parameters can be utilized for quality evaluation and prediction of gravel dam filler. Additionally, Liu et al. [17] summarized the filling standard of the dam body based on the construction experience of panel dams exceeding 100 m in Xinjiang over the past 30 years. They recommended employing large-scale relative density tests of the original gradation to determine the filling standard for panel sand and gravel dam projects, as opposed to indoor test methods.

The growing prevalence of asphalt concrete core wall dams in China has led to a scarcity of suitable terrains for their construction, with many being built in complex valley terrains characterized by steep bank slopes [18,19]. This topography can lead to large shear deformation at the joint between the asphalt concrete core wall and the base, excessive tensile stress on the dam abutment, and the occurrence of significant arch effects due to the clamping effect of the valley sides on the core wall. These factors pose serious threats to the dam's anti-seepage capabilities and overall safety [20,21]. Therefore, some scholars have selected factors such as bank slope and valley width to study the influence of complex topographic and geological conditions on the arch effect of the core wall. For instance, Sukkarak et al. [22] studied the influence of dam geometry on dam settlement characteristics through finite element analysis. By considering the slope of the abutment, a modified shape factor S_β was proposed to reflect the influence of dam geometry on dam settlement. The results show that dam geometry plays an important role in dam settlement in narrow valleys. Additionally, Li et al. [23] performed three-dimensional finite calculations on straight and inclined core wall rockfill dams, finding that the state of inclined core wall asphalt concrete core wall dams is superior to that of straight core wall dams. Gao et al. [24] proposed improvement measures for curved core wall dams based on the mechanism of tensile stress generated by the core wall and investigated the effectiveness of the new dam type through finite element calculations. The results indicated

that this dam type can reduce tensile stress within the core wall to a certain extent, with the degree of improvement becoming more pronounced with greater curvature of the core wall. Despite these efforts, there remains a dearth of research on the optimization of joints between asphalt concrete core walls and concrete bases in both domestic and international contexts. The existing optimization methods are relatively simplistic, limited, and time-consuming [25,26]. Therefore, there is a need for further research to optimize the joint structure of asphalt concrete core walls on high and steep bank slopes, with the aim of providing valuable insights for engineering applications.

This paper presents a case study of the Bamudun asphalt concrete core wall dam as an engineering example. It addresses the challenges encountered in constructing high and steep bank slope rockfill dams in Xinjiang. This study establishes a method for determining the compaction characteristic index of the original gradation dam material based on large-scale relative density testing, offering a reference standard for quality control in dam construction. Furthermore, it optimizes the connection type between the core wall and the bedrock of the asphalt concrete core wall dam in narrow valleys to enhance construction conditions in the riverbed section. Additionally, this paper proposes a structural design method for the concrete gravity wall to improve the foundation surface.

2. Study on Compaction Characteristics of Original Graded Dam Materials

2.1. Research Background

The filling standard of the sand and gravel fill body is expressed by relative density. Determining the appropriate filling standard is the key to deformation control and seismic design of the dam body [27,28]. In the past, it was determined through indoor testing methods, influenced by characteristic parameters such as gravel content and maximum particle size [29,30]. However, it is difficult to determine the maximum dry density of the original graded gravel material on site, which complicates the evaluation of quality inspection results and affects the filling quality of the project. The relative density test method for coarse-grained soil with a particle size less than 60 mm is specified in the Standard for Soil Test Methods [31] (GB/T 50123-2019). While some of the methods can be applied to test soil with a particle size greater than 60 mm, such as the elimination method and the equivalent substitution method [32,33], it is noted that these methods have certain limitations and should be determined based on the soil properties and test items. Engineering practice has demonstrated the shortcomings of these methods, often resulting in relative density greater than one or repeated rolling failing to meet the standard, which does not align with engineering requirements.

Currently, with the utilization of large-scale rolling construction machinery, the determination of the filling standard for gravel filling bodies is gradually transitioning from indoor to on-site [34,35]. The large-scale density bucket method is employed to design the grading envelope according to the gravel material, and the air-dried gravel material is artificially prepared for testing. The compaction principles of different compaction methods are illustrated in Figure 1.

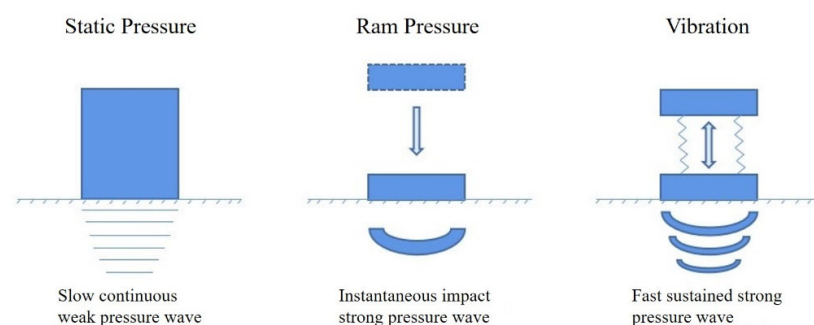


Figure 1. Principles of different compaction methods.

2.2. The Influence of the Compaction Mechanism on the Compaction Characteristic Index

For the same grading of the gravel material, even with the same-sized specimen cylinder, due to the test of vibration compaction mechanism being different, the test results are not the same [36]. In order to study the effect of compaction methods on the relative density index, we conducted relative density tests on typical engineering dam-building gravel using the shaking table method and the surface vibration method, as shown in Figure 2. Both the shaking table method and the surface vibration method generally rely on the vibration of an electric motor to compact the test soil material, but the vibration compaction mechanisms of the two methods are not exactly the same [37]. In the shaking table method, the whole soil sample is restrained by the top weight plate, and at the same time is subjected to the inertia force generated by the vertical high-frequency vibration, which prompts the internal particles of the test material to adjust their positions to achieve compaction. The surface vibration method is conducted by exerting the vibrating rammer excitation force directly on the surface of the test material in the specimen cylinder; the surface of the excitation force from the top down on the test material particles produces an extrusion effect to achieve the effect of compaction. The test results are shown in Table 2. Therefore, from the point of view of the compaction mechanism and effect, under the premise of the same compaction work, the surface vibration method has a better compaction effect on the test material, and the maximum dry density obtained from the test is greater than that of the vibrating table method.

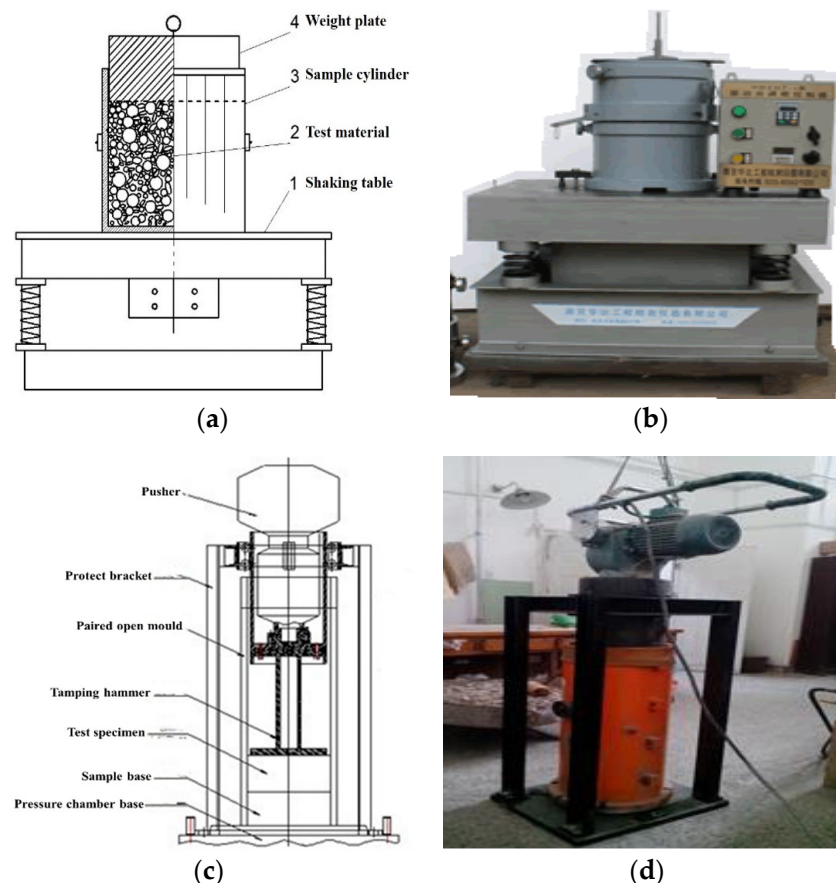


Figure 2. Shaking table method and surface compaction method. (a) Principle of shaking table method; (b) shaking table relative density meter; (c) principle of surface compaction method; and (d) surface compaction relative density meter.

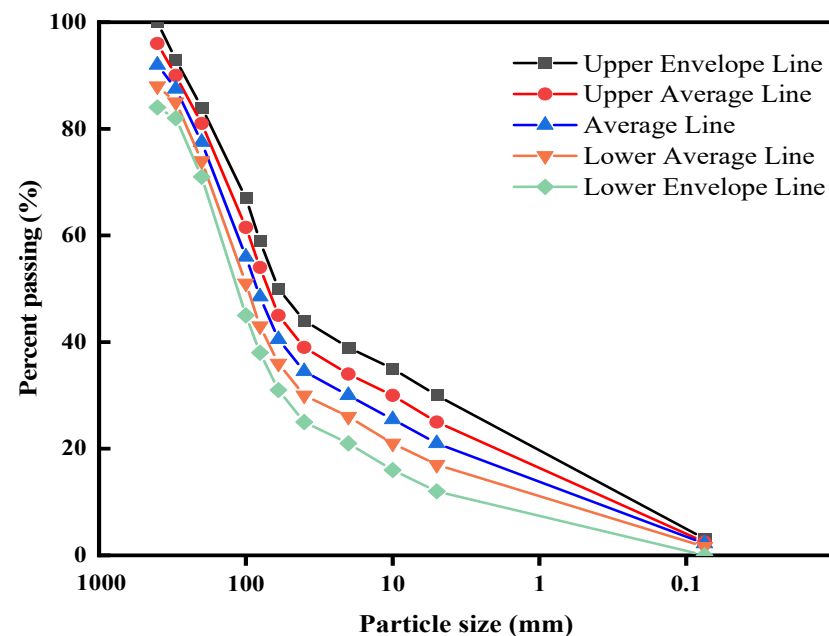
Table 2. Relative density test results under different vibratory compaction methods.

Indoor Experiment	Minimum Dry Density (g/cm ³)	Maximum Dry Density (g/cm ³)
Shaking table method	0.36	11
Surface vibration method	0.42	13

2.3. Large-Scale Field Relative Density Test of Bamudun Reservoir

2.3.1. Experimental Soil Material and Gradation

The five characteristic gradation curves chosen for the tests were the upper packet gradation line [38], the lower packet gradation line, the average gradation line, the upper average gradation line, and the lower average gradation line, which also characterize the five different gravel contents. The maximum and minimum dry density tests were carried out twice for the different gravel content, and after the tests were completed for the five characteristic gradations (gravel content), the optimum gravel content was prepared again according to the optimum gravel content determined from the review tests. The grading curves of the test soil materials are shown in Figure 3.

**Figure 3.** Test gradation curve.

2.3.2. Field Relative Density Test Process

First of all, in the site on a layer of test material, with a vibration mill, first perform static grinding once, and then 10 to 12 times, until the difference between the two adjacent milling settlements is less than 5 mm and the degree of compactness is greater than the design of the dry density of the test material; at the same time, in the site around the set of drainage, use ditches to prevent the accumulation of water. Then arrange 4 density barrels of 2 m in diameter and 1 m in height, with a net spacing between barrels of not less than 3 m. The layout of the site is shown in Figure 4.

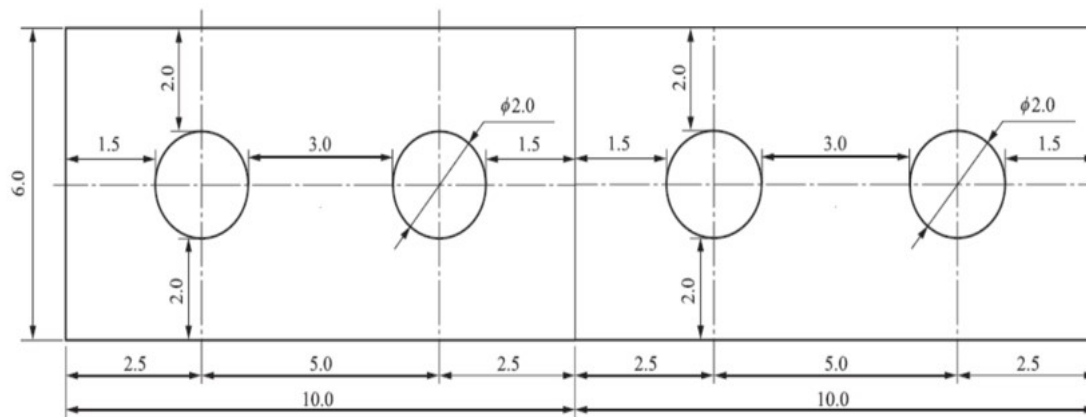


Figure 4. Relative density test arrangement.

The minimum dry density test is carried out by a manual loose-filling method [39], in which the test material is evenly and loosely filled into the density test pail. When filling, the soil material is put into the pail gently to prevent shocks and vibrations, so as to simulate the natural state of accumulation of the soil material as much as possible. Upon completion of the filling, the total mass of soil in the bucket is recorded, and the minimum dry density is calculated from the weight of the filled soil and the volume of the bucket. After the minimum dry density test is completed, the maximum dry density test is continued by spreading the remaining soil from the minimum dry density test around the density bucket, with the surface of the spreading soil about 25 cm above the top of the bucket, to ensure that the site is leveled after spreading the soil. The vibratory mill was started off-site, and the traveling speed was controlled at 2~3 km/h. The vibratory mill was first vibrated and compacted 16 times in the upper area of the density drum, and then vibrated and compacted for 15 min at low speed in the range of each density drum, and the soil was replenished in time in the process of crushing so that the vibratory mill did not come into direct contact with the density drums. After the vibratory crushing is completed, remove the excess soil material above the top of the drum and level it. All the soil in the bucket is excavated and weighed, and the maximum dry density is calculated from the total mass of soil and the volume of the bucket. Regardless of the maximum or minimum dry density, two tests were conducted for a specific grade of soil material, and the average value was taken as the final test result to minimize chance errors.

2.3.3. Test Results

Based on the DL/T 5356-2006 Code for Coarse-Grained Soil Test, a three-factor plot of ρ_d -P5-Dr (dry density, gravel content, and relative density) of dam-building gravel materials for the asphalt concrete core wall dam at Bamudun was drawn, as shown in Figure 5. In the three-factor diagram, the maximum and minimum dry density values of different grades (gravel content) and the absolute dry density values corresponding to different relative densities are shown, which can be used as the evaluation criteria for evaluating the crushing quality of dam construction gravel. In this test, the maximum dry density is 2.43 g/cm^3 , and the corresponding minimum dry density is 2.06 g/cm^3 , which is obtained by using the upper average line of the original gradation of the stockpile, and the maximum dry density is 2.06 g/cm^3 . It can be seen in Figure 5 that the values of the maximum and minimum dry density of the sand and gravel material show a trend of increasing first and decreasing later, and the optimum gravel content is characterized by the highest compacted density. The optimum gravel content, corresponding to the maximum dry density, is 75%.

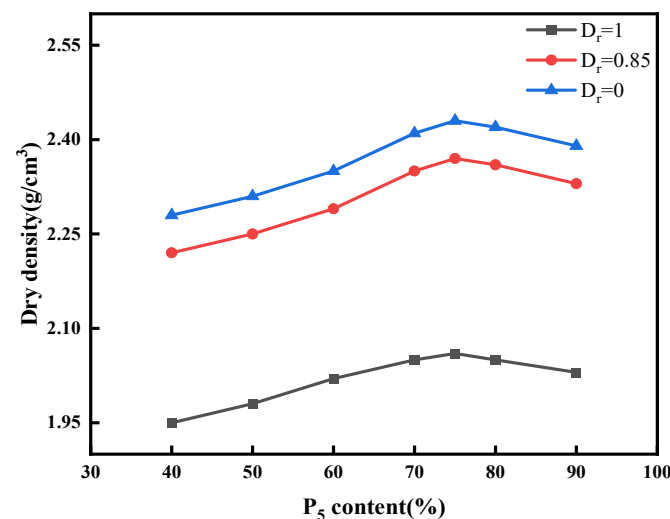


Figure 5. The Pd-P5-Dr three-factor curve of sand gravel in Bamudun Reservoir.

3. Optimization Design of the Connection between Asphalt Concrete Core Wall and Bedrock in Narrow Valley

3.1. Dimensional Details of Dam

Bamudun Reservoir Engineering is located in Hami, Xinjiang Province, China. The dam is an asphalt concrete core wall dam, and the maximum section is selected for the study, as shown in Figure 6. The dam crest elevation is 1547 m, the maximum height of the dam is 128 m, and the width of the dam crest is 10 m. The upstream cofferdam is combined with the dam body, and the slope of the cofferdam is 1:2.0, and that of the dam body is 1:2.25 above the elevation of 1474 m, and the slope of the downstream section of the largest section is about 1:2.01. The dam body is divided into a gravel material area, a transition material area, an asphalt concrete area, a transition material area, and a drainage material area from upstream to downstream. The valley where the dam is located is in the shape of “V”, with a riverbed width of 20~100 cm and a specific drop of 6.5~7.5%.

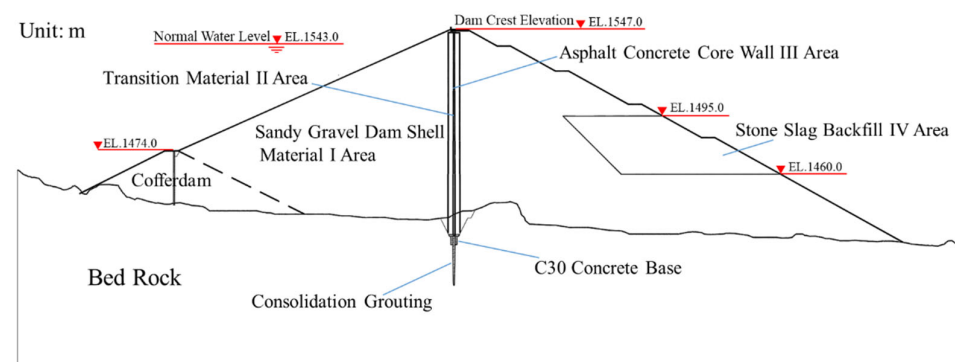


Figure 6. Cross-section of Bamudun dam.

3.2. Form of Base Arrangement

The base is a special structure that connects the core wall to the dam foundation and is critical to maintaining the stability of the dam. The concrete base of the conventional core wall is 1.5 m to 2.5 m thick; however, this project is located in a narrow valley area; the riverbed section of the pit is 26 m deep and the length is 31 m; the impermeable body of the core wall is situated in the upper part of the weakly weathered layer; and the excavation of the core wall trench has the slope of the left side of the trench at 1:0.5 and the slope of the right side of the trench at 1:78. If the design is based on the conventional method, the construction of the core wall can only be manually paved, the advantages of mechanical

paving cannot be fully exploited, and the filling of the dam body on both sides will be delayed for 3 months. According to the actual situation of the project and with reference to the experience of similar projects, it is proposed to adopt the design method of a concrete gravity wall base. As shown in Figure 7, the elevation of the bottom of the base is 1419 m, the elevation of the top of the wall is 1430.4 m, the width of the top is 3 m, the width of the bottom is 8.5 m, and the height is 11.4 m. Therefore, this is an isosceles trapezoidal structure.

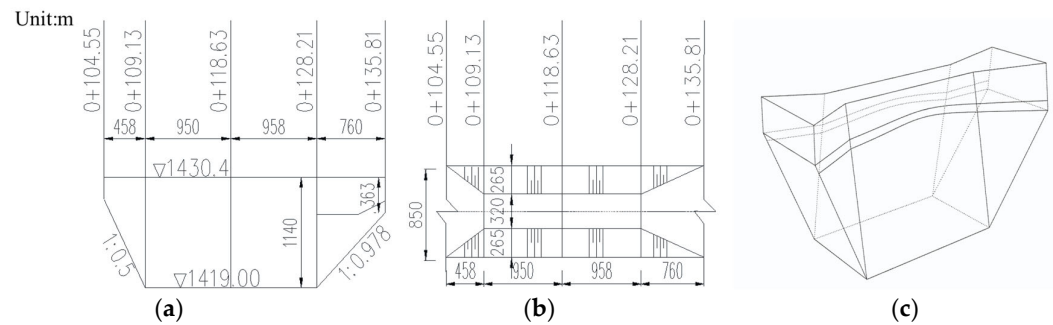


Figure 7. Concrete gravity wall base. (a) Front view; (b) Top view; (c) 3D perspective view.

3.3. Three-Dimensional Static Finite Element Analysis of Bamudun Dam

3.3.1. Finite Element Model

The three-dimensional finite element model is established according to the engineering reality. The three-dimensional finite element mesh of the dam is shown in Figure 8, with 307,055 cells and 327,338 nodes.

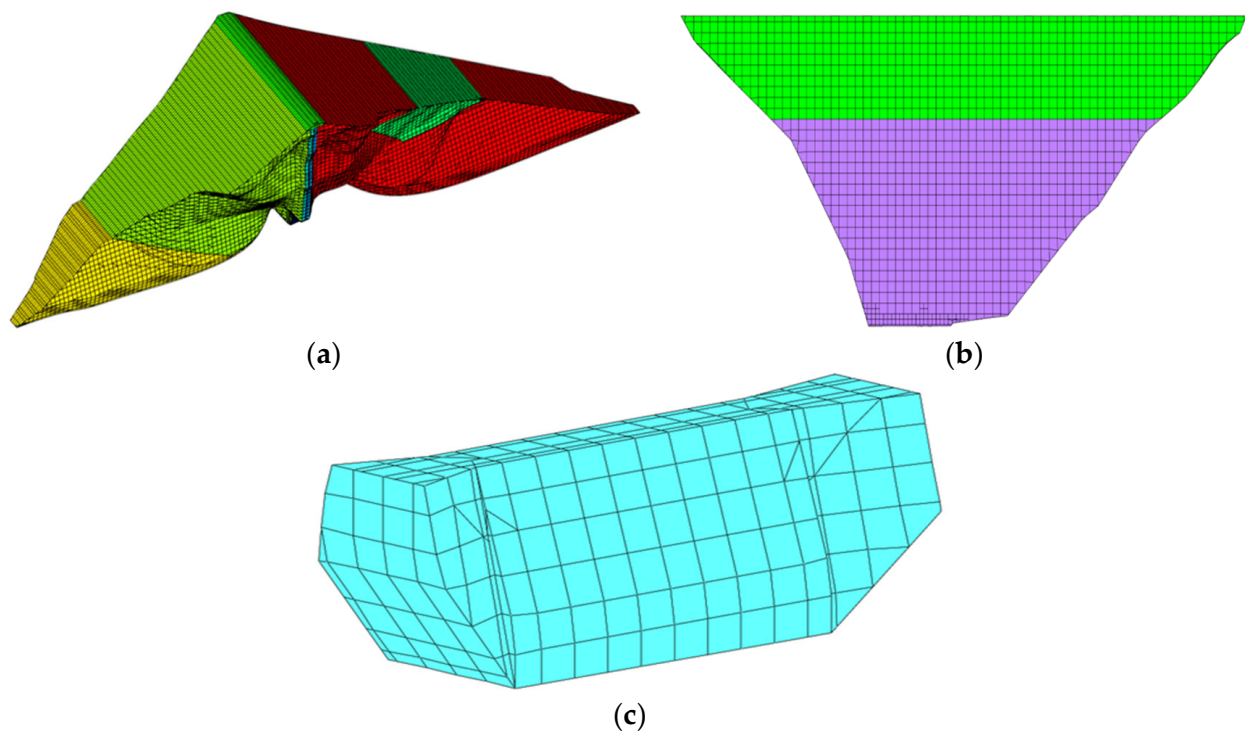


Figure 8. Three-dimensional finite element meshes. (a) Three-dimensional finite element mesh of dam; (b) three-dimensional finite element mesh of core wall; (c) the finite element mesh of the base at the bottom of the valley.

3.3.2. Intrinsic Model and Calculation Parameters

A graded loading method was used to simulate the dam filling and impounding process, and three-dimensional nonlinear finite element method calculations were performed

to analyze the deformation and stress of the dam body and dam foundation [40,41]. All the loads are applied in 73 stages, with 42 stages for dam filling construction and 31 stages for water storage. The dam body is subjected to water pressure during the rise of the water level, so the water pressure corresponding to the water level is applied on the upstream side of the core wall and concrete base. Normal constraints are applied to both sides of the model, and fixed constraints are applied to the bottom.

The Duncan-Zhang (E-B) model was used for the earth and stone materials and asphalt concrete core wall, and the linear elasticity model was used for the concrete base and bedrock. Based on the provided investigation data and dam material test data, and with reference to the relevant experience of similar projects, the values of each material parameter are shown in Tables 3 and 4.

Table 3. Linear elastic model parameters.

Material	ρ (g/cm ³)	E (GPa)	ν
Bed rock	2.60	18.0	0.200
Pedestal	2.40	25.5	0.167

Table 4. Duncan E-B model parameters.

Site	ρ_d (g/cm ³)	K	n	R_f	φ	c (kPa)	K_b	m
Lower part of the core wall	2.42	410	0.11	0.68	26.7	325	2884	0.11
Above the core wall	2.42	380	0.10	0.58	26.1	390	2455	0.23
Sand–gravel material	2.25	1250	0.30	0.75	41.9	126	920	0.11
Transition material	2.20	970	0.20	0.77	39.5	105	520	0.08

3.3.3. Result Analysis

In this study, the advanced refined three-dimensional nonlinear stress and deformation finite element analysis method is employed to comprehensively examine the stress and deformation characteristics of the dam body, core wall, and base of the Bamudun asphalt concrete core wall dam. In addition, we take stress as positive in compression, and the displacement towards the riverbed is positive.

Deformation and Stress of the Dam

The stress–strain diagram depicting the deformation of a typical section of the dam during the construction and impoundment phases is illustrated in Figures 9 and 10. Taking the typical section 0 + 91.9 as an example, the stress deformation law of the dam body is analyzed. The analysis reveals that during the construction phase, the maximum settlement of the dam body is 22.6 cm, while during the full storage period, it is 20.2 cm. Additionally, the maximum displacement along the river during the construction phase is 13.8 cm downstream and 7.8 cm upstream. Conversely, during the full storage period, the deformation of the dam body on the upstream side decreases, while on the downstream side, it increases due to water pressure. The maximum values are 16.2 cm downstream and 7.3 cm upstream. Furthermore, the maximum principal stress of the dam body during the construction phase is 1.42 MPa, which decreases to 1.41 MPa during the full storage period due to buoyancy effects. Consequently, the stress and deformation characteristics of the dam body adhere to general law, and the displacement and settlement along the river during both construction and full storage periods are at a normal level.

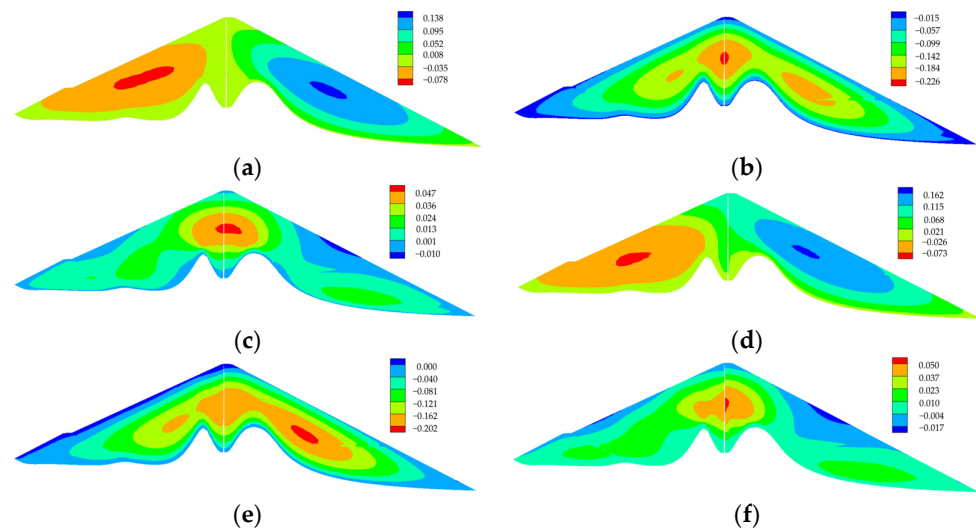


Figure 9. Dam displacement cloud map. (a) section 0 + 91.9 completion period dam along the river displacement (unit: m); (b) section 0 + 91.9 the vertical displacement of the dam during the completion period (unit: m); (c) section 0 + 91.9 completion period dam axial displacement; (d) section 0 + 91.9 full storage period dam along the river displacement; (e) section 0 + 91.9 full storage period dam vertical displacement; and (f) section 0 + 91.9 full storage period dam axial displacement.

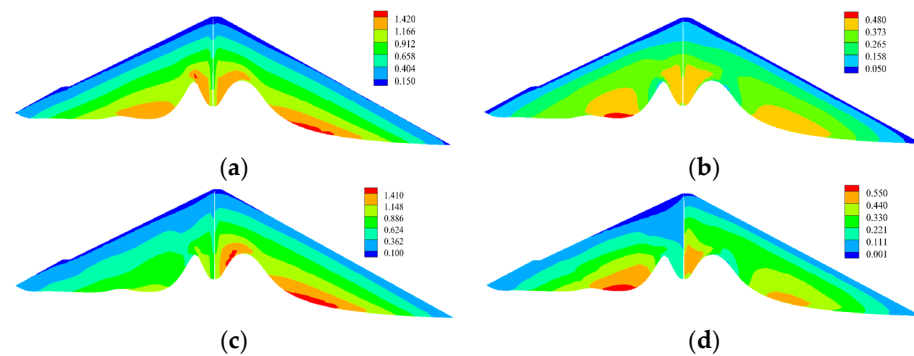


Figure 10. Dam stress cloud map. (a) The major principal stress of the dam body in the section 0 + 91.9 completion period (unit: MPa); (b) the minor principal stress of the dam body in the section 0 + 91.9 completion period; (c) the major principal stress of the dam body in the section 0 + 91.9 full storage period; and (d) the minor principal stress of the dam body in the section 0 + 91.9 full storage period.

Deformation and Stress of Core Wall

The illustrations in Figures 11 and 12 depict the displacement of the core wall and the distribution of the major and minor principal stresses. The corresponding peak values are presented in Table 5. Analysis reveals that during the completion phase, the displacement of the core wall along the river is minimal, measuring 2.1 cm upstream. The maximum vertical settlement of the core wall, reaching 35.0 cm, is situated near the midpoint of the valley at a height of 1/2 of the core wall. Additionally, the maximum axial displacement of the core wall along the dam is 4.7 cm. Subsequently, during the full storage period, the core wall experiences an increase in displacement along the river due to water pressure, with the maximum displacement downstream measuring 12.0 cm and being located at the top of the core wall. The maximum vertical settlement during this period is 30.0 cm. Furthermore, the maximum compressive stress of the core wall during the completion period is 1.36 MPa, concentrated at the base of the core wall. In contrast, during the full storage period, the maximum compressive stress of the core wall is 1.62 MPa, with no tensile stress observed. The simulation results of deformation and stress are consistent with the general law of the

core wall. It is noteworthy that the vertical stress of the core wall and the axial stress of the dam during the full storage period exceed the water pressure at the corresponding position. Consequently, even according to the hydraulic fracturing method of the clay core wall dam, the asphalt core wall will not undergo hydraulic fracturing.

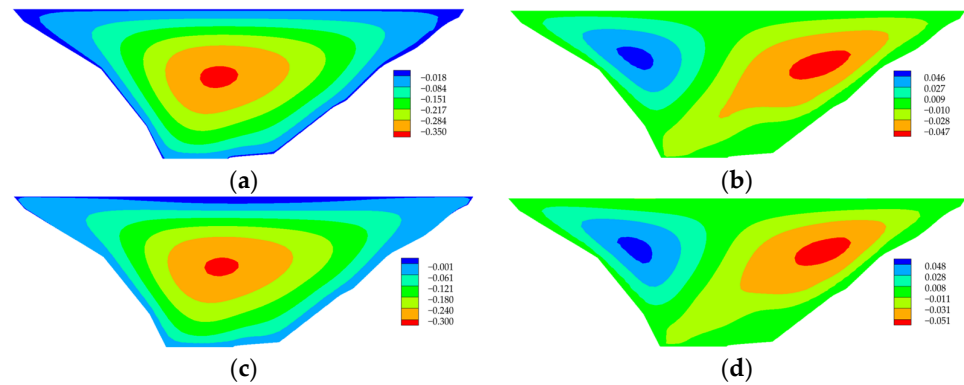


Figure 11. The displacement cloud map of the core wall. (a) Vertical displacement of core wall during completion period (unit: m); (b) axial displacement of core wall dam during completion period; (c) vertical displacement of core wall in full storage period; and (d) axial displacement of core wall dam in full storage period.

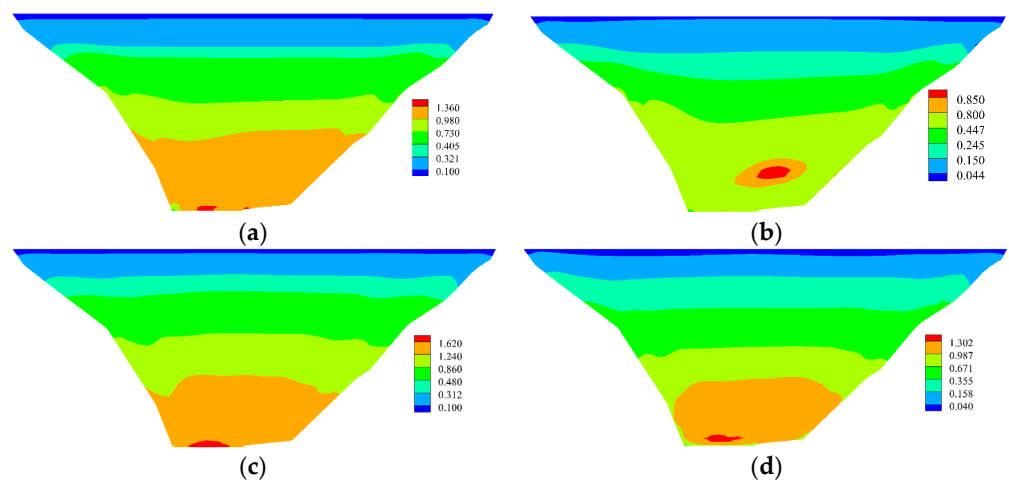


Figure 12. Stress distribution of core wall (unit: MPa). (a) Major principal stress at the end of construction; (b) minor principal stress after dam impounding; (c) major principal stress at the end of construction; and (d) minor principal stress after dam impounding.

Table 5. Peak value of three-dimensional static calculation of core wall.

			Item	Maximum Value
Completion of dam construction	Core wall deformation (cm)	along river	up current	2.1
			downriver	0.1
		hill-and-dale		35.0
	Core wall stress (MPa)	dam axial direction		4.7
		maximum compressive stress		1.36
maximum tensile stress		—		
Full impoundment stage	Core wall deformation (cm)	along river	up current	5.0
			downriver	12.0
		hill-and-dale		30.0
	Core wall stress (MPa)	dam axial direction		5.1
		maximum compressive stress		1.62
maximum tensile stress		—		

Base Stress

The distribution law of the primary and secondary principal stresses of the pedestal is depicted in Figure 13, with corresponding peak values presented in Table 6. It is evident that during the construction phase, the highest compressive stress experienced by the pedestal is 4.01 MPa, situated at the base's right bank bottom. Localized tensile stress is observed, with a magnitude of only 0.2 MPa. Conversely, during the full reservoir stage, the pedestal undergoes deformation in the downstream direction due to water pressure, resulting in an increase in compressive stress on the downstream side. The maximum compressive stress reaches 5.30 MPa, accompanied by a localized tensile stress of 0.5 MPa. Consequently, finite element analysis indicates that the maximum compressive stress remains within acceptable limits, while the maximum tensile stress is minimal and falls within a safe range.

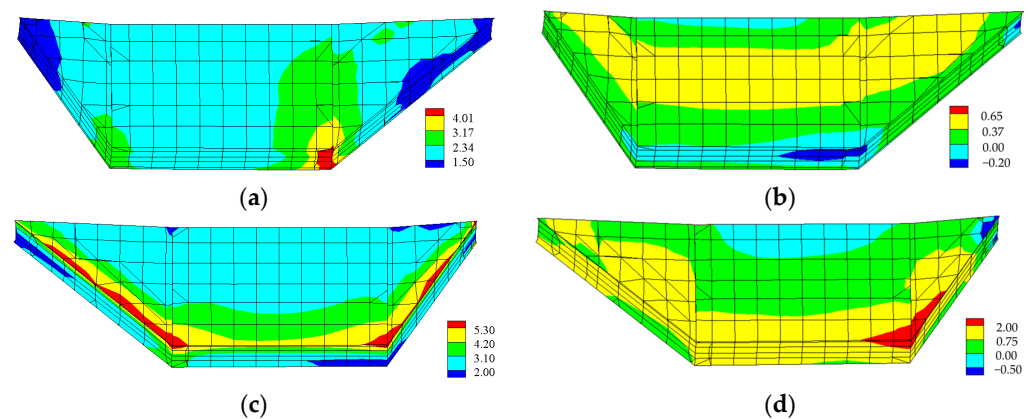


Figure 13. Stress distribution of base (unit: MPa). (a) Major principal stress at the end of construction; (b) minor principal stress after dam impounding; (c) major principal stress at the end of construction; and (d) minor principal stress after dam impounding.

Table 6. Static calculation peak of base.

	Item	Value
Completion of dam construction	maximum compressive stress (MPa)	4.01
	maximum scale tension stress (MPa)	0.20
Full impoundment stage	maximum compressive stress (MPa)	5.30
	maximum scale tension stress (MPa)	0.50

3.4. Base Mass Concrete Construction Temperature Control

The concrete base has a maximum size of 8.5 m × 9.6 m, and the allowable temperature differential is 25 °C or less. The pouring thickness varies based on the location within the foundation area: 2.0 m for 0~0.2 L in the strongly constrained area, 2.0~4.0 m for 0.2~0.4 L in the weakly constrained area, and 4.0 m for >0.4 L outside the constrained area (where L represents the length of the foundation pouring block). Cooling water pipes are required to be embedded in the concrete pouring parts for initial cooling. In the strongly constrained area, steel pipes with a diameter of 2.54 cm are used for the cooling water pipes, which are arranged parallel to the dam axis. The spacing of water pipes in the basic constraint area is 1.5 m (vertical spacing) × 1.0 m (water pipe spacing).

Throughout the construction process, a designated individual was tasked with monitoring the temperature of the concrete and maintaining meticulous records. This was done to gather data for future construction projects and to validate the precision of theoretical calculations. In accordance with the aforementioned construction specifications, the mass concrete construction for the base of Bamudun Reservoir was successfully executed. A visual examination of the concrete structure was conducted, revealing no signs of cracking. This outcome minimized the need for secondary grouting treatment for the base concrete's anti-seepage measures, thereby enhancing construction quality and expediting progress.

4. Conclusions

In this paper, we discussed the key technology of the rapid construction of high asphalt concrete core wall dams under complex terrain conditions based on the project of Bamudun Reservoir and demonstrated the reliability of structural design optimization of a high asphalt concrete core wall dam under bad geological conditions. The main results are as follows:

- (1) The maximum dry density measured by the shaking table method is 2.29 g/cm^3 , and the maximum dry density measured by the surface vibration method is 2.35 g/cm^3 . The results show that the surface vibration method can have a better compaction effect under the condition that the compaction work of the surface vibration method and the shaking table method is equal.
- (2) The maximum dry density obtained by the original grading curve of the material field is 2.43 g/cm^3 , and the minimum dry density is 2.06 g/cm^3 . The corresponding optimal gravel content is 75%, and the compaction density is the highest. With the increase in gravel content, the maximum and minimum dry density values of gravel increase first and then decrease.
- (3) The results of a three-dimensional fine analysis show that the stress level of the dam core wall is low and there is no tensile stress. The hydraulic fracturing resistance of the dam core wall is guaranteed. The maximum compressive stress of the foundation during the completion period is 4.01 MPa. After the impoundment, the compressive stress on the downstream side of the foundation increases to 5.30 MPa, and the tensile stress is small.

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