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Standards of Classical Architecture Criticism: Between Mathematics and Philosophy

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Abstract: Criticism is an intellectual process that primarily searches for beauty aspects in the works of art, including architecture. This article explores the mathematical and philosophical principles of classical architectural criticism. It is hypothesized that design criteria during the Classic period were clear and specific. The research presents theories of classical art that focus on the process of beauty interpretation. It also assesses the mathematical evaluation of architectural art and beauty through “The Golden Ratio” and “The “Fibonacci Sequence.” Classical philosophy, and its perception of beauty, is discussed as an essential basis in any artistic critical activity. The research asserts that the science of aesthetics is both objective and subjective, which explains the difference in aesthetic evaluation across eras. Objectivity stems from conditions of proportionality that must be met for an architectural art to be aesthetically judged as beautiful. Subjectivity lies in the time and place of the architectural work, whereby tendencies, tastes, and needs related to the human and geographical environment can affect the standards of beauty. This makes the evaluation of beauty in classical architecture a delicate and complex process in which many aspects must be considered to have an objective, fair, and correct judgment.

Keywords: Beauty; Aesthetics; The Golden Ratio; Fibonacci sequence; Theory of imitation; Judgement of Taste; Absolute idealism

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1 Introduction

Architecture criticism generally refers to the critical assessment of art and literature in the Classical period of art history. The Classical period falls between the fifth century BC and the beginning of the Middle Ages, which was characterized by the dominance of both Greek and Roman arts. It also encompasses the period from the late Middle Ages to the seventeenth century (a.k.a. the Renaissance), in addition to the Neoclassical era between 1770-1830 CE.

What makes Classicism distinctive is its long-term prevalence and its consideration as one of the most inherent and treasured schools in the history of art. Classicism represented dignity, prestige, and a high respect for values and standards, which drove many monarchs in different countries around the world and throughout history to employ it as their official architectural style. For instance, it was adopted by Napoleon during his rule of France, Stalin in the former Soviet Union, Hitler in Germany, and Mussolini in Italy. Then again in the second half of the twentieth century and under the name of ‘Postmodern Architecture’ – driven by nostalgia for the originality of the past – classical architecture re-emerged through many of its terms and elements.

This research explores the standards of “Classical Architecture Criticism” and their role in preserving the Classical period for a long time. Moreover, it highlights the reasons behind people’s attachment and nostalgia to this form of architecture. The article also examines the reasons that lie behind considering some classical buildings as memorable architectural icons. It is hypothesized that the design criteria during the Classical period were clear and specific. On one hand, it considered the laws of the universe and creation by

imitating the proportions in nature and humankind. On the other hand, it reflected concepts and ideas of the hosting cultures and nations. These criteria were set and defined by philosophers, who were the prominent reference for people at that time as they provided insights, ideas, and explanations on all aspects of life. Artists, including architects, used to design while abiding by specific rules and regulations and avoiding any personal inclinations or whims. Moreover, their works of art were subject to criticism which was strongly characterized for being always present and effective throughout the Classical period. This controlled architectural production and often amended its course. As such, the research will trace design criteria in various eras where classical art was prevalent to understand the logic behind them and their basis of origin.

It is worth mentioning that the movement of criticism in classic architecture was highly associated with “beauty.” Criticism was an intellectual process that primarily examined the aspects of beauty in the works of art, including architecture. Hence, the criteria of classical art criticism were not different from those of beauty. Since evaluating beauty was generally based on mathematical concepts and philosophical theories produced by classical philosophical schools throughout ages, aesthetic judgments were applied to architectural works based on these concepts and theories. Thus, we will successively review the most significant ideas and theories of classical art, focusing on the process of interpreting beauty and defining its criticism criteria.

2 Beauty and Mathematics

“Without mathematics there is no art.” Luca Pacioli (1509)^[1]

Historically, architecture has been part of mathematical interests. The most prominent architects of antiquity were at the same time mathematicians and vice versa. The most distinctive historical buildings (pyramids, temples, churches, ...) were designed by mathematicians^[2]. Pythagoras is considered the first mathematician to have had a major influence on architecture. He considered beauty to be related to order, so he established an aesthetic theory based on proportion and symmetry. Symmetry here is derived from the Latin word *symmetria*, which means the repetition of shapes and proportions in a building from the smallest part to the entire structure^[3]. In other words, the parts of the building must be in

their proper position and linked in clear, harmonious, and proportional relationships with each other. Plato, and later Aristotle, were influenced by the ideas of Pythagoras, as they considered that harmonious proportions, which are often based on mathematical equations, are an indication of beauty.

To achieve proportion, many mathematical principles had been set; perhaps the most famous ones which were related to architecture are: The Golden ratio and the Fibonacci Sequence.

2.1 The Golden Ratio

The first man, with his innate sense, recognized the beauty around him and felt a great comfort and pleasure contemplating the beauty of the universe. He began to sense beauty without knowing its secret. Accordingly, he searched and researched beauty through mathematics and philosophy until he discovered its secrets. Perhaps the most important of these is proportion, which is considered one of the greatest beauty secrets. The Greek scientist Euclid, who was born in the year 300 BC, was the first to develop a recorded and documented mathematical equation to understand and explain the proportions of beauty in nature, which he called “Extreme and Mean Ratio.”

It is very important to clarify that this ratio was not set by Euclid, but rather was always present in the entire universe in humans, animals, plants, and different aspects of nature. It was even adopted by ancient civilizations, including the Pharaonic ones, to build the pyramids. Recent studies have shown that The Great Pyramid of Khufu was built according to the golden ratio (Figure 1)^[4]. So basically, discovering the equation that produces this ratio was what Euclid did.



Figure 1. The Great Pyramid of Khufu^[48]

The first Greek scientist who spoke about

what was later known as the golden ratio was the mathematician Pythagoras (570-495 BC), whose study of the standards of beauty and the proportions in the natural world led to what is known as the “Golden Rectangle,” which was adopted in Ancient Greek architecture. One famous example is the Parthenon – Acropolis of Athens (Figure 2).

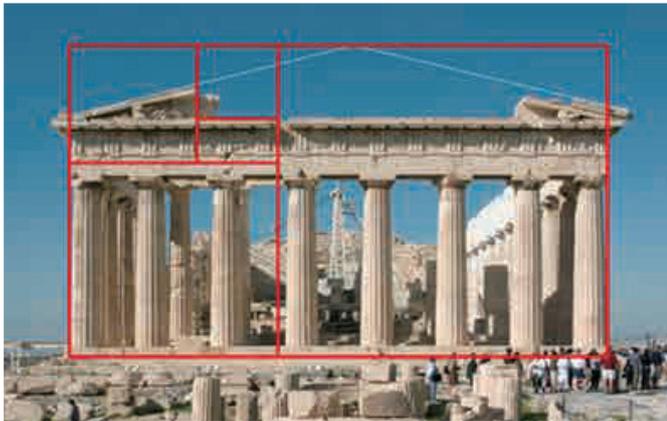


Figure 2. The Pantheon and the golden rectangle [49]

Pythagoras also talked about other geometric shapes associated with golden ratio including the regular pentagon (a five-sided geometric shape contained in a circle and its sides and angles are all equal) (Figure 3), the pentagram (which was the Pythagoreans’ symbol, and later for the philosophers of the Middle Ages and the Renaissance) (Figure 4), and the regular ten-sided polygon [5].

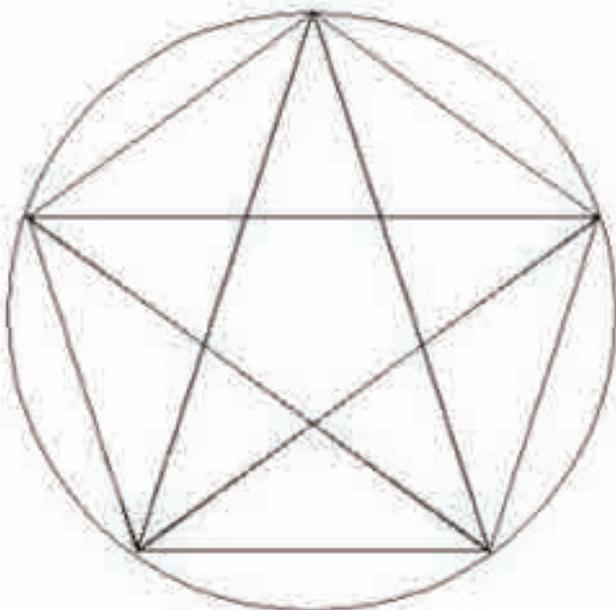


Figure 3. The regular pentagon [50]

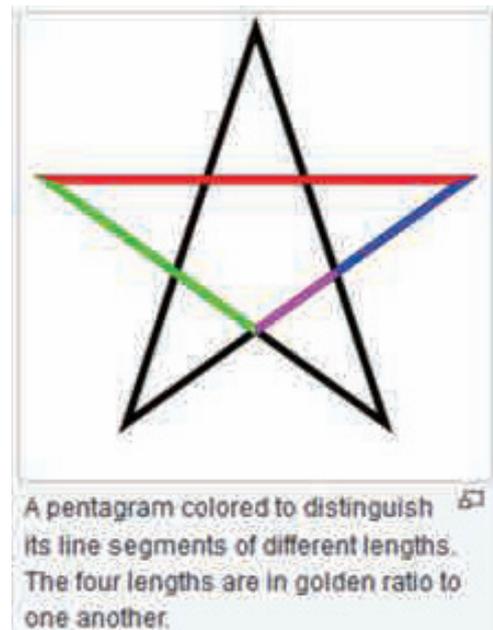


Figure 4. The pentagram [51]

In his book “Timaeus”, written around 350 B.C., Plato (427-347 BC) had described the regular solids which were later known as Platonic solids (the Cube Dodecahedron, Icosahedron, Regular Octahedron, and Regular Pyramid Tetrahedron) (Figure 5). Later, research showed that these solids are related to the golden ratio (Figure 6) [6].

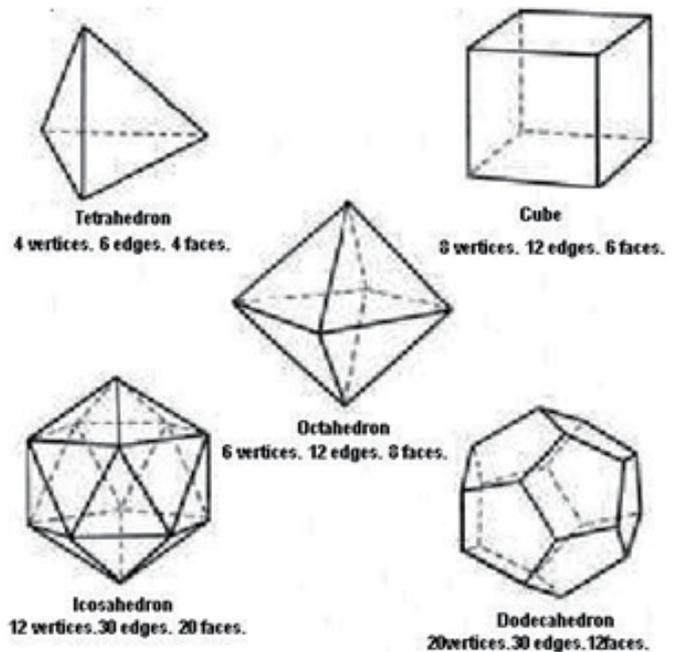


Figure 5. The Platonic solids [52]

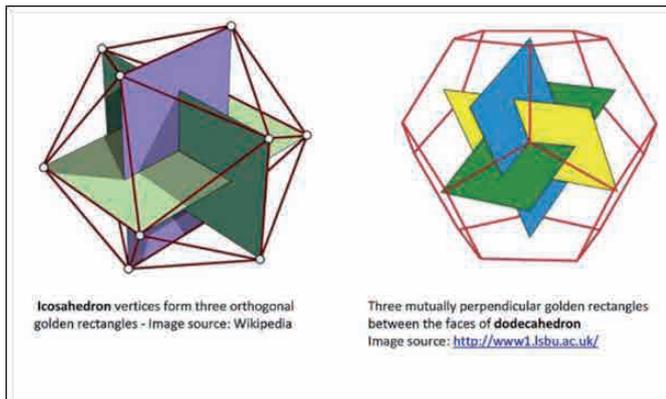


Figure 6. Platonic solids and the golden ratio^[53]

The first documented definition of what is known today as the “golden ratio” belongs to Euclid (325-265 BC), in his famous book "Elements", where he said: “The line AB is divided by the point C according to ‘extreme and mean ratio’ when the ratio of AB over AC (the greater part of the line) equals the ratio of AC over CB (the smaller section of the line) (Figure 7) [7].”

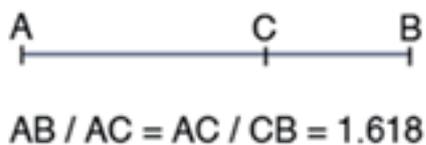


Figure 7. The Golden Ratio

The Greeks found that this ratio is visually soothing, as it achieves a distinct balance and special charm, and it generates spiritual joy, psychological comfort, and automatic attraction to the work of art, so they applied it in their architecture. The application of this ratio had not been confined to merely straight lines, but expanded to include many other forms mainly in two-dimensional shapes (the golden rectangle and the golden triangle) as well as in the three-dimensional shapes (the regular pyramid, pentagram, ...).

With time, this ratio preserved its charm and attractiveness. The Romans had taken it from the Greeks (Figure 8), and Vitruvius in his treatise “De Architectura” (27 BC) provided detailed explanations of it. Muslims who were introduced to this ratio used it in their architecture as well. One of the most impressive examples is the Great Mosque of Kairouan in Tunis, and the Taj Mahal in India (Figures 9 and 10). It also came back and appeared strongly in the thirteenth century following the discovery of the Fibonacci sequence.



Figure 8. Proportions of its major elements are clearly those of the golden rectangle, favored by Roman architects^[54]



Figure 9. The Great Mosque of Kairouan in Tunis^[55]

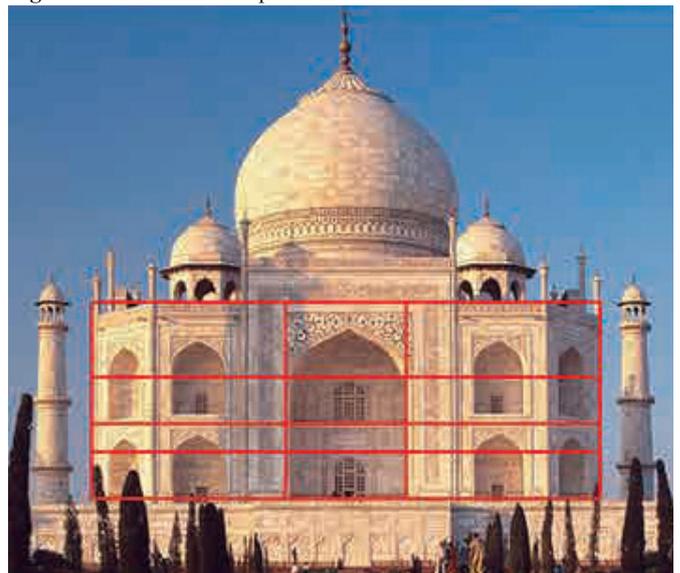


Figure 10. The Taj Mahal in India^[56]

2.2 The Golden Ratio and the Fibonacci Sequence

As awareness to surroundings increased, humans began to realize that beauty in nature is not random, but rather follows well-studied and balanced systems and rules. The Italian mathematician Leonardo of Pisa, known as Fibonacci, who lived in the thirteenth century (1170-1250 AD), discussed in his book “Liber Abaci” (1202) a numerical sequence he observed while studying the breeding of rabbits. This was later named “the Fibonacci sequence” by the French scientist Edward Lux (1842-1891). Nevertheless, this sequence was previously known by ancient Indians as they applied it to the science of weights of poetry ^[8]. This sequence begins with zero, then one, and ascending numbers whose value is a result of the sum of the two previous numbers. To illustrate: one plus one equals two, two plus one equals three, three plus two equals five, five plus three equals eight, and so on to infinity (example: 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144...) ^[9].

Johannes Kepler (1571-1630), a mathematician, noticed later that one of the advantages of this sequence is that if you divide any number by the number before it, you gradually get closer to the ‘extreme and mean ratio’ described by Euclid (specifically, starting from verse 5), since this sequence is practically an application of Euclid's equation ^[10]. In other words, the Euclid equation, can be applied to any two consecutive numbers “a” and “b” from the Fibonacci sequence with “a” being the largest number. He explained this in a letter he wrote in 1608 indicating an approximate value for the golden ratio of 1.6180340.

$$(a+b)/a = a/b = 1.6180340$$

Later studies showed that this sequence is largely present in nature. For example, in the botanical world, the number of petals in a flower corresponds to the numbers of Fibonacci (1, 3, 5, 8, or 34). Also, if we look at the bottom of the pinecone, we often see lines that have spirals with two directions. If we count the first direction, we see that its value corresponds to one of the Fibonacci numbers (for example: 13), but if we count in the other direction, we find the Fibonacci number being so close to the previous in

the series (for example: 8) (Figure 11). The same applies to the seeds in the sunflower, as we find two sets of spiral lines arranged in two directions. If we count these lines, we will find that its value clockwise is 34 and in the opposite direction, it is 21. These are also Fibonacci numbers (Figure 12) ^[11].

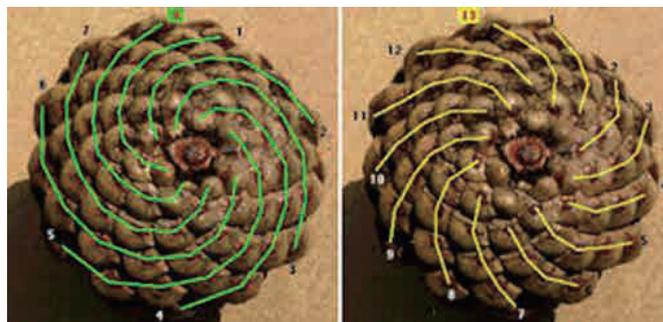


Figure 11. The pinecone spirals as a natural illustration of the Fibonacci sequence: clockwise=8; counterclockwise=13 ^[57]

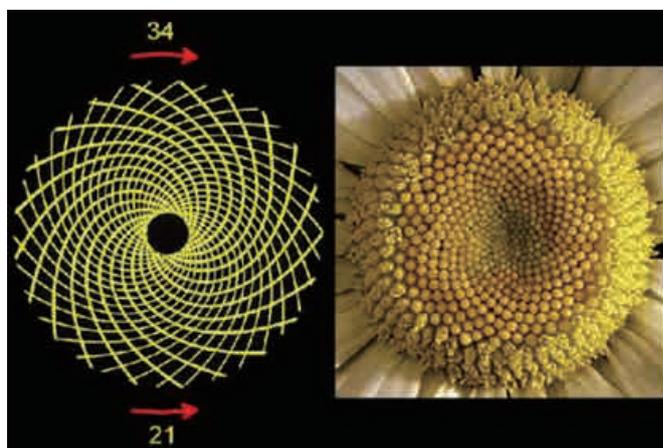


Figure 12. The spirals in the sunflower follow the Fibonacci sequence. clockwise=34; counterclockwise=21 ^[58]

Starting from this point, scientists tried –through the link between the golden ratio and the Fibonacci sequence – to explain the rules of beauty in the universe and then determine the proportions that produce beauty. This led to the Fibonacci rectangle, which consists of adjacent squares where the sides are successive numbers from the Fibonacci sequence, and the Fibonacci spiral, which is created by tracing arcs that connect the corners of squares in a Fibonacci rectangle ^[12] (Figure 13). This spiral is found in many aspects of nature, such as the spiral shape of shells, the bends of sea waves, and some shapes of galaxies... etc. (Figure 14).

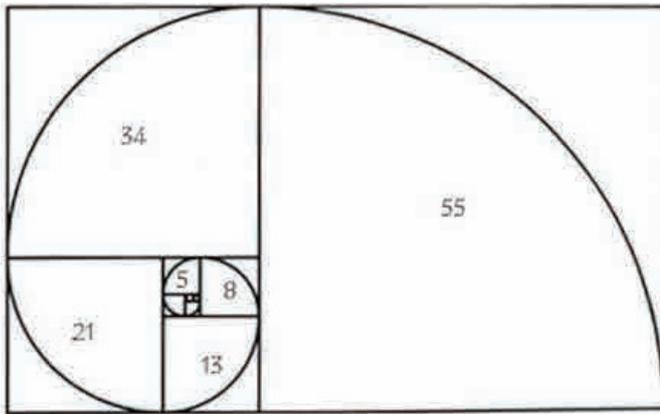


Figure 13. Fibonacci spiral inscribed in a Fibonacci rectangle^[59]



Figure 14. The golden spiral in nature.^[60]

In the sixteenth century, the Italian mathematician Luca Pacioli (1445-1517), known as the “monk drunk on beauty,” delved into the study of ‘extreme and mean ratio,’ where he called it ‘The Divine Ratio’ in his published book in 1509^[1]. The pictures of this book were drawn by Leonardo da Vinci, who, like him, was a researcher of beauty and fond of this proportion (Figure 15). Da Vinci used the extreme and mean ratio in many of his works, as did other artists such as Angelo, Rembrandt, Raphael, Georges Seurat and others. Furthermore, this ratio prevailed during the Renaissance, especially in the works of Palladio (1508-1580) (Figure 16), as this ratio was essential for creating balance and beauty in the artistic and architectural works of that time.

In 1835, Martin Ohm launched the term ‘Golden Ratio’ for what was known as the divine ratio or proportion. At the beginning of the twentieth century, specifically in 1900, Mark Barr suggested that the golden ratio be symbolized by the Greek letter “phi.” It was also named in honor of the Greek architect and sculptor Phidias (480 BC, - 430 BC) who often used this ratio in most of his works, especially in the

design of the Parthenon sculptures^[13]. From that time on, the common definition of the golden ratio became a visual representation of the symbol Phi (ϕ), whose value is approximately 1.618.

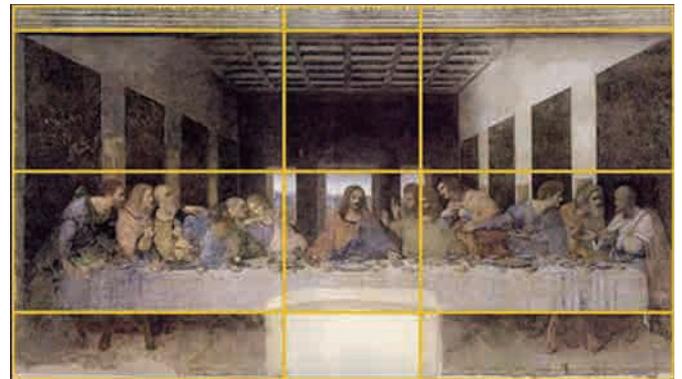


Figure 15. The use of golden sections in the Last Supper painting of Leonardo da Vinci^[61]



Figure 16. Villa La Rotanda designed by Andrea Palladio^[62]

Since then, the use of the golden ratio expanded. So in addition to the golden rectangle (the ratio of its length to its width equals the golden number Phi 1.618), there is the golden triangle (which is an equilateral triangle and the ratio of the length of the large side to the small side i.e. the base side equals the golden number Phi 1.618) and the golden pyramid (a pyramid that has a square base and can be defined by its right-angled triangle in the middle) (Figure 17), in addition to many golden geometric shapes that can be formed through the use of golden section ratios such as the circles, ellipses, pentagrams, and spirals^[14].

The golden ratio, which is simply 1 to 1.618, can also be adopted in all design fields (Figure 18). In architecture, for example, it can be used in the design of windows and doors, especially in the portico, in dividing the facades, or in determining the width or length of decorative elements. It can also be adopted when the design is composed of several elements of

the same type, for example, a group of rectangles of different size and area. In this case, to achieve the golden ratio, it is sufficient that the ratios of the dimensions of these rectangles are equal to the golden number i.e. 1.618. The same goes for triangles, circles, and squares.

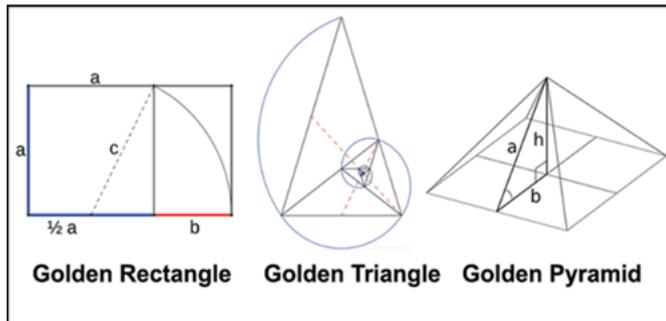


Figure 17. Use of the golden ratio in the golden rectangle, the golden triangle, and the golden pyramid^[63]

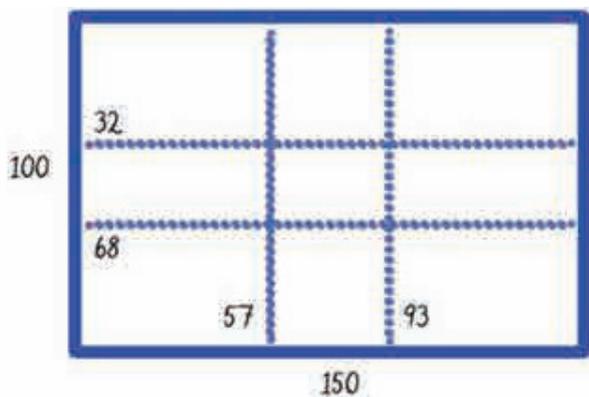


Figure 18. The golden ratio is 1 to 1.618

Throughout ages, the golden ratio has preserved its charm and attractiveness and has been the subject of research and exploration by many biologists and anatomists who have shown that the human body is governed by the golden ratio (Figure 19).

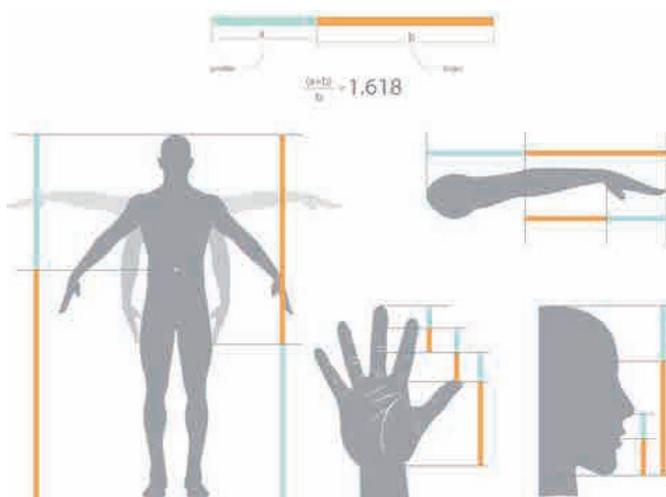


Figure 19. Implementation of the golden ratio on human anatomy^[64]

It has also preserved its presence in many important and timeless classical architectural works in addition to modern works. The architects Le Corbusier and Mario Botta were famous for adopting this ratio in many of their buildings (Figures 20 and 21).

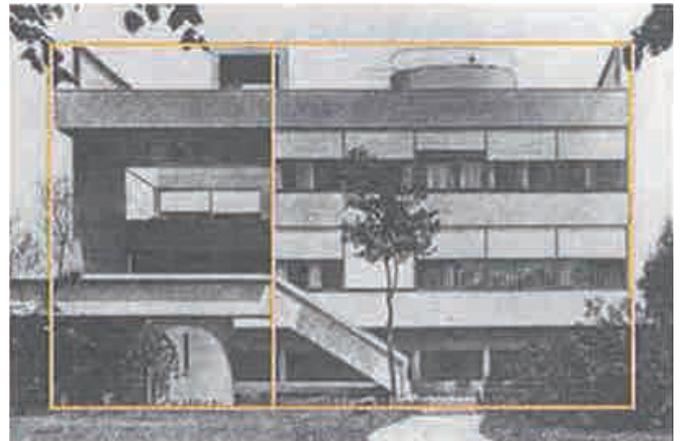


Figure 20. The golden ratio in the villa Garche designed by Le Corbusier.^[65]



Figure 21. Mario Botta's house in Origgio^[66].

To this day, this ratio is still used in many contemporary architectural designs, most notably the United Nations Building. The ratio of the building's width to height for every ten floors is equal to the golden ratio (Figures 22 and 23). In addition, this ratio was adopted in sculptures, paintings, photography (it should be noted that the most important photographic techniques adopted by professionals are the use of The Phi Grid and the Fibonacci Spiral), graphic design, and various types of designs.

In short, it can be said that the golden ratio can be applied and used in all areas of design, as many important companies and commercial and industrial establishments in our world today adopt the golden ratio in designing their logos and advertisements^[15] (Figure 24). We believe that the golden ratio constituted the highest standards of beauty for classical art due to

the proportion and balance it achieves, which are the basis of classic design. Thus, the golden ratio and the Fibonacci sequence are among the basic principles that have contributed to directing and evaluating classic architectural works since ancient times and up to this day.

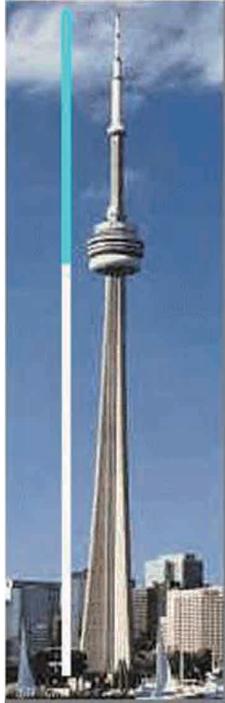


Figure 22. CN Tower in Toronto.^[67]



Figure 23. The golden ratio in the UN Building.^[68]

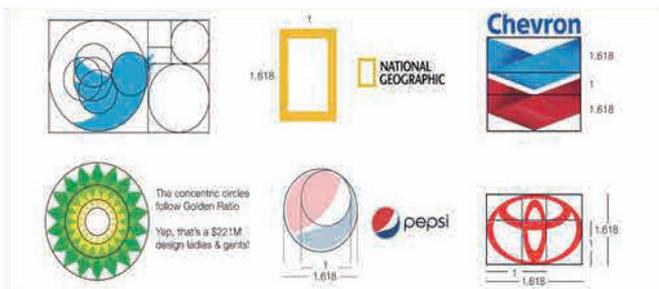


Figure 24. The golden ratio in logos and advertisements.^[69]

3 Beauty and Philosophy

We mentioned previously that perceiving and enjoying beauty is an innate experience for humans. However, thinking about it philosophically by analyzing and explaining its manifestations and defining its criteria came into existence with ancient Greek philosophy.

Firstly, it is worth noting that philosophy in the ancient times - especially in the classical period - was considered the mother of all sciences. Philosophical ideas and theories used to reflect the people's culture and social events. Therefore, the perception of beauty changed as human thought developed and life progressed through discoveries and complexity. For this reason, we will trace the perception of beauty and define its standards in parallel with the historical development of civilizations and peoples.

Philosophers did not come to a common agreement about the essence of beauty, specifically about what is beautiful and the conditions that must be met in things in order to consider them beautiful, and whether it is necessary for the beautiful to be useful or good. As such, we will later review the most significant theories of classical philosophers related to beauty, and the criteria that they set to achieve successful works of art and architecture.

3.1 The Standards of Beauty of Greek Philosophy

Socrates (469-399 BC) linked beauty to utility. Beautiful is what brings benefit, advantage, or a higher moral purpose (Matar, 1962). For Socrates, "what is useful for a specific purpose is to be used beautifully for this purpose^[16]." In other words, things are beautiful when they are designed in a way that makes them function better. For example, the protruding eye is more beautiful than the normal eye because exophthalmos increases the widening of the field of vision. Also, the snub nose is more beautiful than a straight nose because it does not obstruct the angle of vision.^[17] For Socrates, whether it is fine arts or industrial arts, it must be devoted to the service of man and directed to the values of goodness, wisdom, and virtue. It is worth noting that the benefit for Socrates is not limited to the material and tangible benefit only, as the psychological pleasure resulting from a sense of beauty is included in the benefit and advantage as well^[18].

As for Plato (427-347 BC), a disciple of Socrates, he considered that the universe consists of two

worlds: the realm of ideals, or spiritual realm, which includes the values of goodness, truth, and beauty, and the physical realm, which comprises evils and sins. Beauty, according to the theory of Utopia, is something divine with an absolute meaning found in the essence of things. It is synonymous with good and beneficial (the good is beautiful). Real or absolute beauty does not exist on earth, but only happens in the world of ideals, and what on earth (the sensible world or the material world) is nothing but an imperfect imitation of true or ideal beauty. Plato says, "The contemplation of beauty causes the soul to grow wings, so it flies high towards the spiritual world where it used to live before it fell down to earth and to which it always yearns to return"^[19]. Plato considers that earthly beauty is a light shade of absolute beauty that exists in the ideal world, and that man had previously experienced it before this earthly life. So, when a person sees beauty on earth, he remembers the mystery of absolute beauty and feels a sense of pleasure and comfort that he previously felt there^[18]. In his opinion, this is the secret of beauty and the secret of the pleasure it creates.

Based on the above, beauty in the arts – including architecture – is achieved for Plato through the imitation of nature (which means a literal imitation without any additions), that is basically an imperfect imitation because it is in turn an imitation of the ideal world. The type of imitation has been defined as an enlightened imitation that includes knowledge and awareness of the origin that it imitates and is linked only to the values of goodness, truth, and beauty, and avoids evil and material desires. Hence, art, according to Plato, is a "copy of a copy", an imitation of the sensible realm, which is in turn an imitation of the ideal world, and this puts art in the third place, for it moves away from the sublime truth by two levels; so to speak, it is the shadow of shadow^[20]. This explains his critical campaign against artists and the reason for expelling them from the republic, maintaining only certain types of poetry for educational purposes^[21].

In addition to linking beauty with moral values such as truth, goodness, and justice, Plato emphasized that beauty exists within a specific order and proportions and in everything that is subject to number and measurement. Therefore, in his opinion, it is important to respect ideal geometric proportions and measures, as similar to Socrates, he opposed the principle of aesthetic pleasure, which is the type

of art that is based on a mere feeling of pleasure or subconscious emotion.

Aristotle (384-322 BC) emphasized the theory of art imitating nature through his 'Theory of Imitation' and connected art to virtuous values. However, unlike Plato, he rejected the separation between the ideal world and the sensible world, and considered that perfect beauty exists in the real or sensible world and not only in the world of higher ideals. He also stressed the importance of art, as it combines the beauty of nature and human effort. Therefore, imitation for him does not mean a literal imitation of nature, but rather an imitation of the essence of truth or an imitation of conformity and form in nature^[22]. Thus, according to Aristotle, imitation is more complete than nature, since art completes what nature does not with the support of the artist's thought.

Aristotle defined the standards of beauty to be order, proportion, and definiteness. For him, things look beautiful when their parts are symmetric or arranged according to a specific order, and when they have an appropriate non-arbitrary size because the extra size leads to confusion in the mind of the recipient. Beauty, according to Aristotle, is only achieved through specific proportion and order. As such, we say that the artistic production in ancient Greece was based mainly on the "Theory of Imitation." The proportions adopted in architecture are an imitation of proportions found in nature. The ancient Greek architects had innately realized this matter, so the Greek architectural orders are closely related to the ideals in the human bodies^[23]. In addition, the symmetry and harmony in ancient classical buildings is simply an imitation of the symmetry of the human body and the harmony of its organs. For example, the Doric imitates the proportions of the body of a warrior, the Corinthian imitates the body of a graceful young girl, and the Ionic fits with the body of a mature woman^[24] (Figure 25).



Figure 25. The Doric, the Corinthian, and the Ionic^[70]

3.2 The Standards of Beauty of Roman Architecture

The best representative of the ancient Roman architectural thought – especially with regard to beauty standards – is Marcus Vitruvius (80-70 BC), who is famous for his book “DE Architectura,” which is considered the oldest written architectural document we received from ancient civilizations. The book includes Vitruvius' theory of architecture in addition to the concepts, principles and proportions that contribute to achieving beautiful architecture.

Vitruvius, like other ancient Greeks, considered that the architectural proportions were inspired by the proportions of the ideal human body. Accordingly, Vitruvius determined the ideal measurements for the human body and the proportions that connect its various organs. In addition, Vitruvius discovered that the ideal human figure could be located within a circle and a square at the same time, so that their center corresponds to the position of the navel and the tips of the fingers of the hands and the feet, touches the perimeter of the circle and the corners of the square. Leonardo da Vinci was impressed by the proportions that Vitruvius set for the human body, and after more than 1400 years, he drew the ideal man described by Vitruvius and he called it “The Vitruvian Man” (Figure 26).

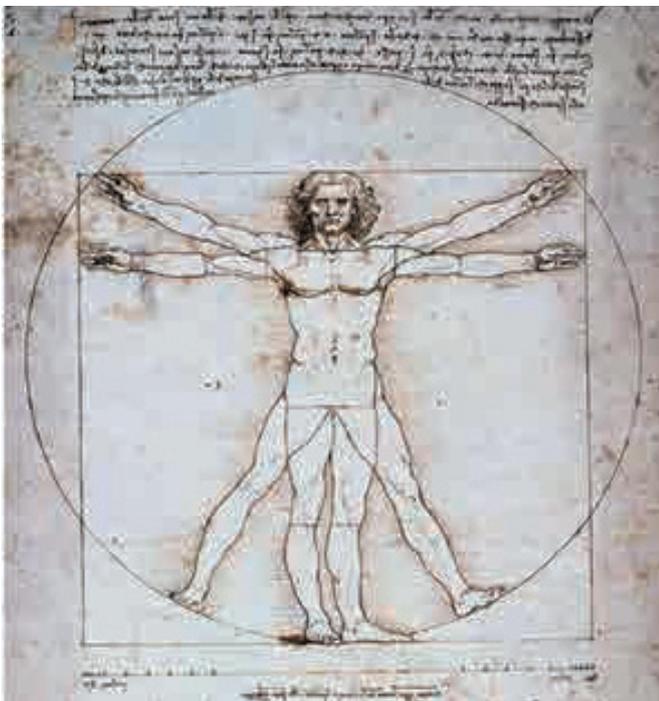


Figure 26. The Vitruvian Man ^[71]

Vitruvius' eternal theory of architecture, which is still adopted and taught today in various academic

institutions, states that good architecture achieves a balance between three principles: utility or function (*utilitas*), firmity (*firmitas*), and beauty (*venustas*).

As for the architectural beauty, in his opinion, it is achieved through arranging the various elements of the architectural work in an orderly, harmonious and proportional manner with each other on the one hand, and with the surrounding on the other hand. This results in achieving balance, integration, combination, and rhythm, leading in the end to attain complete beauty. Furthermore, Vitruvius stresses on the ethical dimension of architecture and the importance of having well-knowledgeable architects in the field of philosophy, by saying: “As for philosophy, it makes an architect high-minded and not self-assuming, but rather renders him courteous, just, and honest without avariciousness. This is very important, for no work can be rightly done without honesty and incorruptibility” (Vitruvius, 1914).

3.3 Beauty in the Medieval Ages

Arts in the Middle Ages – including architecture – reflected the religious values of the Christian faith through their symbolism and idealism. The prevailing beauty standards, which were an extension of Greek and Roman thought, had been altered to become more sublime and harmonious with Christian theology and the teachings of the Church. New artistic forms have emerged that are more compatible with the common taste that seeks tranquility and a spiritual reverence.

Art criticism – including art of architecture – in the Middle Ages, which spanned from the end of Roman civilization to the fourteenth century, was influenced by the theory of goodness and beauty, which considered that the best types of art are in the good and beautiful works. Most of the artworks of this period, whether in the Romanesque, Gothic, or Byzantine era, depicted religious themes that were painted on huge murals in churches and on the ceilings of cathedrals ^[25]. Art criticism during this period was subject to the opinions and authority of the clergy, so images or drawings that express the pleasures of the worldly life were forbidden, as they contradict the Byzantine Church's call to a life of asceticism, austerity, and worship ^[26].

The most prominent philosophers of the time who dealt with the subject of beauty is Thomas Aquinas, a saint, priest, and Italian theological philosopher who lived between 1225-1274 AD. Thomas Aquinas

defined the beautiful as “that pleasing when seen”^[16]. What is beautiful is pleasing for being an object of contemplation, whether through the senses or within the mind itself^[27]. For Thomas Aquinas, beauty is achieved by three things: wholeness or perfection (things that are imperfect are ugly), proportionality or symmetry, and radiance (beautiful things lie in the brightness of colors)^[18].

Perhaps the most noticeable change in architecture during these times is the emergence of Gothic architecture, which originated in France in the twelfth century and quickly spread to most of Europe. Their use was concentrated in religious buildings, especially cathedrals, with the aim of emphasizing their grandeur and prestige through the elements, shapes and methods of construction which allowed them to be higher, luminous, and stronger. The arch and the pointed arch were used, which were inspired by Roman architecture, but they were innovatively implemented (Figures 27 and 28).



Figure 27. Cathedral Chartres In France.^[72]

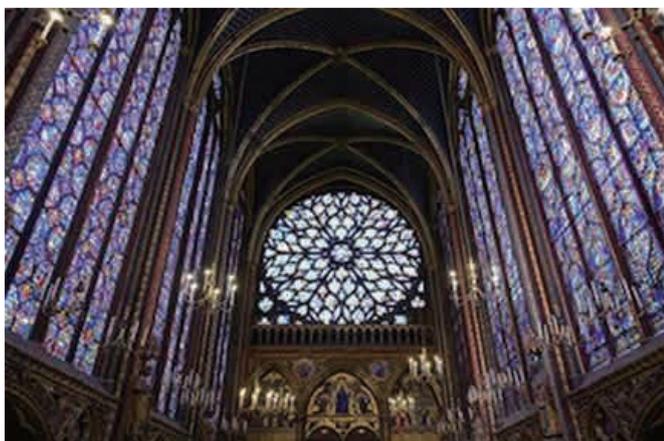


Figure 28. The Roman arch in gothic architecture^[73]

3.4 Principles of Beauty and Criticism in Islam

“Allah is beautiful and He loves beauty” (honorable hadith). Beauty is a value that Islam has called for because of its importance in the transcendence of the human soul. Muslim thinkers and philosophers have worked hard to explain beauty and define its principles. Some of their aesthetic ideas converged with what was mentioned in ancient Greek philosophy, especially the teachings of Plato and Aristotle, while other ideas were different due to their connection with the principles of the Islamic religion. Several Muslim Sufi philosophers dove into understanding beauty and exploring its mysteries and had their theories in this field. We will consecutively review the most important ideas of Muslim philosophers about beauty, which formed the cornerstone for evaluating artworks of all kinds.

The theory of beauty in Islam is mainly related to the idea of belief in Allah and monotheism. The universe and what it holds, the outer and the inner, are all created by Allah, and He created it in its fullest form (“Allah is the Creator of all things” – The Holy Qur’an, Surat Al-Zumar, Verse 62; “Who has made perfect everything He has created” – The Holy Qur’an, Surah Al-Sajdah, Verse 7). The universe, in all its parts and the different worlds in it, follows a system based on accurate proportion and precise connections (“He has created everything, and has ordained for it its proper measure” – The Holy Qur’an, Surat Al-Furqan, Verse 2). So, a defect in one part affects the rest of the parts. Hence, beauty according to Islam results from proportion, harmony, and synchronization. In short, we can say that the standards of beauty in Islam are the same on which the universe was created.

3.4.1 Beauty and Perfection

According to Abu Hamid Al-Ghazali, the Islamic philosopher (1058-1111 AD), “The beauty and goodness of everything is to bring its perfectness that is appropriate and possible for it. If all its possible perfection is present, then it is very beautiful, and if some was present, so it has the beauty of what has been found”^[28].

3.4.2 Beauty and Proportionality

Proportionality is the most subtle aspect of beauty^[29]. It means that the component parts of something are related to each other. Mustafa Lutfi Al-Manfalouti

says in his book “Al- Nazarat” (1955), "Beauty is the proportion between parts of complex bodies, whether in tangible or intangible, in fact or in fiction." He adds: “A beautiful face is considered beautiful for the proportion between its parts. Similarly, a beautiful voice is considered beautiful for proportionality among its tunes.”^[30].

3.4.3 Beauty and Morality

Islam views beauty as a basic value that a person aspires to as he does towards truth and goodness. The concept of beauty has been closely associated with morality. Hence, Islam distinguished between physical beauty and spiritual beauty^[28]. Sensual beauty is perceived through the senses, and spiritual beauty is perceived through the mind. For Ibn Sina, there is worldly beauty, which is the lowest, and divine beauty, which is the highest and a reflection of God and truth and linked to spiritual concepts associated with enlightenment^[31]. So, beauty is not a physical quality present in things, it is more than that, and the word “beautiful” and “beauty” has been mentioned in the Qur’an in eight verses. In only one place did God speak of physical beauty, and in the remaining seven places it was of moral or ethical beauty. For example, patience, which is considered one of the greatest qualities of the human soul is beautiful. Sincere forgiveness for the sake of God Almighty and the subsequent emotional release, which is far from selfishness and self-love is also beautiful.

3.4.4 Beauty and Utility

Beauty is related to perfection, and perfection means that a thing performs its purpose perfectly. Therefore, the beauty of things according to Islam is closely related to their functions as they achieve utility. Hence, beauty is inseparable from utility. God Almighty says in the Qur’an: “and cattle too he has created; you find in them warmth and other uses and some of them you eat. And in them there is beauty when you bring them home in the evening, and when you drive them forth to pasture in the morning. And they carry your loads to a land which you could not reach except with great hardship to yourselves. Surely. Your Lord is Compassionate, Merciful” – The Holy Qur’an, Surat An-Nahl, Verse 5. We notice that beauty is located among the four identified utilities of cattle, and this proves that it is neither a precursor nor

a consequence of a benefit, but rather an accomplice of it. This is also consistent with the terms of purpose and wisdom for which these cattle were made^[32]. We also note in this verse that the benefit is not limited to material benefit only but can be moral to please the soul or as a manifestation of the splendor of creation and the grandeur of the Creator.

3.4.5 The Limited Imitation of Nature

Beauty is one of the divine attributes, such as mercy and kindness. These qualities are manifested in nature as a reflection of the divine beauty in the earthly world^[33]. So, the attainment of beauty can only be achieved through imitating nature, which is a manifestation of divine or absolute beauty. Therefore, Muslims resorted to nature for inspiration and imitation. However, the imitation differed from that of the ancient Greeks. Islam rejected direct imitation without self-intervention^[34]. Since Islam prohibits the depiction of things that have soul, artistic works in Islam were restricted to imitating the inanimate nature, and they relied on abstraction and geometric shapes to express their ideas and beliefs. They also knew the golden ratio and applied it in many of their architectural and artistic works.

3.4.6 Aesthetic Judgment or Criticism According to Islamic Theory

Beauty, according to Muslim philosophers, is an attribute that is noticeable in things and brings pleasure and satisfaction to the soul. Accordingly, the aesthetic judgment or criticism is objective and subjective at the same time. It is objective according to the basic qualities available in the subject of criticism, such as moderation (Al-Jahiz 776-869 A.D.), the proportion between the parts (Abu Hayyan al-Tawhidi 922-1023 A.D.), and harmony and regularity (Ibn Rushd 1126-1198 AD) [34]. It is also subjective according to the psyche (the emotional side) or the reference of the recipient (custom and traditions)^[35].

For Sufism, the arts are an expression of the beauty of creation and the grandeur of the Creator. Beauty for them in particular, and in Islam in general, is characterized by centrality and unity. Allah is the center of the universe in Sufism and represents absolute beauty. For Sufism, beauty ranges from the beauty of particles in the universe to the absolute beauty represented by God Almighty, and there

are those who see absolute beauty first, and then the beauty of particles^[36]. In other words, there is a holistic perception of beauty that transcends the physical particles; looking at the beauty of these particles is considered a starting point to the realization of absolute beauty^[29]. This concept was reflected in works of art, including architecture, where we used to find many elements that represent this thought. Perhaps the Sulaymaniyah Mosque is a prominent example.

The researcher "Othman Nuri Tobash"^[37] analyzes the architectural characteristics of the Sulaymaniyah Mosque within the framework of Sufi concepts and says: "...and the mosque progresses in height, starting from its floor and finally reaching the central dome, which symbolizes the divine unity "Oneness", while the semi-circular and small domes are in harmony with the central dome showing the secret of one of the origins of Sufism, which is: "In unity there is abundance, and in abundance there is unity." In fact, the Sulaymaniyah Mosque embodies the concept of spirituality beautifully, as it symbolizes the transition from the many branches to the divine "unity", and then the return from that unity to the (many) branches (Figures 29 and 30).



Figure 29. The Sulaymaniyah Mosque^[74]



Figure 30. Sidi Abo El Abbas El Morsi Mosque^[75]

In addition to mosques, Sufis had many different religious buildings that they used to teach and spread their teachings in as well as practicing their religious rituals according to the Sufi approach, such as "Al Zawaya", "ATakaya", and "Arribatat." These buildings, regardless of their size, reflected the spiritual values of Sufism such as simplicity, modesty, self-denial, and a sense of mortality^[37].

"Allah is beautiful and majestic" (Ibn Arabi)^[38]. Beauty for Sufism is associated with majesty. In addition to the comfort and joy that beauty brings to the soul, a feeling of majesty is generated at the same time, that is, a feeling of dread for sensing the grandeur of creation. According to Ibn Arabi, beauty generates comfort and joy, but it requires a feeling of dread so that we avoid mischief that will cause us to be disrespectful to God Almighty. Majesty causes fear, but it requires comfort and joy so that we do not despair of God's mercy^[38].

Beauty and knowledge for Sufism are in a debatable relationship. Perception of beauty comes first, and then its sensation. This knowledge is innate, and then comes the deeper mental knowledge after beauty is sensed. That is why it was said, "He who tasted, has known."

In short, we say that the Islamic vision of beauty is complementary, whereby there is no beauty without benefit or good, nor beauty for the outer without the inner, and the awareness or perception of beauty reflects the sublimity of the soul as a result of the great faith in God , the Creator of all beauty^[39].

3.5 Beauty in the Renaissance

Classicism reappeared in the Renaissance, the period from the early fourteenth century to the early sixteenth century, after its absence throughout the medieval period during which artistic styles that glorified the Christian religion and reflected its own spiritual values prevailed. In the Renaissance, an architectural style appeared, known as "Renaissance architecture". Renaissance architecture, which first appeared in France and then spread throughout Europe to replace the Gothic style that prevailed in the Middle Ages, was considered a revival of Greek and classical Roman art, where designs and architectural elements were inspired by them.

The arts, including architecture in the Renaissance, were mainly dependent on the principle of imitating nature and on the beauty standards inspired by it

(proportionality, balance, perfect symmetry, harmony, clarity, order, and respect for human proportions). To apply the principle of imitation, interest in arithmetic and mathematical engineering increased. Studies have delved into the subject of aesthetic proportions, especially the golden ratio and its applications in various fields. The designs were more sophisticated and innovative than they were in both ancient Greek and Roman architectures, and many books were written on architectural theorizing. The most prominent architects of this period, whose influence remained for a long time later, were: the Italian architects Leon Battista Alberti (1402-1472) and Andrea Palladio (1508-1580).

Alberti is considered to be one of the main architects who contributed to the development of Renaissance architecture in Florence. He contributed important architectural works, such as two of the most famous buildings of the fifteenth century: the façade of the Church of Santa Maria Novella and the Palace of Rossellae (Figures 31 and 32). Yet, he is best known for his book “The Ten Books on Architecture,” which is the most important architectural treatise written on the rules and the basis of architecture during the Renaissance.

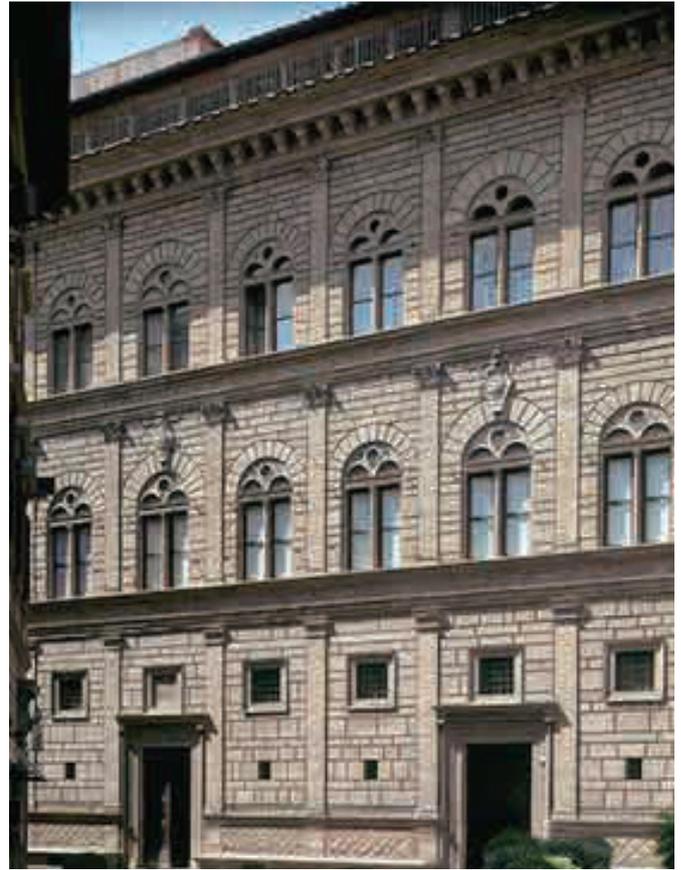


Figure 32. The Palace of Rossellae^[77]

As for Palladio, he was well-known as the most influential architect and theorist in art history. He developed a new architectural approach in design (inspired by Roman architecture), which was later named after him; the architectural style that dominated the last stage of the Renaissance was known as Palladian architecture. Palladian later became a well-established style of architecture whose influence continues today (Palladian Arch, Palladian Motif, Palladian Window...). Palladio's architecture was characterized by the strength of expression and the revival of classical forms, especially Roman, and the adoption of symmetry, proportion, and clarity. Even though his façades seem simple or austere, they have a strong expression; he used ancient Roman pillars and details, but with a stronger expression. Palladio was well-known for using the golden ratio in most of his works especially his famous Villa La Rotonda (Figure 33). He left several books on architecture, the most important of which is: “The



Figure 31. Church of Santa Maria Novella^[76]

Four Books on Architecture,” which was published in 1570 AD.



Figure 33. Villa Foscari, also called La Malcontenta.^[78]

This era witnessed the beginnings of art liberation from the ideals and moral values. The French philosopher Descartes (1596-1650) played a great role in this transition. Descartes rejected the ideas of Plato’s ideal beauty and Aristotle’s imitation, and considered that perception occurs through the mind, and only through it we can explore the beauty of things by analyzing their materials and shapes and their relationship with each other. Thus, beauty became associated with the ability of the self to appreciate aesthetic judgment.

3.6 Beauty in the Enlightenment Era (Eighteenth Century) and the First Half of the Nineteenth Century

The eighteenth century is considered the era of rationality where the mind was considered the main reference for obtaining knowledge. Art was completely free from religious commandments, and new concepts such as creativity and innovation began to appear. Before this era, the concept of creativity was rejected by the fact that it is considered a “creation,” and creation belongs only to God.

During the eighteenth century also, the evaluation of artistic work became the responsibility of artistic academies, and the name of art judges was transformed into art critics, and aesthetic judgments were issued based on a number of criteria that remained to some extent influenced by the concepts of beauty of Greek philosophy, which are based on the concepts of harmony and compatibility in the imitation of nature.

In the second half of this century, “aesthetics” was founded by the German philosopher Alexander

Baumgarten (1714-1762 AD). Aesthetics is the thought that investigates the essence of beauty, and its name was inspired by the Greek word “aisthetos”, meaning “feeling.” Thus, Baumgarten defined aesthetics within the framework of science that searches in sensory or emotional perception and restricted the field of aesthetics to physical beauty, that is, what is perceived only by sense. He excluded the spiritual beauty represented by values and morals and excluded the beauty of nature. According to Baumgarten, aesthetics is the science that is concerned with the study of sensory knowledge, as opposed to the science of logic, which is concerned with the study of mental knowledge^[40]. Since it is a science, it has laws just as the laws of nature that can be revealed through systematic and experimental investigations.

In general, aesthetics is considered one of the branches of philosophy that deals with the study of the artistic aesthetic phenomena and the associated feelings. It also studies aesthetic judgments and their relationship to taste, artistic creativity, and its conditions, through the philosophical method of analysis and mental reasoning.

The most influential philosopher of the eighteenth century who dealt with the subject of beauty is Immanuel Kant (1724-1804), who is considered one of the most important philosophers of “aesthetics” and one of the most influential in the modern era. His book “The Critique of Judgement” included a new theory about beauty. Kant approached beauty through the ‘judgment of taste.’ For him, beauty is not a rational or moral issue, but rather a matter of personal taste related to what is good for the recipient^[21]. Thus, he would have placed beauty in a special field related only to taste and away from reasoning. Kant’s theory of “taste” subsequently had a great influence, especially for supporters of the art theory, art for the sake of art, who adopted it to defend their perspective on the independence of art from the human or natural world^[16].

In his book ‘The Critique of Judgment’^[41], Kant identified basic characteristics of judgment of taste or aesthetic judgment, the most prominent of which are:

- The judgment of taste is not epistemological, nor is it logical. In other words, it is not done through knowledge nor logical analysis. It is only done through imagination and cognition and is intrinsically linked to the feeling of

pleasure. In short, for Kant everything that pleases without any rational representation, is beautiful.

- The judgment of taste is not related to any purpose or benefit. Feeling pleasure towards a beautiful thing differs from the feeling of satisfaction or joy that good, beneficial, or appropriate things leave us with. The latter is related to a form of human interest, while the beauty or aesthetic enjoyment is not related to any interest. It is a free cognition devoid of any purpose.
- The judgment of taste is a contemplative judgment in the sense that it only comes through meditation, which is the highest level of feeling. We feel pleasure when we see or smell a flower, but we judge it aesthetically through contemplation.
- General and personal taste. Although he considered judgments about beauty to be subjective, Kant asserted the existence of a universal taste or universal validity in addition to personal taste. The personal taste is the aesthetic judgment that the individual makes about the beautiful. Kant calls it the taste of the senses and it is a talent present in every individual. As for general taste, it is a sense of aesthetic taste – shared by everyone with good taste – which Kant called the “common sense.” This sense is of great importance, as it makes aesthetic judgments of general credibility that help explain typical works of art as an interpretation that makes them models to be emulated in every time and place. He also asserts that the beauty is what generates pleasure with no need for a rational reason.

Kant distinguishes between the beautiful and the sublime. Beautiful only produces a feeling of pleasure and satisfaction (e.g. seeing a beautiful flower). As for the sublime, it is associated with a special case in which the feeling of pleasure is mixed with distress or discomfort, such as seeing a stormy sea, or a towering mountain.

For Kant, taste is a talent of judgment only and not of creativity. The artistic aesthetic creativity is achieved through the “free play” of the genius imagination. Genius is an innate mental predisposition (a natural gift)^[16]. In short, for Kant, beautiful art

stems from the self, but it communicates with other human selves beyond the context of time and space since human beings agree on aesthetic matters more than they agree on metaphysical, ethical, and religious issues^[21].

3.7 Beauty in the Nineteenth Century

George Hegel (1770-1831 AD) is considered, according to many, the philosopher of this century and the spiritual father of ‘idealism.’ It should be noted that the word idealism was derived from Plato’s philosophy “ideas” which was influenced by it.

For Hegel, art, religion, and philosophy are the paths of the mind to reach the ‘absolute spirit.’ The absolute spirit is the highest level of consciousness or self-knowledge of Absolute idealism. The content of art, religion, and philosophy is basically the same, but the form of presenting this content is different. In art, the idea unfolds itself in a sensual form. In other words, art is the sensory presence of the spirit, where the idea is liberated from finality. While in religion, the idea identifies itself through imaginative conception. In philosophy, which is according to Hegel the highest stage, the idea is aware of itself through the concept in which the absolute spirit reaches absolute knowledge^[42]. Through what was mentioned, we see that art does not differ from religion or philosophy in terms of content, but rather in terms of form and level of attainability. Art, due to the limitations of its sensual-natured capabilities, is unable to reach the full awareness of the absolute idea or the spirit. Rather, its goal is achieving the absolute sensual embodiment.

For Hegel, the absolute is the soul or the divine element. It represents the content of art. Contrary to what is expected, it is not an abstract moral or idealistic entity, but rather it is related to the various objective relationships of man in this world (social, political, moral and historical ... etc.) in other words, “the absolute” represents the deepest interests of man^[42].

Art, according to Hegel, is the sensual embodiment (form) of an idea (spiritual content). The importance of art is that it reveals the spiritual interior of a person. Accordingly, the more works of art express the spiritual interior, the more they rise in perfection and develop in form^[20]. The more consistency between form and content is made, the more art is elevated, and artistic beauty, which stems from the human soul or soul, is attained^[43]. Hegel linked art

and beauty and considered the latter a prerequisite for any work of art. Hegel says: “No work is artistic unless it is beautiful.” Beauty is a way to reach the soul or the absolute. This spirit is central to Hegel's artistic philosophy. The existence, with all its natural, material and human phenomena, is one aspect of this spirit.

Unlike Plato, Hegel does not require imitation in art but considers that art that imitates nature does not produce genuine works of art, but rather produces crafts. The beauty of art is higher than the beauty of nature because it is the product of the spirit^[43]. The spirit is higher than nature, so this sublimity is transferred to artistic products. In addition, nature lacks freedom, unlike art which is based on freedom^[21].

In his book “Symbolic, Classical, Romantic Art”^[44], Hegel considers that art develops in parallel with the rise of cognitive awareness of absolute truth. Accordingly, he considered that art passed through three basic stages, namely:

- The Symbolic Stage. The symbolic style lasted for a long period of art history, specifically the period of eastern civilizations (Pharaohs, Assyrians, ...). At this stage, the relationship between form and idea (content) is not identical, whereby the external form can dominate the content, or it may surpass the corresponding meaning. For example, the image of “bull” in Assyrian art may mean the animal itself, but it may symbolize a different meaning such as strength or greatness^[45]. Architecture belongs to the symbolic stage, as it is the least to provide the spiritual content. The material used in it is a solid substance devoid of spirit, so the idea is abstract and incompatible with its physical form.
- The Classical Stage. In this stage, form and content coincide harmoniously. For Hegel, this stage is considered the pinnacle of art, where the ideal is achieved. This stage is evident in the period of ancient Greek civilization, and sculpture is the best expression of it^[44].
- The Romantic stage. It is the stage in which the idea transcends itself, liberates from the limited sensory forms in the real world, and realizes itself as an absolute spirit, so it floats in the world of the subconscious deserting the outside and getting confined to itself^[46]. Here the form becomes foreign to the idea, or

even lost in favor of the content. This stage is represented in medieval and modern art. It is most expressed in painting, music, and poetry.

According to Hegel, art ends when the artist dominates it, the content diminishes, and the objectivity disappears. Eventually, civilization reaches a stage in which art dies and gives up the task of presenting the truth where a new stage in the search for its essence begins^[45]. Furthermore, the aesthetic experience is rational with an emphasis on the sensory and contemplative character. Thus, Hegel rejects the importance that some – especially Kant – attribute to emotions in aesthetic judgements. In this context, Hegel says in his book “The Philosophy of Fine Arts” that “the work of art is not intended merely to arouse one emotion or another because in this case it will not be distinguished from other forms of activity such as eloquence, historical writings, and religious preaching.” “A work of art cannot be art unless it is beautiful^[47].” Thus, taste, in his opinion, may not be suitable for establishing a philosophical artistic aesthetic theory, and it cannot be adopted alone in making aesthetic judgment as well. Evaluating a work of art requires knowledge, memory, contemplation, and an active imagination capable of perceiving shapes, analyzing, and making comparisons between them^[16].

This new philosophical atmosphere – especially Kant's – influenced the artistic products in this period. Some artistic movements began to emerge liberated from the strict classical norms, such as Barocco and Rococo, which contributed to a gradual and slow transition from rigor classicism to flexible modernity. The Baroque style was distinguished by its grandeur, curved and twisting shapes, and the use of columns and carvings in a complex manner; the most famous example is the Palace of Versailles (Figure 34).



Figure 34. The Palace of Versailles^[79].

The Rococo, derived from Baroque, was distinguished by its sensual aesthetic style. This style expressed fantasy, romance, and elegance, and was characterized by soft colors, curvy lines, and high ornamentation; the shapes mainly used were asymmetrical shells, plant leaves, flowers, angels, and far Eastern motifs. The Rococo style extended to all types of arts: architecture, interior design, painting, and sculpture, and was distinguished from Baroque by being softer, lighter, and more delicate (Figure 35). It is worth noting that these movements, due to their exaggeration in decoration, did not last long especially after the events and changes that took place at the beginning of the twentieth century in various areas of life. That required a radical change in artistic values and standards, including architectural ones.



Figure 35. The Rococo style^[80]

Thus, the nineteenth century is considered the century of the complete liberation of art from classical values where beauty abandoned imitation of nature, and where the beautiful became the strange, the unfamiliar, and the original. As a result, classicism

comes to an end after its standards and principles had changed, closing a major period in the history of art, and opening the doors to modernism which is based on different rules and standards.

4 Conclusion

Classicism is distinguished from other art schools since it lasted for a very long time. It was also often a reference and a source of inspiration for many rulers and architects because of its proportion, balance, and strong expression despite the simplicity of its forms. Classical art, including architecture, was not spontaneous or freed according to the designer's desires, but it was based on specific rules and regulations (golden ratio, Fibonacci sequence, etc.), as well as on physical and cosmic principles and intellectual thoughts that were linked to the prevailing philosophy at that time.

The exploration of beauty secrets started with philosophy through reflections and ideas of philosophers about what beauty is (Socrates, Plato, Aristotle, ...). These ideas were based on the values of goodness, utility, and morals by mimicking the nature which represented for them the absolute beauty. Man alone is incapable of creating beauty which is a divine aspect. He only imitates beauty that exists in nature through simulation or inspiration.

Classical criticism and its standards of beauty had taken a long path which began with metaphysics at its highest levels with Plato's idealism. Then, with time and with the advancement of science, beauty started to liberate from all values to become a value in itself. Thus, aesthetics moved to the critical stage that was influenced in its beginnings by rationality with Descartes where the production of beautiful art – including architecture – became a rational process with specific conditions and factors that get influenced by it and affects the way it is perceived. Then, aesthetics reached experimentalism with Kant, only to go back a new form of idealism (Absolute idealism) with Hegel.

Philosophy is affected by society's events and changes. This leads to a change in beauty standards to become more compatible with the emerging needs of peoples, whether it is material, psychological, or spiritual. Consequently, this will affect the artistic product in general and the architectural one in particular.

Aesthetics – unlike all other sciences – is subjective as much as it is objective. This explains the difference in judgments or aesthetic evaluations from time to time or from one place to another. It is objective since all those who dealt with the issue of beauty, including mathematicians, physicists or philosophers, have agreed that in order for beauty to be achieved, some conditions must be met. For example, proportion, balance, harmony, and order, as all confirmed, are the most important requirements for beauty. It is also subjective since it is being strongly linked to time and place; time in terms of events and changes in all aspects of life which affect the philosophical vision of society, and thus the standards of beauty. It's also linked to the place and what it imposes in terms of conditions, tendencies, common taste and needs related to the human and geographical environment. Here the subjective is divided into two: common and personal. Common that concerns a certain group or society, and personal that is related to the artist himself (his personality, experiences, past, philosophical beliefs ...).

All this makes the evaluation of beauty a delicate and complex process in which many issues must be taken into account in order to have an objective, fair and correct judgement.

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Comparative Study on Test Performance of Two Kinds of High Modulus Asphalt Concrete for the Steel Bridge Deck

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Abstract: Along with the popularization and application of the steel bridge in China, due to the high modulus of asphalt concrete with good waterproof, anti-fatigue, anti-aging and good performance, asphalt concrete with high modulus was widely used in steel bridge deck pavement, the test and comparative study of high modulus asphalt concrete were carried out based on two types of common high modulus asphalt concrete which include the casting type asphalt concrete and epoxy resin modified asphalt concrete, aims to further explore the performance features of the steel bridge deck with high modulus asphalt concrete, and provide help on the application of this asphalt concrete on the steel bridge deck.

Key words: Steel bridge deck; High modulus; Asphalt concrete; Test performance

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1 Introduction

In recent years, with the strong support for the construction of steel structure bridge in China, steel structure girder bridge has been rapidly promoted in highway construction with its excellent comprehensive performance, which has effectively promoted the transformation, upgrading, quality and efficiency improvement of China's highway construction. In order to deal with the problems of easy rust, fast thermal conduction and high elastic modulus of steel bridge deck, the transition

layer between steel bridge deck and ordinary asphalt concrete pavement should not only have good performance of waterproof, rutting, shearing and sliding resistance, but also have high elastic modulus. In this paper, two kinds of high modulus asphalt concrete commonly used for steel bridge decks, pouring asphalt concrete and epoxy resin modified asphalt concrete, are tested and compared. Through in-depth research and analysis, the purpose of this paper is to further reveal their performance characteristics and explore the pavement technology of high modulus asphalt for steel bridge decks.

2 Preparation of raw materials

2.1 Aggregation

The coarse and fine aggregates used in the comparative test of the casting asphalt concrete and the epoxy resin modified asphalt concrete are the same, which are igneous rocks, in which diabase content is 84.6%. Mineral powder with high quality limestone mineral powder, plastic index is less than 1.7, the pass rate of 0.075 mm sieve is 99.9%.

2.2 Modified asphalt

The casting asphalt concrete adopts TAL+SBS high-strength bisexual modified asphalt, the TAL: SBS ratio is 60:40. The modified asphalt has good high temperature stability and low temperature crack resistance, and has good follow-through with steel bridge deck. The technical indexes are shown in Table 1. Epoxy resin modified asphalt concrete adopts two component modified asphalt, component A (epoxy resin) and BV (asphalt and curing agent mixture), the two-component mixing ratio of A: BV=12:88.

Table 1. Technical indexes of TAL+SBS high-strength bisexual modified asphalt

Indexes	Design requirements	Real testing	Experimental methods
Penetration (25℃)	30~50	33	T0604-2000
Softening point (ring and ball method) ℃	≥80	98.2	T0606-2000
Rebound rate (25℃) %	≥90	95.4	T0662-2000

3 Comparison of laboratory tests between the casting asphalt concrete and the epoxy resin modified asphalt concrete

3.1 Comparison of gradation design of asphalt concrete mixture

The casting asphalt concrete and the epoxy resin modified asphalt concrete are different in the gradation design of their mixtures due to their

different paving and strength formation modes. In order to obtain higher fluidity and workability of the casting asphalt concrete, the asphalt content and low particle size aggregate content are higher in the design of mixture grading. The strength formation of epoxy resin modified asphalt concrete needs a certain health preservation, so more attention is paid to the skeleton function of gradation. Pairing ratios of the two levels are shown in Table 2.

Table 2. Comparison of pairing ratio

Asphalt concrete	Weighting percentage of passinf through sieves below (regular sieve, mm)(%)									Dosage of asphalt (%)
	19	13.2	9.5	4.75	2.36	0.6	0.3	0.15	0.075	
Casting	100	92.0	--	73.4	54.5	44.4	36.7	30.1	23.8	8.5
Epoxy	--	100	97.4	74.5	61.4	35.7	--	--	10.8	6.4

3.2 Performance control of castable asphalt concrete

The casting asphalt concrete has high fluidity. Before preparation, the temperature of modified asphalt should be controlled at 220 ℃ for mixing with preheated aggregates and mineral powder, and the final temperature of mixed material should be controlled within 240 ℃ . Because characteristics of the casting asphalt concrete are different from that of the common asphalt concrete, and the traditional Marshall stability test cannot be adopted to achieve

the quality control, the construction workability was tested through the fluidity of the asphalt mixing material, the performance at low temperature and paring reasonability were tested through the buckling strain results at low temperature. In this test, the period of asphalt mixture flow is controlled in 15 ~ 20S, asphalt penetration is controlled in 2 mm ± 0.5 mm, (penetration increment is controlled in 0.4 mm) and the rationality of the mixture is finally tested with low temperature bending strain index. The test results are shown in Table 3.

Table 3. Performance indexes of the casting asphalt concrete

Indexes	Controlled requirements	Experimental data	Experimental methods
Fluidity of asphalt mixing materials (s)	<30	18	ZTVasphalt STB94
Penetration at 60℃ (mm)	1~4	2.3	ZTVasphalt STB94
Penetration increments at 60℃ (mm)	<0.4	0.33	ZTVasphalt STB94
Buckling strain at low temperature -10℃	>6×10-3	12×10-2	ZTVasphalt STB94

3.3 Performance control of epoxy resin modified asphalt concrete

The formation mode of strength of the epoxy resin modified asphalt concrete is different from that of the casting type asphalt concrete, there was an inert period in the early stage of the combination of the epoxy resin and curing agent in the modified asphalt, the reaction became more significant with the increasing temperature after the inertia period, it was shown that a large number of 2D lock structure were

formed in the combination material under the micro electron micrograph, characterized by the mixture specimen Marshall stability increased as the growth of the curing time. Therefore, the performance control of the epoxy resin modified asphalt concrete is determined by "regimen - strength relationship experiments" and "construction time experiments".

1) Regimen - strength relationship test

14 Marshall specimens were made according to the optimum asphalt content in the experiment, put them

into 20°C temperature 30°C constant temperature box with the group of seven to healthy preservation, the strength experiment of one Marshall specimen was carried out every 24 h, and the Marshall strength and curing time diagram (Figure 1) were draw out, it be concluded that the strength of the epoxy resin modified asphalt concrete and the curing temperature and time is proportional to the relationship from figure 1.

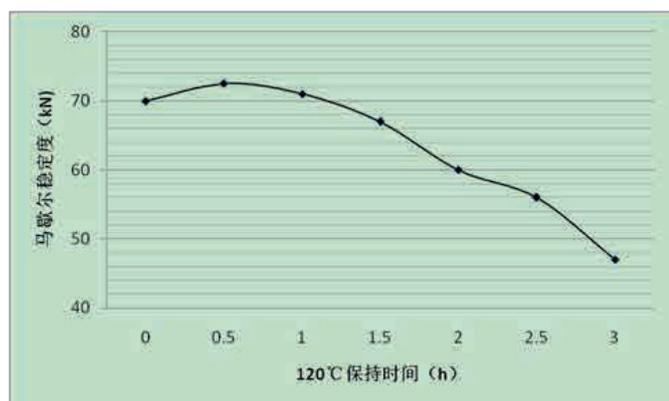


Figure 1. Health preservation-strength relationship experiments

2) Construction time experiments

In this experiment, the prepared epoxy resin modified asphalt concrete was stored in a thermostat at 120°C, and a group of Marshall specimens were made by sampling every 0.5h. The specimens were placed in a thermostat at 30°C for health preservation after cooling. After 7 days, the Marshall strength of each group was tested and the relationship curve was drawn (Figure 2). It can be concluded from Figure 2 that the Marshall stability of all samples within 2h is above 60kN, therefore, the construction time of the epoxy resin modified asphalt concrete should be controlled within 2h.

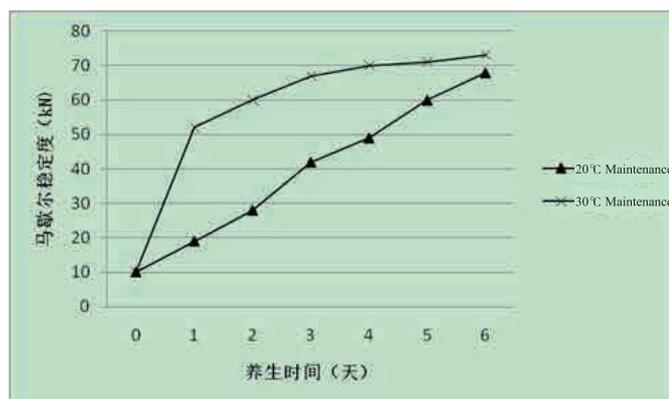


Figure 2. Construction time experiments

4 Analysis of paving the casting asphalt concrete and the epoxy resin modified asphalt concrete

4.1 The casting asphalt concrete

The casting asphalt concrete has good fluidity and workability, so the temperature of the mixture during construction should be maintained between 230°C and 240°C, and the high temperature spreading should be carried out to ensure the quality of the paving. Through many on-site placement tests, it concluded that the aggregate were added into the mixing axe when it was preheated to 300 °C, the cold mineral powder were added into the mixing axe, dry mixing them for 10 s and 220°C of modified asphalt was added and mixed for 90 s, temperature of the discharge was controlled at around 240 °C, the discharge load was set into the transmission device which has the thermal insulation characteristic, the site construction temperature was kept at 230°C ~ 240°C to ensure the quality of pavement.

4.2 The epoxy resin modified asphalt concrete

The construction of the epoxy resin modified asphalt concrete is similar to that of ordinary hot mixed asphalt concrete. After the material is discharged, it is transported by conventional transport vehicles. Because its "construction time" is generally less than 2 h, the construction needs to be completed within 2 h, which makes the construction organization difficult. The pavement strength needs to be formed after 7 days of drying and health preservation, so the requirements for the site after health preservation conditions are higher.

5 Conclusion

The casting asphalt concrete needs to be constructed at high temperature, and the strength will be formed immediately after the pavement temperature is lowered, without the need for health preservation. Because the site construction temperature is high, a high temperature early warning system must be established during the construction, the contraction of the expansion joint should be uninterrupted observed, in order to control the construction speed, to prevent accidents caused by thermal expansion. At the same time, due to the high temperature water gasification expansion coefficient is very high, the construction

should keep the site environment without water.

The paving process of the epoxy resin modified asphalt concrete is similar to that of the conventional asphalt concrete. Due to the limitation of construction time, health preservation temperature, humidity and other conditions, the inert period of the mixing materials should be determined before construction, the construction should be processed in the warmer season, and the construction should be completed within the inert period, after construction, the waterproof bonding material should be sprayed immediately to achieve water resistance, the upper layer should be paved as soon as possible.

Both types of high modulus asphalt concrete for steel bridge deck have advantages and disadvantages, the application environment and applicable conditions should be fully considered in the design and construction to choose a reasonable paving scheme. In the case of difficult site health preservation conditions

and long transportation distance, the casting asphalt concrete should be choose; The epoxy resin modified asphalt concrete should be selected when it is difficult to meet the high temperature mixing requirement, and conditions of the close transport distance, high temperature and moisture-proof.

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Study on the Application of Mongolian Cultural Elements in Mascot Design

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Abstract: The Mongolian culture is part of China's traditional culture. It is a prairie culture of fusion Mongolian wisdom for nearly a thousand years. This article briefly introduces the basic concepts of mascots and Mongolian cultural elements, and carries out a design practice by using the horse culture, color matching, boke clothing in the Mongolian cultural elements. The white horse mascot was designed by combining with national culture. It can be found that Mongolian traditional culture is a huge resource treasure house for mascot design through design practice, and the design of mascot is the characteristic of the era that inherits the development of Mongolian culture. The integration of Mongolian culture and mascot design can achieve mutual benefit.

Key words: Mascot; Mongolian cultural elements; Mascot design; The traditional culture

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1 Overview of mascots and Mongolian cultural elements

1.1 Overview of the mascot

The mascot originated from the French Provencal Mascotto, and it was officially incorporated into the French dictionary with the spelling form of Mascotte at the end of the 19th century. The English Mascot evolved from Mascotto, which means people, animals or things that can bring happiness and good luck^[1].

The mascot is the product of the business, and its birth is to satisfy commercial purposes.

The mascot is a visualization created by combining people's emotional desires with real things in China. A long time ago, ancestors created many symbols to pray for the success of all things. And these things that yearn and pursue happiness and beauty were called "mascots". The earliest mascot representing human spiritual culture in China is the "dragon"^[2]. The auspicious visualization of dragons and phoenixes and Kirin are more to give a symbolic meaning, such as blessing, auspiciousness, etc., or to satisfy people's psychological needs of praying for blessings. Various mascots are derived from the original animals, and are rich inauspicious connotations, it can be said to be endlessly interesting. One of its methods is to enlarge or extend the appearance, characteristics, or practical value of things and other attributes to make them have auspicious connotations. Later, Because of the changes and needs of the development of the times, people have a different understanding of mascots. More and more government agencies, sports meets and other institutions have regarded mascots as the necessity of life. People slowly started to realize that mascots have also representativeness. It expresses not only a kind of pursuit and aspiration, but more importantly, it reflects the ideals and characteristics of the times and society. Individuation, ideological nature, advancement and future nature are the precise connotations of modern mascots performance.

1.2 Overview of Mongolian cultural elements

Mongolian culture has a cultural heritage of the long

historical and brilliant. The Mongolian nationality is a very legendary nation. In the long-term practical life, the Mongolian nationality has established its own cultural system, it is prairie nomadic culture. The Mongolians are mainly distributed in the Inner Mongolia Autonomous Region of China. A song named "The sky is blue, the wild is boundless, the wind blows the grass, cows and sheep can be seen" has been widely circulated, which closely describes the cultural environment of Mongolian. There are not only the vast grasslands of Inner Mongolia, but also unique ethnic customs and rich natural resources. These resources are our inexhaustible reference materials.

The Mongolian cultural element refers to characteristics of certain historical and cultural features and can reflect the custom of a place or nation. It covers politics and economy, philosophy and literature, language and literature, art and customs and many other factors, it forms a complete cultural system. At the same time, it has also created a brilliant and outstanding national culture because of many typical traditional cultural elements with national characteristics. The design of the mascot is to make a big breakthrough and improve the design on the basis of not changing the original traditional concept, and then create a new visual expression effect, and give the audience a refreshing visual experience and cultural experience. Because the Mongolian cultural system is too large, the author only briefly describes the cultural elements that will be applied to the design case.

1.2.1 Horse culture

Mongolians are called the "nation of horseback". Horses carried human from ancient times to modern times, from ignorance to civilization. The Mongolian people who have lived a nomadic life on the grassland for generations are almost accompanied by horses in production, labor, marching, social life, sacrificial customs, and literature and art, and the sound of horseshoes can be heard. As a result, a colorful horse culture was naturally formed in the national life, and it was recorded in the annals of history along with the Mongolian people who able to conquer the war. For the definition of the concept of "horse culture", most scholars believe that there are two meanings, one refers to the type of animal folklore, that is, it is the original meaning; the other refers to the folklore

for trainers and riders of the horse, that is, it is the extended meaning. The extended meaning refers to human social behavior related to horses. This extended concept of horse culture affects all aspects of people's lives to varying degrees in different regions, different nationalities, and different cultural ways.

1.2.2 Boke clothing

Boke is Mongolian wrestling. It is transliterated from Mongolian. It is the most traditional sports competition of Mongolian and is listed as one of the "Men's three skills". The inimitable style of clothing worn by the Boke player is a dazzling branch of Mongolian costumes. The Boke clothing used in the design case of this article is the wrestling suit of Kaerka tribe. It is composed of "Jiang Ga", waistcoat, crotch pants and wrestling boots. The most distinctive feature is the colorful necklace of Boke's neck. It is called "Jiang Ga" in Mongolian. It is made of multicolored silk. As long as the Boke player wins a match, a ribbon will add to the neck. Jiang Ga is the testimony and honor of Boke player sports career. Meanwhile, it is also the symbol of status.

1.2.3 Decorative colors

The color habits of the Mongolian are gradually formed in the long-term historical development and years of evolution. The Mongolian people have a special feeling for white and blue, and like red very much. Golden and silver are also very common in decorative colors, but black is taboo for them. The Mongols have special feelings for white, because the white clouds floating in the sky can bring them rain. The white yurts shelter them from wind and rain. The white sheep are their source of income, and the food used to fill their stomachs is also white dairy products. All these things for survival are related to white, and the Mongols gradually developed a love for white. Mongolians believe that white has the symbolic meaning of purity and holiness, so Mongolians have a special affection and preference for white. And the natural love for blue is similar to the love for white at first. I mentioned "blue sky and white clouds" in the previous article. I have an understanding of white clouds, and of course, I have a good impression of the blue sky. People think that "the blue of the sky" represents a kind of broad eternity, it is the combination of wisdom, health, eternity, peace and loyalty. The use of yellow is also extremely important

for Mongolians, and it has a great relationship with religious beliefs. At the same time, gold which similar to yellow is considered a beautiful color by Mongolians. Yellow symbolizes the nobleness and supremacy of the earth. It is widely used in the daily life of ordinary people. The Mongolian's enthusiasm for fire is closely related to their production and life, and their love for red also comes from their worship of fire. In the cold northern regions and grasslands where wolves are infested, fire is not only a means of survival for warmth and protection from the cold, but sometimes is even also a major event related to life[3]. The red color of fire is a symbol of happiness and victory, so The right use of red runs past through all areas of the Mongolian people's clothing, food, housing and transportation.

2 Application case of Mongolian cultural elements in mascot design

2.1 Design concept

The design prototype of this plan is selected from the Mongolian culture of the most representative horse. Because the Mongolian horse has a hard-working, loyal and brave character, it has left a deep emotional imprint in the hearts of the grassland children. The design inspiration for choosing the white horse as the design prototype originated from the Mongolian folk narrative poem "The Two Horses of Genghis Khan" in the 13th century. The white horses in the epic have a distinct personality, their character is wise, brave and loyal, Mongolian people also have such a personality.



Figure 1. Design renderings of white horse mascot

2.2 Design description

The white horse in the Mongolian long epic was used as the design image, and the traditional Mongolian cultural elements were blended in Fig.1.

Jiang Ga and Boke clothing were worn in the little white horse, decorating with Mongolian decorative patterns and curly grass patterns. Design renderings were matched with Mongolian colors. It intended to highlight the national characteristics of the mascot and the visualization of the "lively spirituality, sunny and lovely" of Mongolian horse. The visual image application of white horse can be implanted into the cultural and creative development and product promotion of the Inner Mongolia eco-tourism system, and extend the visual image into the construction of the identification system. Meanwhile, it can improve the reputation and influence of the public image of Inner Mongolia, and promote the cultural region and local economy of Inner Mongolia in China.

3 The relevance of Mongolian cultural elements and mascot design

3.1 Mongolian cultural elements promote the design of the mascot

The Mongolian culture has been deeply rooted in the vast and profound Chinese land since ancient days. It is still alive after the baptism of history. The huge cultural heritage for thousands of years is our design elements and materials, and the kind of Mongolian cultural elements can be extracted, it was colorful ranging from Mongolian characteristic buildings to clothing decoration color patterns. If we recombine these traditional cultural elements with the design of the mascot to give it new characteristics of the times, we can create new products that are both national and in line with the characteristics of the new era.

This article draws on Mongolian cultural elements and absorbs the characteristics of Mongolian nomadic culture. Based on the profound cultural connotation of the Mongolian nationality in the process of analysis and research, relevant information was extracted from the constituent elements and various levels of the traditional Mongolian culture. The meaningful deconstruction, reorganization and re-application of traditional folk culture can not only promote the design of mascot, but also improve the propaganda of traditional Mongolian culture.

3.2 The design of the mascot promotes traditional Mongolian elements

The profound culture of Mongolian accumulates the baptism of history. We need to look at the traditional

Mongolian culture from a new perspective, broaden our thinking, stimulate creative thinking, dig out the deep-buried essence of the Mongolian people for re-interpretation and design, and create mascots that can reflect the connotation of the Mongolian culture. Obviously, the mascot with Mongolian cultural characteristics and consumers' favorite was designed, it can be more conducive to the preservation, dissemination and promotion of the traditional Mongolian cultural elements.

Based on the traditional culture as the main body in this paper, Traditional art elements were used to design the mascot. Of course, this method is not a simple reference which traditional Mongolian elements, let alone the stack of traditional visual symbols. It is a process of refining, transforming, reconstructing and applying the most representative elements in the traditional Mongolian culture after stripping away the traditional elements and the appearance of the styling style. Starting from the root of Mongolian culture and combining modern visual aesthetics methods with traditional culture, the paper extracts and uses traditional Mongolian elements to express the visual symbols and forms in line with the characteristics of the Times, and further expresses the values of people's pursuit of aesthetic orientation.

3.3 Mongolian cultural elements are integrated with the design of the mascot

3.3.1 Mongolian cultural elements provide abundant materials for mascot design

As one of the minority nationalities in China, the Mongolian nationality contains a large number of traditional cultural elements with rich connotations. The rich cultural heritages are our inexhaustible creative material in modern times. This precious cultural heritage will bring new opportunities and inspiration to the design of the mascots and create a rich form of expression. It opens up a pluralistic approach for mascot design, which can extend its intrinsic cultural value by digging local characteristic culture, inheriting national history and carrying forward Mongolian traditional culture. Therefore, the use of Mongolian traditional culture materials as the basis for the design of mascots has considerable development prospects.

3.3.2 The design of the mascot inherits the characteristic of The Times in the development of Mongolian culture

Starting from the design concept of the characteristics of The Times, it accurately extracts the elements of shapes, patterns, symbols, colors and others from the form of Mongolian cultural elements to recreate. Under the premise of conforming to society, new products which retain the local national characteristics and the sense of The Times are designed to make the audience aware of the importance of national culture. The key point here is to establish the core design concept of "people-oriented", we must start from the real psychological needs of the audience to select appropriate Mongolian cultural elements to satisfy people's needs^[4].

3.3.3 Mongolian culture and mascot design was integrated to achieve mutual benefit

In the expression of the design concept, the core characteristics of Mongolian cultural elements of "shape" and "spirit" are closely combined to give full play to the functional characteristics of both shape and spirit, and it is also applied to the mascot design to construct the overall internal connection of the combination of shape and spirit, so as to stimulate the vitality of the present mascot. Obviously, there must be a complementary relationship between the two, which is an important way to effectively promote the inheritance and development of the Mongolian culture in the Inner Mongolia region of China.

4 Summary

This article is mainly briefly described the three elements from Mongolian culture of horse culture, Boke clothing, and decorative colors. Mongolian cultural elements have been applied in practice, in order to create a new idea of combining Mongolian culture with mascot design. Mongolian culture can be continuously developed and effective spread to the whole world, and the cultural value of Mongolian traditional culture can be further presented. On the premise of complying with the trend of The Times and development trend, we must interpret and analyze the inner characteristics of Mongolian cultural elements and combine national cultural resources organically with creative design techniques to continuously excavate the visual expression form

of mascot design, and strengthen the mascot design of visual impact and appeal^[5].

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Analysis of Existing Problems with Management of Construction Projects Bidding and Solutions to the Problems

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Abstract: Bidding is a key link during the implementation of a construction project. For the same construction project, there are usually multiple construction companies bidding together to obtain the right to contract for the project. However, there are still various irregularities in the bidding stage. This article analyzed the above problems and proposed a management strategy for the optimization of bidding, looking forward to improving the quality of bidding management of construction projects, solving various illegal bidding problems, and purifying the environment of bidding management.

Key words: Construction engineering; Bidding management; Problems; Solutions

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1 Introduction

In the construction project management stage, bidding management is the key link. However, judging from the current bidding management status of the project, there are still many problems such as malicious bidding, irregular bid evaluation, disturbing bidding, and imperfect review. In this regard, it is necessary to conduct standardized management of the bidding process, use scientific methods, strengthen supervision, purify the environment of bidding market, and lay a good foundation for the sound development of the construction field.

2 The problems of bidding management in construction projects

2.1 Malicious bidding

If the bidding company maliciously bids, it will have a serious impact on the bidding price, and it will also affect the development of the company^[1]. The so-called malicious bidding is to increase the quotation in order for certain companies to win the bid, which can increase the bidding price and cause a blow to the enthusiasm of other bidding subjects. Generally speaking, in order to improve their own interests, bidding companies want to control the bid price through low-price competition and reduce the bid price to the lowest level, which may also cause loss-making quotations. If the winning bid price is 7% higher than the expected quotation, it can be regarded as a loss-making quotation, which is extremely detrimental to the development of the bidding company and will also affect the bidding order. After bidding companies bid successfully, in order to reduce construction costs, they may modify bids, or even cut corners, which is not conducive to the guarantee of the quality of the project, and also restricts the development of construction companies to a certain extent.

2.2 Unreasonable bid evaluation

In the bidding management process of construction projects, bid evaluation is at a critical link. The bidding companies mainly screen many companies participating in the bidding, and choose a more suitable company as the main body of responsibility for project implementation. The selection process

should follow the principles of the best quality, the least investment, and the shortest construction period. However, in the selection of bidding companies, some tenderers did not take into account the comprehensive capabilities of the tenderers, and selected the construction party according to the bidding price. At this time, if the construction technology level of the construction company does not meet the standard, it will affect the efficiency of the bidding party. The bid evaluation process needs to be based on the bidding materials provided by the construction party. And the bidding companies should follow the principles of objectivity and fairness. Combined with specific needs and under the premise of ensuring the quality of project construction, the bidding companies should control the construction cost, make a reasonable selection of bidding schemes, and improve the quality of bid evaluation^[2]. After the most suitable bidding plan is selected, the bidding company needs to carefully calculate the cost of the bidding plan from the actual situation, so as to prevent violations and to ensure the rationality of the bid evaluation stage.

2.3 Disturbing bidding

In the bidding process, the construction company is the main participant, and its behavior has a greater impact on the bidding process, especially the bidding price. If the construction company uses special means to disrupt the bidding process, it may cause the bidding price to be depressed, mainly in the following aspects. (1) The construction party maliciously expands the profit margin of the company in order to win the bid at a low price. After winning the bid at a low price, it will cut corners and materials in order to obtain benefits, which will affect the quality of project construction and engineering safety. (2) Construction companies that have not obtained bidding qualifications borrow names of other companies to participate in the bidding process to increase the competitive pressure of bidding companies, and have an impact on other bidders, resulting in an increase in bid prices. (3) The construction company may use legal loopholes with other bidders to generate collusion behaviors, causing disturbance to the bid price, in order to achieve the purpose of winning the bid at a low price^[3].

2.4 Supervision and review

The workload of the bidding management process

is relatively large, and the review process is complicated. Professional guidance is needed to effectively supervise the bid evaluation process. However, in the bidding process, some supervision departments failed to play their supervisory role, and even hinder the bidding behavior of foreign companies in order to protect the development of local industries. There are loopholes in the supervision and review, which allow illegal companies to interfere in the bidding process. These seriously affect the bidding price, and will also make qualified companies lose bidding opportunities, which is not conducive to the management and may disrupt the market order of bidding. Therefore, relevant departments need to do a good job in supervision work^[4].

3 Solutions to the problems with construction engineering bidding management

3.1 Standardize market management

In order to ensure the smooth progress of bidding and bidding work, it is necessary to improve market management through the following aspects. First, pay attention to the integrity management of enterprises during the period of participating in bidding projects to prevent them from untrustworthy behaviors. A management platform can be established to enter corporate information and share it among the same industry to regulate companies' participation in bidding. Second, the supervision departments need to conduct a comprehensive review of the bidding process to ensure the fairness of the bidding process. If violations are found, they should be strictly prohibited to improve the market system^[5]. Third, at the stage of signing the bidding contract, the construction company should ensure that there are more than three people on site. Before the contract is signed, a comprehensive review of the construction site is required to ensure the effectiveness of the bidding plan. After the contract is signed, it is transferred to the supervision agency and managed by a third party to better regulate the behavior of both parties.

3.2 Evaluate bids scientifically

At the bidding stage, the bid evaluation work should be paid attention to and carried out in accordance with the construction engineering bid evaluation process, and the the personnel of bid evaluation

should have high professional quality to deal with the problems existing in the bid evaluation process. If the traditional bid evaluation method is used, the budget quota is mainly used as a reference, and the bidders may quote according to the budget quota, and provide an opportunity for some companies to disrupt the bidding process. In order to solve this problem, it is necessary to innovate the bid evaluation model, evaluate bids with the physical bill of quantity, no base bid and with the base bid, and optimize the bid evaluation model, which will help maintain the fairness of the bidding environment. In addition, owners can also be invited to serve as bid assessors to maximize the fairness of the management of bidding process^[6].

3.3 Punishment of violations

In order to regulate the behavior of the construction party, it is necessary to increase punishment and maintain the order of bidding management in the construction market. During the bidding period, the companies participating in the bidding need to sign a contract with the bidding party in order to clarify the rights and responsibilities of both parties, guarantee the interests, and lay a good foundation for the smooth progress of the bidding-related work. The bidding parties must strictly follow the requirements of the contract and participate in the bidding in accordance with the corresponding laws and regulations. If violations occur, the relevant departments can punish them in accordance with the law to maintain the order of the bidding management^[7]. In addition, to make it serious, the punishment process can go public, and the information of companies that violate the regulations will be disclosed to restrict their future participation in bidding, improve the quality of the bidding management process, ensure that the bidding process is open and fair, and standardize the violations of bidding companies.

3.4 Strengthen supervision

To improve the effectiveness of bidding management and attract other enterprises to participate in bidding, it is necessary to strengthen the supervision of the bidding process^[8]. For the supervision of the bidding process, the following measures can be taken. First, intensify the review of bidding companies. If the company does not have the bidding qualifications, it needs to punish such companies in accordance

with the corresponding regulations. Second, if the company has obtained the qualification to participate in bidding, it must also register information with relevant departments to provide information for the management and supervision of its participation in the bidding process to prevent unqualified companies from entering the bidding site. Third, to ensure the fairness of the bidding process, it is also necessary to strengthen supervision and execution, publicize the bidding plan, and all participating bidding companies can browse information, give full play to the mutual supervision function of enterprises, and ensure that the entire bidding process is open^[9]. Fourth, during the bidding, the tenderers' information must also be effectively verified, and enterprises are strictly prohibited from participating in bidding as agents^[10]. Through the above methods, the supervision and management during the bidding period will be strengthened, so that the bidding management can proceed smoothly.

4 Conclusion

In short, the development of the construction industry needs to rely on standardized management. In view of the various problems in the bidding management of construction projects, it is necessary to proceed from reality, find solutions, strengthen punishment, standardize bidding behavior, so as to maintain the smooth progress of the bidding process, and lay a good management foundation for the smooth construction of construction projects.

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Causal Analysis on the Lining Exfoliation and Treatment Design of an Operational Tunnel

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Abstract: According to the actual situation of the secondary lining of a expressway tunnel in Chongqing, this paper analyzed the specific reasons for lining exfoliation with corresponding test reports. According to this, a quick treatment scheme for lining exfoliation is proposed, which can make the treatment timely and effective, and suggestions for treating similar diseases in tunnels are put forward, which can provide reference for similar projects.

Key words: Operational tunnel; Lining exfoliation; Causal analysis; Treatment design

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1 Project overview

A certain tunnel is an extra-long tunnel on the Yuhe (Chongqing-Hechuan) Expressway of China National Highway 212, and is one of the all-round control projects. The tunnel is a single tunnel with two lanes, where the left and right tubes are placed separately. The right tube is 4,011 meters long, and it was bored through in December 2001.

The tunnel is located in the Zhongliangshan anticline of the Huaying Mountain broom-shaped fold bundle in the arc structure belt in the southeast

of Sichuan. The secondary structure is the Datianwan reverse fault and some secondary small faults.

① Zhongliangshan anticline

It is the main structure of this tunnel, which traverses north and south, and is the southern extension of the Huaying Mountain broom-shaped fold bundle. It is characterized by tight anticline folds, asymmetric flanks, gentle in the east and steep in the west, and the axis of the anticline is twisted and crooked in reversed S-shape, with varying axial tilt, many structural branches, many independent high points, and many fractures.

② Datianwan reverse fault

Located in the Jialingjiang Formation and Leikoupo Formation in the west flank of the anticline, the ground surface is manifested as follows: deep gullies are formed in the fault zone, and the lithology and occurrence of the rocks on both sides of the gullies are obviously different. The fault is roughly parallel, extending 2km along the axis, and the fracture width is 8-10m. The fault occurrence is as follows: inclination E57°S, dip angle 71°, crossing the left tube at ZK21+674, and crossing the right tube at YK21+677.

③ Joint

There are three sets of tensile joints of 91° ∠ 58°, 210° ∠ 50°, and 324° ∠ 63° in the sandstone

developing at the entrance of the tunnel. The cracks are 1~3mm wide, and are rust-colored, brown-black, with clay fillings; a group of $300^\circ \angle 69^\circ$ tensile fractures developed in the axis of the anticline, the fractures developed and extended much longer, and cutting and dissolution occurred.

The main lithology of the tunnel: From the two flanks of the anticline towards the axis, the tunnel crosses the Middle-Jurassic Shaximiao Formation (J_{2S}), the Middle-Jurassic Xintiangou Formation (J_{2X}), and the Middle- and Lower-Jurassic Ziliujing Formation (J_{1-2Z}), Lower-Jurassic Zhenzhuchong Formation (J_{1Z}), Upper-Triassic Xujiahe Formation (T_{3Xj}), Middle-Triassic Leikoupo Formation (T_{2l}), Lower-Triassic Jialingjiang Formation (T_{1j}), Lower-Triassic Feixianguan Formation (T_{1f}), The Middle-Permian Changxing Formation (P_2^C) and Longtan Formation (P_2^L) strata successively. The strata above the second segment of the Triassic Feixianguan Formation (T_{1f}^2) are completely exposed on the ground surface, and the Quaternary strata only appear on the gentle slopes of karst depressions and cave openings.

The surrounding rocks of the tunnel belong to type II, III, IV, and V.

Among them, the part of the tunnel where the secondary lining partially exfoliated is the type III surrounding rock, which is interbedded with gray-dark gray medium-thick shell limestone and asphaltene mudstone, with joint fractures developing.

2 On-site investigation and detection of the exfoliation of secondary lining of the tunnel

In February 2017, the secondary lining of the K22+356 ~ K22+368 segments of the right tube of the tunnel partially exfoliated. In addition to the partial exfoliation of secondary lining, there were 13 obvious longitudinal faulting of slab ends on the secondary lining of the segments, and the segments with faulting of slab ends were through cracks, extending along the secondary lining of the mold (Figure 1-3).



Figure 1. Partial exfoliation of the tunnel secondary lining



Figure 2. Faulting of slab ends on the secondary lining on the right side of vault of the k21+241 segments



Figure 3. Faulting of slab ends on the secondary lining on the right side of vault of the k21+275 segments

2.2 Tunnel inspection results

2.2.1 Lining thickness inspection results

The lining thickness inspection lines were laid on the tunnel vault, left and right arch waist, and left and right side walls respectively.

The inspection results show that the thickness of the secondary lining on the K22+345~K22+380 segments of the right tube of the tunnel is 40cm~64cm.

2.2.2 Lining cavity inspection results

The inspection lines for lining cavities were respectively laid on the vault of the tunnel and the left and right arch waists.

The inspection results show that there are 9 defects behind the lining of the K22+345~K22+380 segments of the right tube of the tunnel, and the defect volume is about 8.1m³. Among them, the vault is void in 4 places, and the arch is void in 4 places.

2.2.3 Lining strength test results

The positions of concrete strength coring testing were respectively set at the side wall and the arching position of the lining;

A total of 5 molds of secondary lining concrete were coring tested. Among them, there were 3 molds in the adjacent chunking positions, where 2 sets of core samples were taken for each mold from the side wall and the arching line. For the 2 molds in the K21+259-K21+271 and K21+452-K21 +464 (designated pile serial number) segments, one set of core samples was taken for each mold.

The measured concrete strength of the coring segment is 30.6~37.0MPa.

2.2.4 Lining clearance inspection results

There are a total of 35 lining segments in the key disease segment inspection. The driving boundary of the inspected segments was not invaded, but the distance from the contour line to the local (near the arch line) measurement point is small.

The typical inner contour cross-section is shown in the figure below(Figure 4 and 5).

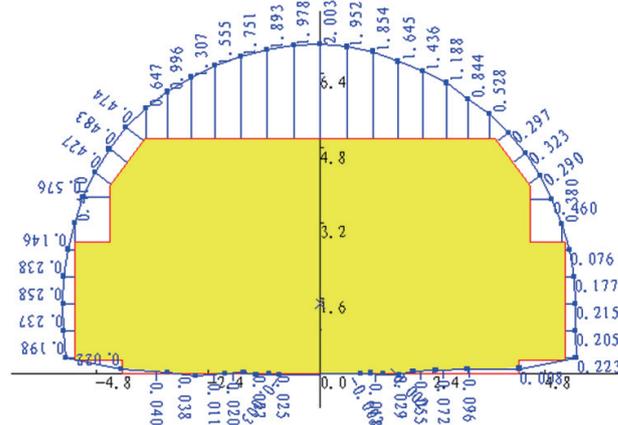


Figure 4. Measured lining boundary contour map of cross-segment k2+485

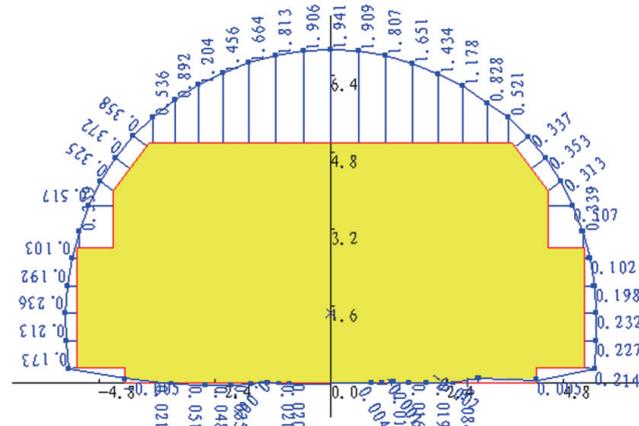


Figure 5. Measured lining boundary contour map of cross-segment k2+526

2.2.5 Inspection results of cold joints in lining construction

There are 12 cold joints in the construction (the lining is more severely deformed), most of which are distributed on the right side of the vault, about 2m from the vault. The typical lining faulting diseases are described as follows:

(1) The K21+259 ~ K21+271 (designated pile serial number) segments are fault by 6cm, the crack width is 4cm, and the depth is about 60cm. It is a through crack and extends along the entire secondary lining.

(2) The secondary lining on the right side of the K21+446 ~ K21+470 (designated pile serial number) segments is faulted by 5.5cm, the crack width is 4cm, and the depth is about 60cm. It is a through crack and extends along the entire secondary lining.

(3) The secondary lining on the right side of the K21+294 ~ K21+306 (designated pile serial number)

segments is faulted by 2cm, the crack width is 1cm, and the depth is about 50cm. It is a through crack and extends along the entire secondary lining.

2.2.6 Inspection results of defects behind the lining

There are 39 voids in the right tube of the tunnel behind the lining within the survey line, of which 29 voids were found in the vault survey line; 9 voids were found in the arch waist survey line; and 1 void was found in the side wall survey line.

2.2.7 Inspection results of secondary lining steel bars

Within the range of the survey line, the right tube of the tunnel has 24 segments with secondary lining containing steel bars, and the cumulative length is 289m.

2.2.8 Initial steel support inspection results

9 segments adopted steel support (steel arch frame or grille arch frame) for the initial support in the right tube of the tunnel within the range of the survey line, and the cumulative length is 439m.

3 Causal analysis of tunnel diseases

Combining the comprehensive analysis of the site topography and geology with the inspection reports, the main reasons for the secondary lining exfoliation of the tunnel are as follows:

(1) According to the inspection report, in addition to the partially exfoliated secondary lining in the segments, there are 13 obvious longitudinal faulting at slab ends in the secondary lining. The faulted segments are through crack, which spans the secondary lining of the entire mold, and there is also risk of secondary linings falling off. Therefore, due to construction technology and other reasons, there are suspected concrete construction cold joints on the secondary linings of the side wall and arch waist (the construction cold joint runs through the single-mold concrete longitudinally), which destroys the overall stressed structural system of the secondary lining and is an important reason of secondary linings falling off.

(2) Due to the simultaneous occurrence of two parallel longitudinal cracks or construction cold joints on the side wall and the arch waist, the secondary lining structure from the vault to the arch waist may topple and fall off after the following actions:

1) The weight of the secondary lining structure of this part;

2) The weight of the secondary lining of the vault acts on this part;

3) External forces such as surrounding rock pressure and groundwater.

(3) According to the inspection report, there are 39 voids behind the secondary linings within the survey line in the right tube, among which 29 voids were found in the vault survey line; 9 voids were found in the arch waist survey line; and 1 void was found in the side wall survey line. There is a cavity between the partial secondary lining and the initial support, which makes the secondary linings bear uneven forces.

4 Tunnel treatment design

4.1 Overall design concept

As the tunnel is an important passage from Chongqing to Beibei, it is under heavy traffic pressure and needs to be opened to traffic as soon as possible. This treatment is defined as an emergency rescue project. Therefore, the general concepts of treatment design are as follows:

(1) For segments that have been given emergency reinforcement, adopt temporary reinforcement measures as far as possible, and the treatment measures of H-beam + shotcrete shall be adopted.

(2) For the remaining segments with serious diseases and has not yet been given emergency reinforcement, the treatment measures of grille arch frame + shotcrete are adopted this time to improve the construction efficiency.

(3) Strengthen observation and monitoring on diseases that do not affect structural safety.

4.2 Treatment design of temporarily reinforced segments

For the segments that have been temporarily reinforced, the following scheme is adopted:

(1) Review the treatment segments, and construct temporary protective frames in the segments to temporarily protect or relocate roads, pipe trenches, and electrical and mechanical facilities.

(2) Apply foot-locking anchors to the I18 I-beam that has been constructed.

(3) Chisel off the inner surface of the secondary lining concrete, clean the surface, chisel off hair,

apply interface glue, and plant shear pins.

(4) Mechanically groove the side wall to ensure that the H-beams are supported on a stable foundation.

(5) Replace the 18 H-beam at the side wall; a layer of steel mesh is placed outside the H-beams, and the H-beams are connected by connecting steel bars in the longitudinal direction.

(6) Repair the local area where the secondary lining has fallen off:

1) Cleaning, chiseling hairs off, and planting reinforcement on the interfaces of existing linings (three sides);

2) Spray CF35 accelerated steel fiber concrete, reserve the connecting bars for the later shotcrete, and proceed to the next step after it reaches the design strength.

(7) Spray 24cm-thick CF35 accelerated steel fiber shotcrete, and cure it to the design strength.

(8) The surface of the shotcrete should be polished, and reflective film should be applied to the ends.

(9) Restore the tunnel's mechanical and electrical facilities.

(10) Demolition of temporary protective frames, temporary supports, etc. (there will be entry and withdrawal every day during the construction period).

(11) Long-term monitoring of the entire tunnel (Figure 6 and 7).

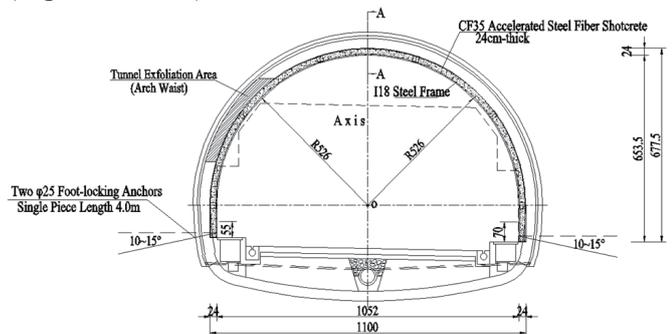


Figure 6. Treatment design for reinforced segments

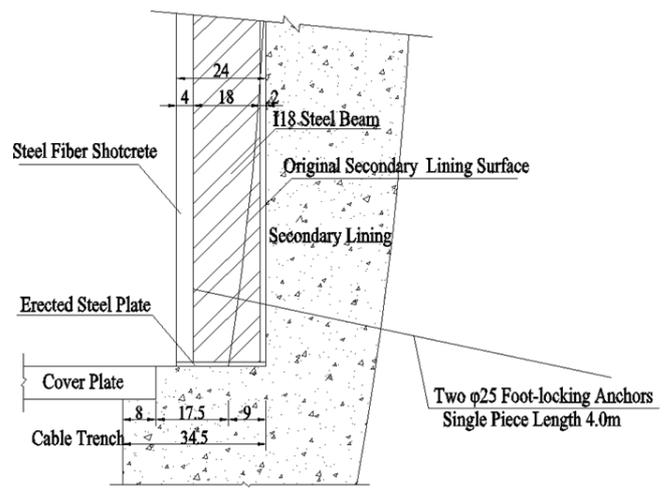


Figure 7. Design of h-beam bottom

4.3 Treatment design for segments not yet temporarily reinforced

For the remaining segments with serious diseases and the segments that have not yet been reinforced, the grille arch frame + shotcrete treatment measures were adopted this time:

(1) Review the segments to be treated, and construct temporary protective frames in the segments to temporarily protect or relocate roads, pipe trenches, and electrical and mechanical facilities.

(2) Chisel off the interior of the secondary lining concrete surface, clean the surface, chisel off hairs, apply interface glue, and plant shear pins.

(3) Mechanically groove the side wall to ensure that the grille steel frame is supported on a stable foundation.

(4) Construct H14 grille steel frames (grille arch frames should be prefabricated in advance), with a spacing of 0.3m; a layer of steel mesh is placed on the inside and outside of the steel frame each, and the steel frame is connected by steel bars longitudinally, and lock foot-locking anchor rods are used at the same time.

(5) Spray 24cm-thick CF35 accelerated steel fiber shotcrete, and cure to the design strength.

(6) The surface of the shotcrete should be polished, and reflective film should be applied at the ends.

(7) The electrical and mechanical facilities of the tunnel were restored.

(8) Demolition of temporary protective frames, temporary supports, etc. (During the construction period, there will be entry and withdrawal every day).

(9) Long-term monitoring of the whole tunnel (Figure 8 and 9).

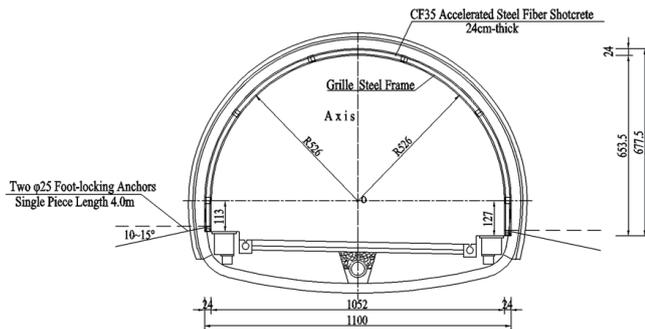


Figure 8. Reinforcement treatment design of grille steel frame

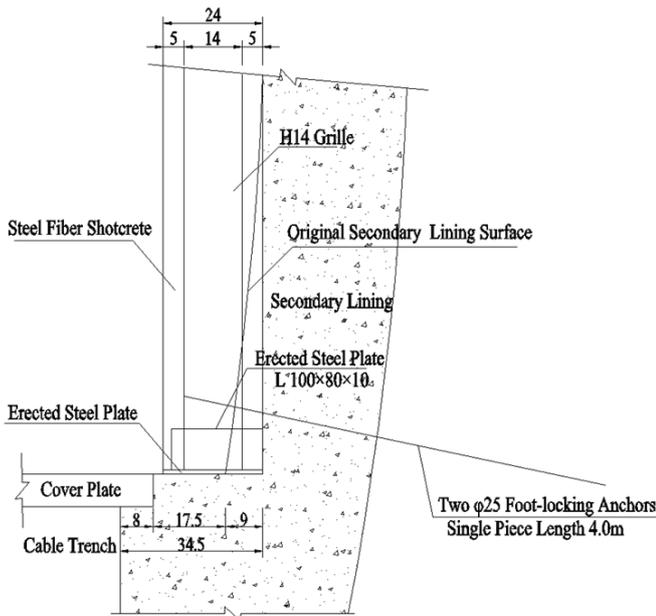


Figure 9. Bottom design of the grille steel frame

4.4 Special treatment of transverse passage intersections and reserved cavity

For the treatment of the transverse passage intersections and reserved cavities in the reinforced segments, H-beam + shotcrete measures were adopted for reinforcement this time. The main construction steps and precautions are the same as the previous segments. At the same time, the intersection position is underpinned, focusing on strengthening the joint structure design. This is mainly manifested in the following parts:

The H-beam connecting steel bars are made of $\phi 22$ HRB400 steel bars, in staggered arrangement with circumferential spacing 0.5m; but the joints were densified within the 3m range of the main cavity with respect to the intersection (circumferential spacing 0.3cm); the underpinning structure adopts HM (250mm*175mm) structural steel, the longitudinal length was tentatively set at 5.3m (transverse passage intersection segment) and 4.5m (reserved cavity

part), the specific sizes were determined according to the actual size of the cavity on site; strengthened-end structure design (reinforcing ribs were provided on the upper and lower flanges), in which the foot-locking anchor rods were installed at the ends on both sides (Figure 10 and 11).

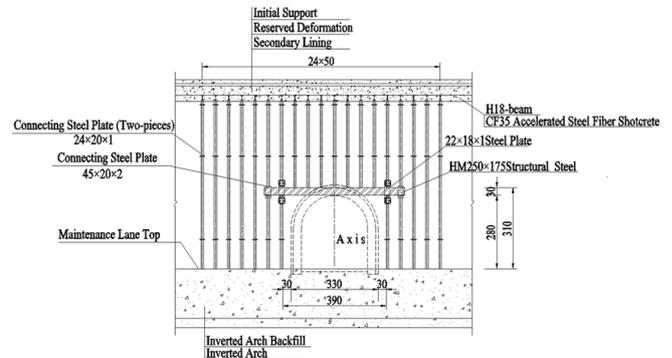


Figure 10. Treatment Design of the Intersection Segment of Transverse Passage

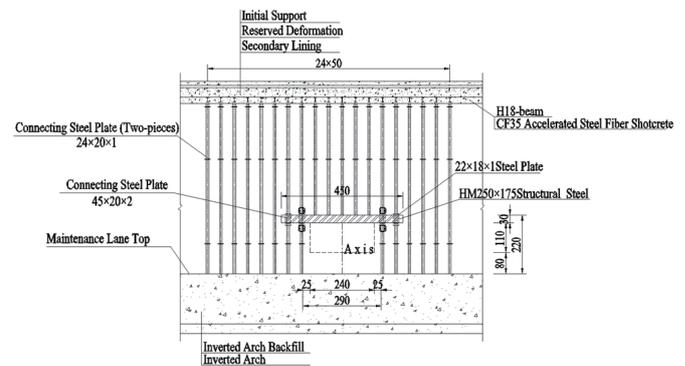


Figure 11. Treatment Design of the Reserved Cavity Segment

4.5 Disease observation and monitoring during construction

Disease observation content during the construction of the right tube of the tunnel: observation of the apparent disease of the tunnel, including network cracks, exfoliation, water leakage, and whether there are new cracks; strengthen the daily observation of the shotcrete segments to prevent the shotcrete from exfoliation. Disease monitoring content during the construction of the right tube of the tunnel:

- (1) Monitor the deformation of the lined vault and surrounding displacement of the treatment segment;
- (2) Monitor the stress of the existing frames in the treatment segment;
- (3) Monitor longitudinal cracks;
- (4) During tunnel construction, the frequency of observation and monitoring of related diseases should be strengthened, and any abnormalities should be reported in time to ensure the safety of tunnel

treatment.

4.6 Disease observation and monitoring during operation

Disease observation content during the operation of the right tube of the tunnel: Observation of apparent diseases of the tunnel, including network cracks, exfoliation, water leakage, and whether there are new cracks; strengthen the daily observation of the shotcrete segment to prevent the shotcrete from exfoliation. Disease monitoring content during operation of the right tube of the tunnel:

(1) Monitor 3 types of longitudinal cracks for crack sealing treatment;

(2) Monitor the internal force of the newly added steel support and the internal force of the steel strip and the stripped part;

(3) Monitor the tension of shotcrete;

(4) If possible, it is recommended to carry out long-term real-time monitoring of the tunnel.

4.7 Key points of construction quality control

(1) The position of the constructed joint of the newly-added arch must coincide with the position of the original structure.

(2) The minimum bond strength between the shotcrete and existing lining is 1mpa, and its cement strength grade is no less than 42.5.

(3) Start construction from both ends of a mold of concrete. After chiseled off the interior paint and concrete, steel-frame or grille arch-frame should be installed immediately, and then foot-locking anchors should be installed to ensure safety during construction.

(4) The surface and substrate treatment of the secondary lining in the middle segment must be carried out under the protection of H-beams on both sides to ensure construction safety.

(5) The shotcrete should be sprayed in place, and it is strictly forbidden to be incomplete or void.

(6) The shotcrete spraying operation should be combined with the on-site traffic organization time to arrange the construction time reasonably; longitudinal spraying can be carried out in segments, and layered spraying operations are strictly prohibited.

(7) Before shotcrete is applied, monitoring of crack deformations and strain and stress of H-beams (grille arch frames) should be conducted, and timely measures should be taken if there is any abnormality.

5 Conclusion

(1) In this paper, the cause analysis and emergency treatment design of the exfoliation of secondary lining of the tunnel were carried out with on-site disease detection, original tunnel design data and completion data. The scheme proposed in the paper played a very good role in the rapid repair of the secondary lining of the tunnel, active guarantee for the opening of the tunnel to traffic, and elimination of hidden hazards of traffic safety.

(2) After the tunnel reinforcement is completed, the content mentioned in the paper should still be monitored to ensure the long-term structural safety and operational safety of the tunnel.

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Safety Design Strategy for Highway Interchange Exit Ramp

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Abstract: Highway is an important type of road in China's road network, and it also carries a larger portion of transportation task. Safety is the first indicator in the stage of its use, so it is necessary to carry out safety design focusing on the highway interchange exit ramp to effectively prevent traffic accidents. Therefore, in this paper, the importance of the safety design of the highway interchange exit ramp and the key factors affecting its safety were discussed and studied in detail, and finally corresponding strategies were proposed for discussion and communication.

Key words: Highway; Interchange; Ramp; Safety design

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As a basic project type in social development, highway project can have a positive impact on the level of social development, and highway is also an important facility type in China's road network. Meanwhile, with the continuous improvement of the current living standards of the general public, private cars have also begun to enter tens of thousands of households, and the number of vehicles on highways has begun to increase. Therefore, the society is also paying more and more attention to travel safety issues. The exit ramp of the highway interchange is prone to traffic accidents. Therefore, it is necessary to actively carry out the safety design of the highway interchange exit ramp, and take scientific and reasonable measures to ensure the safety of the highway at the commissioning stage, avoid traffic accidents, and secure the safety of life and property

of the general public.

1 The significance of the safety design of the highway interchange exit ramp

In China's road network, highways are an important part of it, and they also undertake important transportation tasks. Interchange exits are an important part of highways. On the highways, the connecting roads are connected to the intersecting road turning known as ramps. The ramps are mainly put up to ensure that traffic flows in different directions will not interfere with each other and enter their routes orderly. Under normal circumstances, there are two functional requirements for interchange ramps on highways, namely, left turn and right turn. In practice, they are mainly put up according to the different needs of road guidance^[1]. The exit of the ramp determines the route of the vehicle entering the main road or exiting the highway. Under normal circumstances, there will be multiple ramps merging into the same lane, and if this situation exists, driving errors made by drivers may cause traffic safety accidents. Therefore, it is necessary to carry out the safety design of highway interchange exit ramps to ensure the safety of vehicles during driving, and at the same time ensure that the highway is fully functioning.

2 Factors influencing the safety of highway interchange exit ramp

During the commissioning phase of the highway interchange, safety is the most important indicator, and the exit ramp will be affected to a certain extent. Traffic safety accidents are prone to occur, which will have a certain impact on the safety performance of the

highway during the commissioning phase. Therefore, detailed analysis and research on the influencing factors of the safety of expressway interchange exit ramps are required to formulate targeted and perfect measures according to the types of influencing factors to fully ensure the safety performance of highway interchange and improve its safety. In summary, its influencing factors mainly include the following two points:

First, the impact of road factors: The safety of the highway interchange exit ramp during the commissioning stage will be affected by the road's own factors, and there are certain hidden hazards of accidents. For example, graphic design factors: for small-radius round-curved roads with highway interchanges, widening needs to be carried out, and sufficient space for vehicle passage has to be reserved on the road to reduce the probability of traffic accidents. In addition, longitudinal section design factors will also become a key factor that induces safety problems, which are mainly manifested in the impact of the slope of the highway interchange exit ramp on traffic safety, such as: If the slope is too steep, the vehicle must be braked to reduce the speed when going downhill. At this stage, the vehicle's braking system is prone to failure or slippery problems, and these problems will induce traffic safety incident once they occur. Therefore, setting the ramp slope reasonably has gradually become a key factor to ensure the safety of the highway interchange exit ramp.

Second, traffic factors: Traffic factors will also have certain impacts on the safety performance of the highway interchange exit ramp, and even in some cases, traffic safety accidents may also occur. For example: the traffic volume factor, that is, the actual traffic volume at the highway interchange exit ramp is greater than the designed capacity of the road, and the probability of traffic accidents on the road will increase accordingly, which will also cause traffic congestion and problems in other aspects etc, and have certain impacts on the public's experience of participation in transportation. In addition, when the proportion of large vehicles on the road is too high, certain safety risks will also arise, mainly due to the fact that the steering performance and acceleration/deceleration performance of large vehicles are far from that of small vehicles. Also, the blind spots of the vision of large vehicles are wider, rendering them

prone to accident types such as rear-end collisions or rollovers. At the same time, this factor is also a key factor type that threatens the safety of highway interchange exit ramps^[2]. In addition, the speed of vehicles passing through the highway interchange exit ramp will also have certain impacts on safety. In practice, due to the large speed difference between vehicles, there is a certain degree of dispersion between vehicles, resulting in the phenomenon of overtaking, thereby resulting in the problem of an increase in the incidence of traffic accidents. Therefore, it is necessary to take scientific and reasonable measures to avoid this phenomenon and ensure the safety of the traffic process.

3 Strategies for safety design of highway interchange exit ramp

3.1 Put up traffic signs reasonably

In order to ensure the safety of the highway interchange exit ramp and give play to the excellent performance of the highway, the first task is to put up traffic signs reasonably. First of all, traffic signs such as warnings and reminders need to be continuously put on the main line before the exit to remind the drivers of the position of the exit ahead and the occurrence of dangerous road conditions such as continuous downhill, so that they can serve as a reminder to the drivers^[3]. In addition, a large gantry-type traffic sign can be erected at the ramp exit to inform the drivers of the road conditions ahead, and then a turning and downhill warning sign should be put up before the small-radius section of the ramp to remind drivers to drive carefully and prevent accidents.

3.2 Put up deceleration infrastructures

The installation of deceleration infrastructures can also play a positive role in guaranteeing the safety of the highway interchange exit ramp. Therefore, in practice, it is necessary to fully consider the slope of the exit ramp to remind the drivers to control their speed^[4]. Under normal circumstances, it is necessary to put up a set of lateral deceleration markings at intervals above the main line before the diverge point, and put up the main line speed limit sign above the ramp exit, and need to be 200 meters above the ramp entrance. Put up horizontal deceleration markings within the range, and adopt the speed limit processing

method within the ramp, that is, put up a 60km/h speed limit plate at the entrance of the ramp to remind the driver to slow down and avoid traffic accidents due to excessive speeding, fully guaranteeing the safety of the highway interchange exit ramp.

3.3 Set up protective facilities on the curved downhill section

There will also be curved downhill sections at the highway interchange exit ramp. Therefore, it is necessary to set up protective facilities for the actual conditions of this section of the road to ensure the safety of the driving process. It is necessary to set the height of the roadside guardrail reasonably according to the principle of tolerance design, and strengthen the anti-collision level. SA grade semi-rigid wave beam steel guardrail should also be installed at the position of the curved road to avoid or reduce the injuries caused by traffic accidents and protect the safety of life and property of traffic users to the greatest extent. The selection of pavement materials for curved downhill sections requires the selection of pavement materials with excellent anti-skid performance to ensure stability during operation.

3.4 Optimize ramp alignment

In order to improve the safety of highway interchange exit ramps, it is also necessary to optimize the alignment of the exit ramps to ensure smoother passage of vehicles and avoid traffic accidents when vehicles drive pass. For example, engineering designers can conduct on-site surveys on the highway interchange exit ramps and then improve on the design plan. Where conditions allow, optimize the

horizontal and vertical alignment of the exit ramp. This can improve the traffic safety while ensure the smooth passage of vehicles out of the highway simultaneously, effectively reducing the probability of traffic accidents.

4 Conclusion

In conclusion, after the highway is put into use, ensuring traffic safety is a key measure, and the highway interchange exit ramp is the spot prone to traffic accidents, so it is necessary to analyze and discuss the influencing factors on traffic safety here in detail. After determining the reasons, take corresponding measures to ensure the safety of road traffic, such as: at the safety design stage, attention should be paid to setting up warning signs to remind drivers to drive carefully and slow down so as to prevent safety incidents from occurring at highway interchange exit ramp.

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Construction Safety Management and Construction Technology of Low-gas Tunnels

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Abstract: With the coordinated development of social economy and technology today, various advanced construction techniques and well-established management measures have begun to be widely used in coal-tunnel construction. However, in the construction process of low-gas tunnels, it will also cause a certain degree of adverse impact on the construction quality and safety due to the lack of technical experience and management experience to a certain extent. Based on this, this paper takes the actual tunnel project of a coal mine as an example to analyze the main construction technology and safety management measures of low-gas tunnels, so as to provide guarantee for the quality and safety of such tunnel construction.

Key words: Low gas; Tunnel construction; Construction technology; Safety management

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1 Introduction

With the continuous development of coal industry, the main construction technology and safety management in the construction of low-gas tunnels have begun to receive more and more attention from the society. Therefore, in the specific construction of low-gas tunnels, coal companies should strengthen their safety management and rationally apply their construction

techniques. In this way, the construction quality of low-gas tunnels can be effectively improved and construction safety can be guaranteed.

2 Project overview

The subject of this study is the construction of a low-gas tunnel in a coal mine. The mine is located in the western part of the Sichuan Basin. It is of lowland mountainous feature with a shallow to mid-cut structure, where the Longquanshan anticline has a greater impact on it. In this mine, most of the mountains are multi-faceted, relatively gradual, and the mountain tops are saddle-shaped or hump-shaped, rich in flammable gas in the cracks of rock mass and sandstone mass. Through the initial exploration, it was found that there was flammable gas overflow in the BK255700L20 borehole of the B-line of the tunnel under construction. The ignited flame was about 20-30cm higher than the hole, and it extinguished by itself after burning for 5 minutes^[1]. After detailed survey, it was discovered that when the hole depth of the tunnel line of BK255700L20 reaches 128m within the sandstone section, there will be flammable gas overflow. Its main component is methane and the pressure is about 0.12MPa. Such gas is usually found to accumulate in rock mass and sandstone cracks. From this, it can be determined that this mine tunnel is a low-gas tunnel. The following picture shows the actual shot of the low-gas tunnel construction:



Fig.1 The Actual Shot of the Low-gas Tunnel Construction

3 Analysis of main safety construction technology for low-gas tunnel

3.1 Gas inspection technology

The first is manual inspection. In this process, professional inspectors need to inspect the methane and carbon dioxide concentrations in the tunnel, and make detailed records of the inspection data, and finally report the inspection results to the safety director of the project department.

The second is the determination of the gas detection site. In the specific detection, the monitoring point can be allocated within 20m of the excavation surface, the dead corner in the cave, the front of the lining work trolley, the excavator, the loader, and the front of the tunnel car, switch and spot welding positions near the ventilator or in the hole, avoiding people or vehicles in motion, and other locations with poor ventilation. For each monitoring point, the gas inspection record board should be clearly put up, and each inspection result should be recorded on the record board and the corresponding record book in time, and then the inspected conditions should be reported to the manager^[2].

3.2 Low-gas tunnel blasting technology

First of all, check the following items: First, technicians need to check on-site electric lightning, explosives and other pyrotechnics every day to ensure that the charging structure is consistent with the drilling and blasting design. Second, management personnel should conduct spot checks on the connection construction of blasting nets, plugging, and charging. Third, before the blasting operation, safety inspectors need to check the gas concentration at the blasting sites every day. Fourth, after the blasting, safety inspectors need to check the gas

concentration, ventilation and coal dust at the blasting sites every day.

Before blasting, it is necessary to do a good job in the safety education of construction personnel, and strictly implement the two systems of "one shot, three inspections" and "three-person chain blasting". In tunnel drilling, drilling is mainly carried out in the form of wet drilling, and it should be carried out in the order of boiling water first and then air. In the wind flow within 20m of the operation site, the drilling operation should be stopped immediately if the gas concentration reaches 1%. Before excavation and tunneling construction, it is necessary to fully understand the actual geological conditions ahead through advanced survey. If there is a coal seam, the construction must be carried out by uncovering coal and preventing outburst. During the construction process, the inspection of gas concentration and ventilation should be enhanced, and the construction of advanced probing holes and deepened blastholes should be strengthened. In the specific blasting operation process, safety inspectors and gas inspectors need to jointly inspect the blasting site and do a careful inspection on the residual charge, unexploded charge, coal dust, gases and ventilation etc. 30 minutes after the blasting is finished. If an unusual situation is discovered, it must be handled properly immediately. If the gas concentration in the tunnel is within 1% and the carbon dioxide concentration is within 1.5%, the alert can be lifted, and then the construction personnel can enter the tunnel face to start work.

3.3 Ventilation operation

Before starting the construction of the low-gas tunnel, to ensure that each operation site has good ventilation, the operator needs to check the ventilation effect of each operation surface to ensure good ventilation. The ventilator bracket must be installed firmly to avoid shaking and falling off due to vibration during operation. At the outlet of the fan, the connection should be made through a rigid air-duct, and a gasket should be installed between the air-duct and the flange at the fan interface. At the position where the flexible duct and rigid duct are combined, three-to-one banding should be carried out to reduce local resistance and air leakage. For each working surface of a gas tunnel, independent ventilation must be ensured.

During the construction process, the continuity of ventilation must be ensured. If the ventilation has to be stopped due to power outages or overhauls, the construction personnel must evacuate from the tunnel in time and cut off the power supply. Before the ventilation is restored, the gas concentration inside the tunnel must be checked. The press-in fan is used in this project. In the specific inspection, the gas concentration within 10m of the fan must be ensured to be below 0.5% before the ventilator can be turned on manually. For the ventilation ducts inside the tunnel, a duct with good flame retardancy and antistatic properties must be selected. When the distance between the opening of the ventilation duct and the tunnel face is not more than 5m, it is strictly forbidden to remove the tunnel face duct during blasting.

During the installation process of the press-in ventilator, it should be placed in the fresh air flow of the tunnel to prevent the circulation of dirty air in the tunnel. For the ventilators inside the tunnel, two power sources should be available, and a wind power-locking device should be set up. If one power supply halts, the other power source can supply in time to ensure the normal operation of the ventilators.

4 Analysis of safety management measures for low-gas tunnel construction

In the low-gas tunnel construction of this project, safety management is mainly carried out through the following measures.

(1) The concentration of harmful gases in the tunnel shall be inspected by specialized gas detectors in accordance with specific requirements. Meanwhile, special attention should be given to the locations of excavation bumps and arches in the tunnel that are prone to gas accumulation. For these locations, gas inspection must be carried out well.

(2) In the construction management of the tunnel face, it is necessary to ensure that survey is carried out before the excavation, fully grasp the actual conditions of coal seams and gases, and predict dangerous and unexpected situations^[3].

(3) Strictly strengthen the management of blasting, ensure the quality of electric

(4) detonators and explosives, control the total delay within 130 milliseconds, and ensure that the

blastholes are sealed in compliance with relevant regulations. Before blasting, all personnel should be evacuated from the tunnel, and the distance between the detonation point and both sides of the tunnel opening should be controlled at more than 30m.

(5) During tunnel construction, open-flames should be prohibited, and construction personnel are strictly prohibited from carrying ignition supplies or tobacco into the tunnel. The use of open-flames should also be strictly prohibited within 20m of the tunnel openings.

(6) During construction, personnel should be strictly prohibited from wearing chemical fiber clothing when entering the tunnel.

(7) All personnel entering the tunnel should be equipped with safety protective

(8) equipment and be prepared with emergency rescue materials.

(9) During the construction, there must be assigned personnel on duty at the tunnel

entrance to register and inspect all persons entering the tunnel. They are strictly prohibited from entering the tunnel with prohibited items, and irrelevant persons should be strictly prohibited from entering the tunnel. And in the process of handover, both parties must sign and approve.

(10) Communication equipment must be provided near every construction work surface in the tunnel.

(11) Gas inspectors, blasters and electricians should all have certificates to work.

5 Conclusion

In summary, in the specific construction of low-gas tunnels, good safety technical measures and safety management are the keys to ensuring construction safety. Therefore, in specific construction, coal companies and construction teams must strengthen the management of construction safety and apply reasonable safe construction techniques. In this way, it is possible to eliminate potential safety hazards as much as possible, and to ensure the construction quality and safety of low-gas tunnels. It can also provide a better basis for the development of the coal industry and the satisfaction of social needs.

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Research on the Inspection Method of Chimney Appearance and Masonry Material Performance

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Abstract: As a high-rise structure, the safety of chimneys has always been a public concern. In this paper, the damage condition, tilting, and the strength of load-bearing materials of the chimney were inspected, and the inspection conclusions and maintenance suggestions were given based on the inspection results. The inspection method can provide relevant reference for the inspection of similar structures.

Key words: Chimney; Safety; Inspection items; Inspection conclusions

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This case project is a chimney built in the urban area for about 30 years. The residential area near the structure is crowded, and the safety inspection of the chimney is urgent. The inspection content in this case is the integrity of the chimney appearance, the tilting and the strength of the load-bearing material.

1 Project overview

The chimney under inspection is 40 meters high and has been built for about 30 years. The chimney foundation adopts a pile-cap foundation, and the format of the cap is a single-pile cap. The pile foundation is cast-in-place pile. The inner diameter at the top of the pipe is about 2.0 meters, and the diameter at the bottom is about 40 meters. The main load-bearing material is sintered ordinary clay solid brick. The design basis of the chimney structure is atlas 94G611 "Brick Chimney", some indicators in the atlas have been outdated far behind the current

04G211 "Brick Chimney" atlas in use.

2 Testing standards and basis

- (1) "Load Code for the Design of Building Structures" (GB50009-2001) (2006 Edition);
- (2) Engineering Construction Code "Standard of Structural Inspection and Assessment for Existing Buildings" (DG/TJ08-804-2005);
- (3) "The Method of Evaluating the Fired Common Brick Strength Grading by Rebound Hammer" (JC/T796-1999);
- (4) "Technical Specification for Testing Compressive Strength of Masonry Mortar by Penetration Resistance Method" (JGJ/T 136-2001);
- (5) Engineering Construction Code "House Quality Inspection Regulations" (DG/TJ08-79-2008).

3 Surveying and mapping of chimney building structure drawings

The data collection content of the overall conditions of the chimney includes the height of the pipe body, the thickness of the pipe wall and the lining conditions. The height of the pipe was surveyed and mapped in full-section on the upper structure of the chimney with a Leica Total Station. The thickness of the pipe wall was determined by the method of drilling and coring, and the lining conditions were obtained by the method of filming inside the chimney. According to on-site measurement data: the height of the chimney pipe is 40m, the bottom of the pipe is 490mm thick, and the pipe is lined all the way up to the top. Based on the above data and in conjunction with the current atlas, the schematic diagram of the chimney section was drawn (Figure 1).

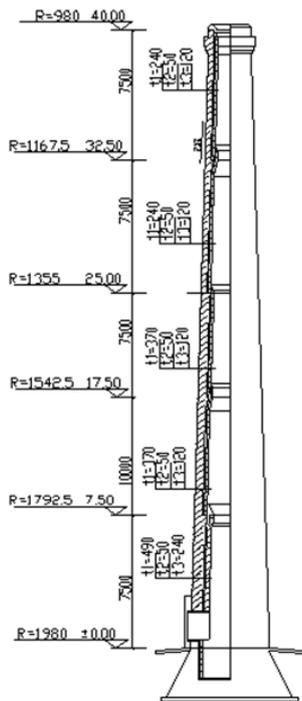


Figure 1. Schematic diagram of chimney section

4 Chimney damage condition inspection

4.1 The pipe

The overall conditions of the pipe are as follows: there are some small cracks on the top, while the rest is intact.

Leica TCR802 Total Station was used to survey and map the crack positions. The detailed conditions of crack surveying and mapping are shown in Table 1, and the schematic diagram of crack distribution is shown in Figure 2.

Table 1. Chimney cracks table

Crack Serial No.	B1	B2
Crack Length(m)	3	2

4.2 Lining

The chimney is lined to full height, it is in good condition and no significant cracks were seen.

Table 2. Measurement results of tilting at each measuring point

Measured Object	Measured Height Section(m)	Measured Height Section No.	K1 Station Site			K2 Station Site			Maximal Tilting(%)
			Δh (m)	Δs (mm)	Tilting(%)	Δh (m)	Δs (mm)	Tilting(%)	
Chimney	0~22	1	20.656	63.8	3.1	20.654	43.3	2.1	4.2
	0~32	2	31.409	95.1	3.0	31.407	92.9	3.0	
	0~39	3	38.776	146.0	3.7	38.775	93.0	2.4	
			39.159	163.2	4.2	40.256	170.7	4.2	

Δh is the difference in height from the bottom to the measuring point; Δs is the horizontal offset between the center of the section at each height and the center of the bottom

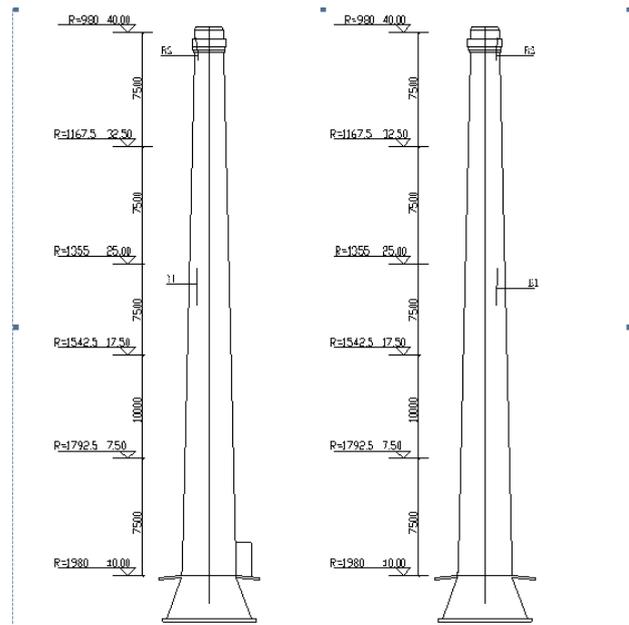


Figure 2. Illustration of chimney cracks

4.3 Auxiliary facilities

The external ladder and the rest platform of the chimney were all rusted. The top of the chimney was directly corroded and weathered by the flue gas, and the ladder and working platform at this part were particularly rusty.

5 Chimney tilting inspection

Multiple measuring points were set up at different heights of the chimney, where two Total Stations of the same model were used to measure the three-dimensional coordinates of the measuring points on site. The center at each height was calculated through the coordinates of the points, and then the centers at different heights were used to calculate the tilting of the chimney at different heights and the overall tilting separately, and the average of two measurements was taken as the final result. See Table 2 and Table 3 for local tilting and overall tilting.

The calculation shows that the tilting of each measuring height section of the chimney is less than 6.0‰, which meets the requirements of the specification. "The Code for Design of High-rise

Structures" (GB 50135-2006) stipulates that the maximum slope of the high-rise structure shall not be greater than 6.0‰.

Table 3. Overall tilting measurement results of the chimney

Measured Object	Difference in Displacement (mm)	Relative Difference in Height (m)	Tilting Direction	Tilting (‰)
Chimney	146	38.776	Northwest	3.8
	93	38.775	Northwest	2.4

The tilting direction of the chimney measured at two sites is northwest, and the average tilting is 3.1‰, which meets the requirements of the specification.

6 Inspection on the material performance of masonry structural components

According to "The Method of Evaluating the Fired

Common Brick Strength Grading by Rebound Hammer^[1]" (JC/T796-1999), a rebound tester was used to evaluate the strength of the blocks by testing the strength of the blocks in different measurement areas. According to the requirements of the specification, 12 and 7 test areas of the chimney had been tested respectively. The test results are shown in Table 4.

Table 4. Test results of the strength of common sintered bricks on the chimney

Serial No.	Testing Position	Average Rebound	Rebound Standard Value	Rebound Standard Deviation	Minimum Rebound	Deduced Strength Grade	Deduced Chimney Bricks Strength Grade
1	B1#	44.8	40.6	2.4	42.4	MU25	MU20
2	B2#	43.5	39.4	2.2	39.6	MU20	
3	B3#	46.0	43.0	1.7	43	MU25	
4	B4#	45.7	41.4	2.4	41.2	MU25	
5	B5#	44.4	41.8	1.4	41.8	MU25	
6	B6#	44.5	39.2	3.0	41.2	MU25	
7	B7#	44.9	40.0	2.9	40.6	MU25	

STY800B penetration mortar strength tester was adopted for the mortar strength test, the strength of blocks was evaluated by testing the strength of the blocks in different measurement areas according to

"Technical Specification for Testing Compressive Strength of Masonry Mortar by Penetration Resistance Method^[2]" (JGJ/T 136-2001). See Table 5 for specific test results.

Table 5. Test result of the compressive strength of chimney mortar

Serial No.	Testing Position	Average Penetration Depth (mm)	Converted Value of Mortar Compressive Strength(MPa)	Deduced Compressive Strength of the Chimney Mortar (MPa)
1	B1#	3.83	8.5	Average $f_m=9.2\text{Mpa}$ Minimum $f_{min}=7.8\text{Mpa}$ $f_{min}/0.75=10.4\text{Mpa}$
2	B2#	3.68	9.3	
3	B3#	4.00	7.8	
4	B4#	3.68	9.3	
5	B5#	3.53	10.2	
6	B6#	3.85	8.4	
7	B7#	3.22	12.5	
8	B8#	4.00	7.8	

According to the on-site inspection results, it was deduced that: the strength grade of the sintered clay brick is MU20, and the mortar strength is 9.2 MPa.

7 Inspection conclusion

(1) Appearance Inspection: There were two

longitudinal cracks on the top of the chimney, the longest crack length was less than 3 meters, and the crack width was less than 2cm. The interior of the pipe was lined all the way to the top, and the condition was good, with no significant cracks or damage found. The external ladders of the chimney

were all corroded, and the working platform was corroded severely.

(2) Tilting Inspection: The tilting of the main body of the chimney (including construction error) is lower than the permissible deformation requirements of the "Code for Design of High-rising Structures" (GB 50135-2006), and the tilting inspection results are in compliance with the requirements.

(3) Material Strength Inspection: Chimney brick strength grade is MU20, mixed mortar strength is 9.2 MPa, and the strength grade is higher than the material strength requirements in the current "Brick Chimney" Atlas (04G211) (sintered ordinary clay brick strength: MU10; cement lime mixed mortar strength: M5). The results of material strength inspection are in compliance with the requirements.

8 Repair measures and suggestions

(1) The cracks at the top of the chimney have a small coverage and a small gap width, which do not have a major impact on the safety of the structure. If no reinforcement measures are taken, the cracks will continue to develop under the influences from the external environment. It is recommended to repair the cracks. The repair method is suggested as follows:

① Reinforce the cement mortar surface with a

reinforced steel mesh of 8mm in diameter and spacing not more than 200mm (the thickness of the cement mortar surface is 50mm and the strength is M10), and grout the cracks with pressure grouting cement mortar. ② Along the length of the crack and within the range of 1m up and below, use a 60X5 flat iron to set up hoops along the pipe every 0.5m. Select hoops made of flat iron of the same model, and add fixed screws at both ends. The treatment method inside the crack is the same as step 1. The repair of the chimney should be entrusted to a qualified company. During the repair, climbing the bricks around the cracks at will is not allowed, and the repair personnel must take safety protection.

(2) It is recommended that the external steel ladder and the steel working platform be replaced.

(3) It is recommended that the horizontal section bearing capacity of the chimney and the reinforcement ring of the pipe be inspected.

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Treatment Design and Construction Strategy for Tunnel Mud and Water Inrush Disaster

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Abstract: With the rapid development of the transportation industry in China, the number and scale of tunnel construction are increasing. Tunneling through fault zones and other complex geological environments is becoming more and more common. In the construction of highway tunnels, due to the special geographical environment and complex geological conditions, mud and water inrush often occur in the tunnel. Water inrush disasters pose a major risk to the construction of highway tunnels and affect the normal construction of highway tunnels. This paper combines the engineering background of the tunnel mud and water inrush accidents, carries out evaluation on the accident treatment measures and the treatment efficiency, and summarizes the main concerns in the construction process and the technical guidelines for dealing with the tunnel mud and water inrush.

Key words: Tunnel; Mud and water inrush; Disaster treatment; Construction strategy

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1 Preface

With the rapid development of traffic construction in China, the number of tunnel projects is increasing, which not only brings huge engineering advantages, but also causes many engineering problems. Among them, tunnel mud and water inrush is one of the common engineering problems. The inrush of mud and water during the construction of highway tunnels

will adversely affect the safety of the project itself and the surrounding ecosystem.

2 Disaster form of tunnel mud and water inrush

2.1 Mud and water inrush in caves

After the mud and water inrush occurred in the tunnel, the disaster area should be investigated in time, and the cause of the mud and water inrush should be analyzed according to the local geological conditions. The bedrock in the tunnel area is mainly composed of mixed rocks (gneisses, gneiss, quartzite, etc.) formed by local metamorphism. However, due to weathering, the rock mass near the cave is shattered, and due to geological tectonic movement, the shattered rock mass gradually enters surrounding rocks, resulting in local intrusion of rock veins, greatly complicating the entire tunnel area and nearby geological bodies. The area around the tunnel is affected by two regional faults. One of these two regional faults is the north-south striking fault^[1]. Under the influence of two faults, the rock mass was squeezed and shattered. After a long period of natural weathering, some shattered rocks were peeled off into fine mineral particles, which mixed with the atmospheric sediments stored in the cracks to form mud.

2.2 Funnel

The tunnel is affected by the interactions of two faults. The surrounding rocks in this area are shattered and the overall stability is poor. When mud and water rush in, the surrounding rocks above

the cavity continuously supply the cavity under the actions of negative pressure and dead load. When the rock and soil shatter, the upper layer of soil collapses, eventually forming a funnel.

2.3 Dislocation cracking

When the surrounding rocks fracture, the upper surrounding rocks are sent into the cavity, forming a funnel. The soil around the rot pit has a large free surface, and the soil tends to become a free surface. Meanwhile, under the influence of the inrush of water and mud, the groundwater level suddenly drops, and the shattered rock and soil clumps redistribute the stress, leading to ground subsidence. The joint movement leads to the appearance of tension-type staggered cracks on the mountain^[2].

2.4 Faulting of slab ends

Under the influence of the water and mud sprayed out of the tunnel, the rapid decrease of groundwater and the redistribution of stress in the rock and soil lead to partial cracks in the national highway. According to the field investigation, the overall stability of the rock and soil layer at the southern end of the east-west fault is relatively good, and is not affected by the drop in groundwater level. Therefore, the subsidence in this area is relatively small and there are few cracks on the national highway. However, the overall stability of the rock and soil layers at the northern end is relatively poor, and is greatly affected by the drop in groundwater level, and there are many cracks in the area^[3].

3 Treatment design for mud and water inrush in tunnel

Considering the large area of karst development revealed by advanced geological drilling, the pre-grouting reinforcement should be comprehensively considered based on the scale of karst development, the relative position with the tunnel, filling characteristics, and groundwater level etc. The angle and number of grouting pipes should be determined according to the development of karst. The characteristics are determined according to actual needs. In other words, a comprehensive treatment construction plan called "mainly blocking, limited discharge, combining both blocking and discharge" was adopted.

4 Construction strategies for tunnel mud and water inrush

In order to prevent mud overflow in highway tunnels, follow the precautionary principle of "mainly blocking, limited discharge, combining both blocking and discharge", and adopt effective and feasible preventive measures. It should be adopted and implemented correctly to achieve the ultimate goal of "reliable waterproofing and worry-free drainage". The specific measures are as follows.

4.1 Mud jet treatment

The sludge discharge of highway tunnels should be controlled first, and pay attention to the prevention of the drainage treatment and blockage of the sludge, and prevent the sludge from entering the tunnel and affecting the tunnel construction. Effective waterproof and drainage measures should be taken to prevent mud gushing. More and more construction projects in China have affected China's ecological environment. Increase the requirements for project structures to avoid further damage to nature. In case of mud flooding, the groundwater system should be kept as unobstructed as possible. If the mud flow is too large and the surrounding trees are lush, drainage equipment must be used to drain the stagnant water. However, this weakened the bearing capacity of the surrounding rocks, resulting in project collapse, subsidence, and ground deformation, etc., which changed the overall structure and the construction of the tunnel, and at the same time affected the surrounding environment and dried the surrounding water. Therefore, if the amount of mud discharged is too large, anti-leakage measures must be taken first, and then discharge appropriately. The cement slurry is partially submerged by cement or other materials, and then the bedrock is reinforced to prevent the gap from expanding. The leakage will prevent the future tunnel from causing secondary threats, and the leakage will have a negative impact on the tunnel project and the ecological environment^[4].

4.2 Water supply and drainage treatment

Drainage pipes and buried pipes are used throughout the drainage process. Drainage pipes (horizontal, longitudinal, circumferential) are used to infiltrate the central drainage channel from behind the initial support, and the buried pipe directly leads the water sprayed from the tunnel. First of all, semi-spring drain

pipes should be used to support the ground for dense circumferential drainage, and several drain pipes should be arranged side by side. If the leakage point is obvious, the gap must be appropriately shortened. Especially when there are many drainage holes, the vertical gap should be further tightened, and the circular drainage pipes and the horizontal drainage pipes should be directly connected and introduced into the central drainage pipe. It is worth noting that the installation and recovery of horizontal drainage pipes, vertical drainage pipes and circular drainage pipes should be strengthened when pouring concrete to prevent cement slurry from penetrating into the pipes and causing poor drainage. Install drainage pipes in areas with a large amount of water and mud, and use buried pipes for water drainage. In order to prevent the water pressure in the karst cave from getting too high, steel pipes are buried in the concrete backfill structure of the karst cave. This is the main pipeline that relieves the water pressure from the cave to the exterior.

4.3 Post-treatment mud cracking and water leakage

After clogging the tunnel with mud and spraying water, due to various reasons, the best clogging effects may not be achieved. Placing mud can better deal with pouring water, reduce potential safety risks and damage to the surrounding ecological environment. In response to this situation, sprinkle concrete on the leaking parts for grouting, and take effective measures to ensure the infiltration of muddy water meets the standard, so as to ensure that the quality and control effect can reach the ideal state.

4.4 Emergency measures for public mud and water inrush

First of all, when a mud and water inrush occurs, the construction personnel should immediately report the problem to the supervisor, and do not panic or take wrong measures. Secondly, construction personnel must mobilize staff immediately after receiving the report to get a hold of the situation around the tunnel, determine an emergency plan for dealing with debris and floods, and set up an emergency team to deal with mudslides and floods. If the geological disaster is more serious, you should seek help from government departments. After the

emergency team arrives at the scene, they must check the situation at the scene, the severity of the disaster, personnel statistics and property losses, and pre-assess the damage caused by mud and water to the safety of the tunnel project. Please follow the on-site instructions to ensure effective handling in emergency response. Anyone injured or killed at the incident site should immediately contact the local hospital and rescue personnel to establish a temporary clinic at the incident site and prepare appropriate medical equipment, such as various medical supplies, medicines, equipment and other first aid supplies. Finally, if rescuers do not arrive at the scene, the emergency team will prevent the situation from worsening, prohibit personnel from entering, ensure the safety of construction personnel, reduce obstacles, and avoid mud and water inrush for rescue work to be carried out. Must be pre-processed.

5 Conclusion

The inrush of mud and water in the tunnel is one of the inevitable geological disasters and project water gushing in the construction of highway tunnels. When dealing with disasters, targeted measures were proposed to deal with the mud and water inrush according to the nature and geological conditions of the tunnel, thus ensuring the safety of the tunnel and normal construction.

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Discussion on the Safe and Guaranteed Access of Interchange Widening in Reconstruction and Extension of Highway

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Abstract: In the process of reconstruction and extension of highways, the most important thing is to ensure that the overall level of the widening of interchanges is comprehensively improved to ensure safe traffic. However, due to the heavy and difficult tasks in the widening of interchanges, higher requirements are put forward for the construction quality of the project. In the actual construction of the project, it is necessary to actively analyze and explain the specific construction of the interchange widening project to ensure that the improvement level of the interchange widening in highway reconstruction and extension project is effectively upgraded. This paper gives a detailed introduction to the main construction technology for interchange widening project, clarifies the technical points of safety and guaranteed access, and proposes corresponding safeguard measures to ensure the comprehensive upgrade of the construction quality and standard of interchange widening in highway reconstruction and extension.

Key words: Expressway reconstruction and extension project; Widening of interchange; Safety and guaranteed access

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The interchange widening project is the top priority of the highway reconstruction and extension. In the actual construction process, there will inevitably be a conflict between the new and old construction at the junction of the ramp and the main line. Moreover,

the safety of the construction of bridge superstructure will also be affected by the traffic flow and natural factors, which will hinder the construction progress, and the interchange widening project will cause the site to be very narrow rendering large-scale equipment unable to be used. In order to effectively avoid hidden dangers of safety incidents, it is necessary to conduct a comprehensive analysis on the characteristics of the construction of the interchange widening project in a timely manner, and to formulate corresponding construction technical plans based on the actual situation of the project.

1 The main points for the safe and guaranteed access construction of the interchange widening project

Most of the interchange widening projects are connected with toll stations, some toll stations do not relocate while some have to. Regardless of which connection method is used, the overpass or culvert channel in the interchange needs to be managed focusedly. As interchange widening project has the characteristics of complexity, variability, coordination, continuity, and interference, the interchange reconstruction in highway reconstruction project needs to strengthen the safety management of the construction site. However, due to the influence of climatic conditions, geological conditions, hydrological conditions, geographical conditions and other related factors, the highway reconstruction and extension projects are more complicated^[1]. At the construction site, due to the very large fluidity of materials, equipment and construction period,

the difficulty in safety management of highway reconstruction and extension projects will also elevate significantly as the project continues to introduce various new materials, new equipment and new processes. In the interchange reconstruction and extension project, different types of work are required in coordination with each other as it involves roadbed construction, bridge and culvert construction, pavement construction, safety protection, construction, electrical and mechanical construction, and greening, etc. In addition, there are many high-altitude electrical operations which require coordination and cooperation between different departments to ensure that the construction progress is effectively controlled, minimize conflicts caused by cross-operations, and reduce the incidence of safety accidents.

There are many segments involved in the interchange widening project. The entire construction cycle is very long, any problem in any segment is likely to cause interference to subsequent work and cause major safety incidents. The interchange widening project needs to ensure the normal operation of the traffic lines and avoid obstructing the traffic. Therefore, there are obvious safety hazards. The entire highway has a lot of traffic and is easily interfered by factors of vehicle driving.

2 Construction technology for widening of interchanges in highway reconstruction and extension project

2.1 Hoisting of prefabricated beams and slabs

It is necessary to strengthen the safe hoisting of prefabricated girder slabs in the safe and guaranteed access construction of the interchange overpass project. When installing at the first hole, two 50t cranes can be used in coordination with each other. When the first 50t crane installs the 8th to 9th prefabricated beam slabs in the gap of the first hole, the crane must be moved to a suitable position until the installation of the first hollow beam slab is completed. Each bracket of the crane can use the four 15×15cm square wooden support, and the safety and guaranteed access work of traffic control and vehicle directing should be carried out well^[2].

2.2 Construction of the junction between the old ramp and the main line in the interchange area

During the extension of highway, the main points

of the construction at the junction of the old ramp and the main line are inevitably involved. Therefore, proper treatment must be carried out on the entire roadbed, and some sections of the old ramp must be strengthened to achieve vehicle flow diversion. Reduce the interfering factors of traffic flow, and finally carry out the construction of the junction of the toll station and the old ramp. In the construction of new and old roadbeds, it is necessary to fully excavate strictly according to the overall thickness of the pavement structure as it needs to be destroyed, and then backfill the earth. After the construction of the new ramp is completed, the guardrails need to be removed, and the opening of the central sub-belt needs to be rebuilt and displaced to ensure the efficiency of the connection between the interchange ramp and the main line, and to ensure that vehicles are cut off to protect the normal passage of vehicles.

3 The main measures to speed up the safe and guaranteed access of the interchange

3.1 Organizational measures for safety and guaranteed access

In order to ensure the smooth completion of the junction between the interchange ramp and the main line and avoid affecting normal traffic, it is necessary to do a good job in manpower preparation, time preparation, and preparation of the format of guaranteed access in terms of personnel preparation. The entire project department has to set up a specialized team for safety and guaranteed access, select a safety engineer with rich experience as the team leader and equip the team with relevant personnel such as the technical group and coordination group etc^[3]. During the guaranteed access period, all construction adopts the format of closed-construction, and the interchange overpass adopts intermittent release traffic control. The intermittent construction adopts route changing, traffic control or continuous construction as the format of safe and guaranteed access at the heart-brain ramp interchange junction and the toll station. During the safe and guaranteed access construction, it is necessary to increase the construction management of the safe production responsibility system. This is also the key to all safe production management systems. The safe production responsibility system needs to strictly follow the guidelines for safe

production. Responsibilities of persons-in-charge, functional departments, and job positions at all levels must be clarified, and work safety tasks must be broken down to specific project leaders of relevant units.

3.2 Strengthen organizational leadership

In order to improve the level of coordination and overall planning during the safety and guaranteed access stage, it is necessary to establish a leading group for overpass dismantling in time, and group the toll substations to ensure safety and guaranteed access. Realize unified command and unified dispatchment to ensure the smooth development of the interchange widening project. It is also necessary to actively establish a temporary traffic command center to coordinate command and overall planning of traffic factors to ensure that the responsibilities and labor division of the teams in each zone are clarified. The construction team must be carefully arranged, including the dismantling group, the transportation group, the segmentation group and the clearing group. Each team member must closely cooperate with other team members to ensure the orderly management of the entire construction team. During the construction management stage, strictly implement the requirements of refined management, and strengthen the effects of target management and quality management. At the same time, establish a typical model, adopt an incentive mechanism to reward the good and punish the bad, and re-evaluate the actual operation at the construction site to effectively reduce the negative emotions of the construction workers.

3.3 Technical measures for safety and guaranteed access

In the development of safe and guaranteed access construction technology, we must first actively strengthen the technical disclosure of the plan, especially the full training of operators, so that they can master the correct construction technology, and ensure that their job positions are fixed, which is forbidden to change at will. Effectively implement the construction technical disclosure system to ensure the accurate and timely demolition of the overpass. In addition, it is necessary to plan the temporary site zoning well, because the construction site area is narrow, the construction tasks are too concentrated, and cross-operation is very prominent. In view of this

situation, it is necessary to strengthen the reasonable zoning analysis of different sites. Safety signs must be placed strictly in accordance with regulations. After the application is approved in advance by the Highway Administration Department, relevant safety warning signs shall be put up on the highway, and an expert shall be responsible for traffic command. All construction workers need to wear reflective vests on the old highway emergency parking strip to catch the attention of drivers^[4].

It is necessary to focus on strictly following the regulations of continuous construction and intermittent release during the mechanical construction at the junction between the old ramp of the toll station and the main line. The platform security is provided by the guaranteed access staff in coordination with traffic management 24 hours a day, and it is never allowed to affect the normal passage of vehicles. At the off-ramp, a striking slogan has to be put up to remind passing vehicles to slow down appropriately. Conical anti-collision buttresses need to be put up at the toll stations in the interchange area to make guidance signs, and construction management should be arranged for the junction to ensure the smooth passage of vehicles.

4 Conclusion

The widening of interchanges in the reconstruction and extension of highways is critical to ensuring safety and guaranteed access. Scientific and patient guidance is required during the construction process to ensure that all segments are fully implemented and improve management quality. In the safety management of construction sites, it is necessary to actively carry out publication and education work, through the exhibition of books and materials on safety production, so that the majority of construction personnel can master the rules and regulations of safe production. In addition, specialized operators are regularly trained to upgrade safety management experience to modern scientific management concepts. Only by continuously improving the quality of management can we ensure the smooth development of safety and guaranteed access work.

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Design Strategy of Highway Speed Transition Section

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Abstract: In this paper, combined with the relevant speed theory and characteristics of the law, the current highway speed transition design problems are studied and analyzed. In the process of specific analysis, mainly combined with the characteristics of different types of highway speed changes and road section design requirements, this paper studies and analyzes the design methods of different types of highway speed transition section. And on this basis, according to the design principles and requirements of highway operation speed transition section, the paper summarizes the matters needing attention in the design of highway operation speed transition section, in order to provide certain reference value for relevant personnel.

Key words: Road route; Operating speed; Transition section design; Strategy analysis

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1 Introduction

Generally speaking, scientific and reasonable design of highway speed transition section can not only effectively reduce the change of running speed between adjacent sections, but also improve the safety and rationality of highway route design, and provide good guarantee for driving safety. It can be said that the design of highway speed transition section can be regarded as the extension of highway route design method in China, which has important design significance. Combined with the previous design

experience, due to the influence of geographical environment and traffic flow and other factors, there are great differences in the performance of operating speed characteristics of highways at all levels in China. For example, for expressways and first-class highways, the driving speed has a decisive influence on the running speed on horizontal curves with different radii to a certain extent. For all levels of highway curve sections, the influence of curve length on the running speed is small, and the influence of entering speed and curve radius is large. That is to say, in the specific design process, designers should choose the appropriate design strategy for application according to the performance law of different road section speed characteristics.

2 Based on different types of highway design index and running speed change law research

In this paper, different types of highway design indicators and operating speed change law research, mainly according to a large number of built highway project comprehensive indicators and operating speed investigation, according to the design speed performance, the highway project is divided into the following types for research and analysis.

2.1 Class I

This kind of highway is mainly for the first-class highway with design speed ≥ 100 km/h and expressway in plain area. For the design work of the transition section of the operation speed of this kind of highway project, because of its flat and open terrain and relatively high design speed, the operation speed

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can be consistent with the design speed. According to the current design feedback, the running speed transition section under the condition of this kind of highway project can basically meet the running speed requirements of 100 ~ 120km / h. It should be noted that the terrain conditions of this kind of highway are good, and it is easy to cause the problem of speeding.

2.2 Class II

This kind of highway is mainly for projects with design speed between 60 km/h and 90 km/h. Generally can refer to the mountain highway and a highway. Due to the influence of terrain and construction scale, the design speed of these highway projects is lower than that of class I. And in terms of the overall linear index, it is not very high. That is to say, the running speed is easy to be affected by the geometric alignment conditions of the local highway, resulting in the reduction phenomenon. Generally speaking, on this kind of highway, drivers often take acceleration driving for operation^[1].

2.3 Class III

This kind of highway is mainly aimed at the highway section with design speed between 30 km / h and 60 km / h. generally, it is mainly two lane highway. Combined with the previous design experience, the design of two lane highway is easily affected by the project scale and cost factors, so the selection of the current design index needs to consider a number of factors for reasonable determination. Generally speaking, highway line shape design will give priority to the use of the principle of bending with the ditch. Therefore, for this kind of highway project, the horizontal curve radius is usually less than 250 m. From the aspect of speed change, due to the limitation of horizontal curve radius, the vehicle will be forced to slow down in the process of driving on curve road or long steep slope road. Combined with previous experience, the running speed of vehicles in these two sections should be strictly controlled within the specified range, that is, 40 ~ 60 km/h.

3 Analysis on design strategy of transition section of different types of highway operation speed

Combined with the above contents, it is not difficult to see that except for class I, there are obvious differences between the operation speed and design

speed of the other two kinds of highway projects. The main reason is that the speed difference between the two kinds of highway projects in the adjacent sections is too large. At the same time, the running speed of some sections is inconsistent with the design. Therefore, the contradiction between highway alignment design and driving expectation is easy to occur in the operation process. In order to solve this problem in time, we need to optimize the operation speed transition section for the above three types of highway projects, as follows.

3.1 Type I design strategy

This kind of highway project has a high performance in terms of operation speed, and there is often little difference between the design speed and the operation speed. Therefore, there is no need to pay attention to the design of speed transition section. However, it should be noted that this kind of highway project has superior performance in geometric alignment conditions, and can support higher running speed, which can easily lead to the problem of vehicle speeding. Combined with the past experience, the problem of vehicle speeding in this section is much higher than the other two types of highway projects. Therefore, in the design process, designers should check and analyze the superelevation and sight distance according to the actual running speed of the section, so as to ensure the driving safety^[2].

3.2 Class II design strategy

This kind of highway project is easy to be affected by the local geometric alignment, and there are fluctuations in the running speed. In addition, there is a big difference between the running speed and the design speed of some sections, so in the design of the running speed transition section, we can add a speed transition section to ensure that the section has enough transition length. At the same time, in the design process of the transition section, the designers should combine the determination of the technical indicators of the route with the transition operation speed, in order to achieve the purpose of good operation speed control. In the specific design process, designers should reasonably determine the technical indicators according to the running speed of the section. In addition, the transition section of super-high subgrade should be set scientifically in combination with the change of running speed. At

the same time, do a good job in the inspection of supporting work to ensure the traffic safety of the highway section.

3.3 Class III design strategy

This kind of highway project is easily affected by the cost factors and regional environmental factors in the process of planning and design, which leads to the comprehensive consideration of many factors in the specific design. Combined with the past experience, this type of highway can mainly reflect the characteristics of deceleration in the curve and acceleration out of the curve. As the speed of the road section changes greatly, in the specific design process, the designer should reasonably set the speed from the overall design point of view. And on this basis, combined with the actual situation of running speed, the super-high transition section and driving sight distance are set reasonably. It should be noted that according to overtaking and other requirements, overtaking sections can be set at intervals of good linear conditions to avoid dangerous driving^[3].

4 Analysis of matters needing attention in the design of highway running speed transition section

First, the design of highway speed transition section should be combined with horizontal and vertical design index parameters to realize continuous transition design process. For all types of highway projects, the plane and vertical design index should not be widely used in the design of high limit index. Instead, the transition design process should be relaxed according to the balance of the front and back indicators.

Second, the proportion of curve to total mileage should be appropriately increased in the design of highway speed transition section. Combined with the previous design experience, it is not difficult to see that when the longitudinal slope of the route is slow, the running speed is easily affected by the radius of horizontal curve, resulting in the phenomenon

of speed slowing down. In view of this, in order to ensure the safety of the driving process, designers can use the growth horizontal curve to achieve good speed relaxation.

Third, the design of highway running speed transition section should take the running speed as the final speed to realize the design process of superelevation and widening. In the specific design process, designers should make overall planning and reasonable deployment for the highway superelevation design and widening design according to the running speed and numerical performance of specific sections. And according to the speed numerical feedback, do a good job in the inspection of driving safety sight distance, to ensure the safety of the car driving process^[4].

5 Conclusion

In a word, in order to ensure the accurate implementation of the design work of the transition section of highway operation speed, it is suggested that the designers should take the initiative to make overall planning and reasonable deployment of the relevant design work in combination with the type of highway project and the surrounding factors, so as to ensure the design effect of the transition section from many aspects as far as possible, and provide a good guarantee for the driving safety.

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Pollutant Sources and Foaming Control Measures of Decarbonization Solution in Natural Gas Purification Plant

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Abstract: Yanbei project of Schlumberger Copower Oilfield Engineering Co., Ltd. - natural gas purification plant decarbonization unit is equipped with two sets of decarbonization systems (parallel operation). The two sets of systems adopt two tower process, full lean liquid circulation regeneration process, one tower absorption (absorption pressure 5.4mpag), one tower regeneration (regeneration temperature 95°C ~ 110°C), purified natural gas carbon dioxide content $\leq 2.5\text{vol}\%$, single set The treatment capacity is 2300 KM³ / d. This paper introduces the problems existing in the decarbonization solution of the decarbonization unit in the natural gas purification plant in recent three years, analyzes the causes of pollutants affecting the quality of the decarbonization solution, and probes into the control measures for the pollution of the decarbonization solution, so as to provide reference.

Keywords: Natural gas purification plant; Decarbonization solution; Foaming reason; Control measures

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1 Introduction

Decarbonization is the process of removing carbon dioxide from the mixed gas, which is mainly used in the treatment of raw natural gas or coal gas. The main component of decarbonization solvent is N-methyldiethanolamine (MDEA), which is usually colorless or yellowish viscous liquid. It can dissolve with water and alcohol, has low reaction heat, stable chemical properties, non-toxic and difficult

to degrade. It has strong absorption capacity for acid gases such as carbon dioxide. In the absorption process, the solubility of non-polar gases such as hydrogen, methane and higher hydrocarbons is very low, so it is difficult to purify. The loss of effective components in natural gas is small; the whole absorption process belongs to physical and chemical absorption process, and the regeneration process needs external heat source. The by-product carbon dioxide has high recovery and purity ($\geq 99.5\%$ dry basis). After simple treatment, it can be used for carbon supplement in urea synthesis. MDEA solution decarbonization method has many advantages, such as high acid gas load, low regeneration energy consumption and low corrosion to equipment. However, foaming is easy to occur in the process of natural gas desulfurization and decarbonization^[1]. After solution foaming, the treatment capacity of natural gas purification unit will be reduced, the carbon dioxide content of purified gas will exceed the standard, or the alcohol amine solution will enter the downstream unit with the natural gas flow, resulting in potential safety hazards and economic losses. Economic losses^[2]. This paper introduces the changes of MDEA solution, treatment capacity and corrosion in the process of natural gas decarbonization, summarizes the actual operation experience, and puts forward some suggestions on the operation and management of MDEA solution.

2 The existing problems of decarbonization solution in natural gas purification plant are summarized

Since the operation of the decarbonization unit in the purification plant in 2018, only a small amount of

MDEA solution has been supplemented every year. However, with the continuous high load operation of the unit, there are gradually problems such as solution foaming in the absorption tower and regeneration tower, decarbonization efficiency decreasing, solution loss increasing, solution color changing from light yellow to dark brown, etc. when the wall thickness of the MDEA rich liquid pipeline elbow is detected,

the pipeline elbow is also detected. There are different degrees of thinning. At the beginning of 2021, the purification plant analyzed the MDEA lean solution and found that the concentration of acetate and thiosulfate ions in the solution was on the high side, while the concentration of chloride and sodium ions was on the high side. (Table 1 is the main analysis index of MDEA lean solution)

Table 1. Main analysis indexes of MDEA lean solution

Category	Test items	Unit	Test methods	Test results
Chemical composition	Total amine concentration ^a	%wt	GB/T 9722-2006	53.7
Nonmetallic anion	Acetate	mg/L	SY/T 7001-2014	675.4
	Chloride ion	mg/L	SY/T 7001-2014	85.6
	Oxalate	mg/L	SY/T 7001-2014	5.4
	Thiosulfate	mg/L	SY/T 7001-2014	96.6
Metal cation	K	mg/L	Consult HJ 700-2014	34.1
	Na	mg/L	Consult HJ 700-2014	82.6
	Fe	mg/L	Consult HJ 700-2014	5.9
	Ca	mg/L	Consult HJ 700-2014	Not detected, <5

When the concentration of acetate is high, MDEA solution is degraded after long-term use, and acetate, oxalate and other heat stable salt ions are generated^[3]. Oxygen or other impurities in feed gas can react with amine to form a series of acid salts, such as chloride, formate, acetate, thiosulfate, etc. The relatively weak salt formed by H₂S and CO₂ and amine solution will decompose during regeneration heating, while the salt formed by other acidic components in feed gas and amine solution will not decompose during heating, and can not be regenerated by heating and desorption. These salts are collectively referred to as heat stable salt (HSS). Because the anion of the thermal stable salt formed is easy to replace the combination of sulfur ion and iron ion on iron sulfide, the dense iron sulfide protective film on the inner wall of pipeline and equipment will be destroyed, and the corrosion of pipeline and equipment will be accelerated. Although the allowable concentration of thiosulfate is high, it will accelerate the formation of N, n-di (hydroxyethyl) glycine, which is the degradation product of MDEA, and N, n-di (hydroxyethyl) glycine is one of the important factors causing corrosion^[4].

3 Analysis of pollution sources affecting decarbonization solution of natural gas purification facilities

3.1 The operation fluctuates greatly

The results show that the system has fast loading and

unloading, large fluctuation of working pressure, too much external heat supply of reboiler in regeneration tower, too fast gas-liquid contact speed, and excessive stirring of amine solution. Defoamer can effectively reduce the surface tension and completely diffuse in the gas-liquid interface, thus reducing the surface elasticity and viscosity. Defoamer molecules are easy to disperse and absorb, resulting in a low strength surface film. In the diffusion process, defoamer molecules can effectively reduce the thickness of liquid film of bubbles, destroy the stability of bubbles and make bubbles explode. The diffusion coefficient of defoamer must be greater than 0 in order to be a thermodynamic spontaneous process. If the foaming agent of the defoamer is determined by many experiments, it means that the defoamer will not be spontaneously and evenly dispersed on the surface of the defoamer, so it can continue to play the defoaming role. There are two kinds of Defoamers in common use, one is the foaming agent which can reduce the surface tension of two layers of liquid film to form the breaking point, the other is the foaming agent which can inhibit the formation of bubbles.

3.2 Surfactants

Surfactant is easy to cause solution foaming. Common surfactants include corrosion inhibitors and lubricants. The mechanism of surfactant affecting the foaming of MDEA solution is that the surfactant molecules are arranged on the surface of the liquid

membrane in an orderly manner, and the hydrophilic groups of the molecules continuously attract the liquid part of the liquid membrane. Lipophilic groups can effectively prevent liquid evaporation, and at the same time, these two functions make bubbles relatively stable and not easy to break.

3.3 The influence of solid particles

The solid particles in the solution mainly contain corrosion products, such as steel slag in pipes, FES, Fe in carbon steel equipment, etc., and activated carbon which plays a role of filtration is gradually crushed and becomes finer in the process of use. These solid particles gather in the liquid film of the bubble, increase the surface viscosity and flow resistance of the liquid film, slow down the flow of the liquid film, and increase the stability of the bubble. Iron sulfide particles have the greatest influence on the foaming performance. Moreover, the suspended iron sulfide Solid Particles in the solution, when flowing at high speed in the heat exchanger pipeline, will accelerate the iron sulfide film falling off, thus accelerating the corrosion of pipeline and equipment.

3.4 Natural gas contains H₂S

If natural gas contains H₂S, H₂S will react with MDEA solution to reduce the active components in MDEA solution, which is also a kind of pollution. At the same time, Fe reacts with H₂S in process gas to form FES (Fe + h₂s-fes + H₂), which can promote the fusion of MDEA solution with a small amount of hydrocarbons. In natural gas of absorption tower, hydrocarbons can become strong foam stabilizers and cause severe froth.

4 Research on the control measures of decarburization liquid foaming in natural gas purification plant

4.1 Amine purification unit

The device mainly removes the thermally stable salt from the system to reduce the corrosion of the equipment, reduce the increase of bound amine and reduce the foaming frequency, so as to improve the efficiency of decarbonization solution. In order to keep the solution clean, a bypass filter system is used to effectively remove mechanical impurities, iron sulfide and decomposition products. Filter about 10%

MDEA solution (6 ~ 7m³ / h) before the inlet of lean solution pump. In the first step, a mechanical filter with a filtration accuracy of 10 μ m is used to remove large solid particles from the solution. In the second step, the activated carbon filter is used to remove the small particles while desorbing the decomposition products of the solution. In the third step, the mechanical filter with a filtration accuracy of 5 μ M can filter the activated carbon powder and other small particles carried upstream^[5]. By adopting the above measures, the mechanical impurities, iron sulfide and decomposition products in MDEA solution are greatly reduced, and the solution system is gradually stable.

4.2 Purification of feed gas

Feed gas contains many components, such as oily wastewater and various surfactants, which can cause bubbles in the solution. Therefore, before the introduction of feed gas, a coalescence filter is set up, and a filter element with a filtering accuracy of 10 μ m is used to remove most of the solid impurities and oil impurities in the gas phase. The pollution and loss of MDEA solution caused by solid-liquid impurities carried by gas phase are reduced as much as possible.

4.3 Strengthen the blowdown and make up the desalted water in the system. If necessary, the solution can be filtered by external circulation online

The foaming of MDEA solution is mainly affected by the impurities entering the solution, the solution itself and the thermal stability of decomposition products. The impurities and sediments can be discharged from the system through low point blowdown, and the frequency and duration of blowdown can be increased appropriately, and then the desalted water can be added to maintain the liquid phase equilibrium of the system. When the solubility of MDEA is lower than 40%, fresh solution should be added to keep the overall concentration of the solution at about 45%. When the impurity content of the solution is large, the external filtering and degreasing device can be used to filter the MDEA solution online to remove most of the system It can be divided into solid impurities, sediment and oil impurities^[6]. In addition, underground tanks and storage tanks storing MDEA solution are protected with nitrogen to prevent oxygen in the atmosphere from polluting the solution.

5 Summary

Through the study of decarbonization solution, it is found that: it is widely used in coal acid gas purification and acid gas removal of gas, oil field gas, refinery gas and city gas, and has good selective adsorption effect on H₂S and CO₂. It is commonly used in the purification of synthetic ammonia, methanol production gas and natural gas purification process. According to the characteristics of decarbonization solution, this paper analyzes the existing problems of decarbonization solution in natural gas purification plant and the causes of pollution sources of decarbonization solution, and puts forward the strategy of decarbonization solution in natural gas purification plant.

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The Distinction of the Major Design Principles of Planning Systems and How They Potentially Impact Planning Outcomes

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Abstract: This paper addresses how different urban planning systems play their role in the development of cities, and how this directly affects the role and status of urban planning in social construction, and how to determine the social awareness of urban planning. By contrasting and defining the challenges and advantages of the regulatory, discretionary and hybrid urban planning systems, as well as examining the potential possibilities of each system, which system is more effective will become apparent. Therefore, planning and policy implementation can be more extensive and special. At the same time, a sound planning system can form relevant information feedback to propose amendments and adjustment methods for the city's planning content and policy and planning operation, which comply with the objective requirements of urban development.

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1 Introduction

Planning systems are established in various countries according to their own legal system, administrative system, form of land ownership and differing development goals. Planning is the government's tool of controlling and managing land use according to the legal system. The planning system directly identifies or affects the content and procedures for planning permission required for land development

and construction projects^[1].

2 Regulatory systems

Regulatory planning systems are a direct planning tool that plays an important role in urban planning systems. Control and regulation as an important stage in the planning system, its implementation based on an evaluation of the city^[2]. In the frame of the urban planning system of a lot of countries, regulatory detailed planning becomes the key basis of development control. At the same time, due to the unique regulatory control, evaluation has certain particularity. For example, the implementation process of Harlow S.person has been divided into several parts. Each part has a multi-level and hierarchical model from the top down. Under the actions of an "institutional mind", these parts will be in accordance with the established strategies then implemented on a schedule. With this method, Person believes the operational process of planning is guided by "system thinking". There is a simple combination for the original part of each unit. At the same time, this system is easy to determine the costs and benefits of policy plan, predicts the future development situation and advance to deal with^[3].

The main strength of a regulatory system is that it protects the interests of the public, rather than permitting the development of a single block of control. With the development of city planning evaluation theory, the viewpoint is that planning results and design principles should not be a simple relationship. A regulatory system should see whether the planning implementation scheme embodies the

main intent of the plan. Therefore, evaluation of the implementation of planning should determine whether it does protect the interests of the public, and how to balance the public interest and related interests. However, full regulatory implementation is not necessarily good. In the implementation of any adjustment of a plan, the core objectives of the control rules should be achieved. Therefore, the main weakness is the investigation of the current situation of construction. The core position of regulatory rules is the management of development and construction, and there is a certain procedural regulation for the adjustment of regulatory planning and management.

3 Discretionary systems

Compared with the regulatory planning system, the discretionary planning system is more flexible and the most representative example of it is the British planning system. The regulatory system needs to take into account the details of each scheme and predefined standards or specifications, whereas the discretionary system has a distinct difference^[4].

The discretionary system is generally based on case law and previous cases as the basis of decision-making and policy formulation^[3]. In general, there is no detailed plan for this type of planning, only a schematic representation of development. This type of planning does not specify the content of control. Instead, it sets forth the policies and objectives of development, and decides the specific implementation plan and measures for the control and management of planning. The text of the plan is an exposition of the general land use policy and development policy, and does not stipulate specific land use. Therefore the discretionary planning system provides a large discretionary space for planners and statesmen.

Although one of the most important features of the discretionary planning system is its flexibility, it also has great uncertainty. Specifically, a plan has only defined the goals and policies of development, which is used to guide the development, and the specific control and management work is carried out only through development control^[2]. In addition, statutory planning is only one of the factors for planning approval. Because of this discretionary power, there may be a lot of randomness in planning examination and approval. There is also a need for the urban planning and the various interest groups (including statutory bodies, such as central government agencies

and local governments, and other institutions, such as non-governmental organisations, neighbourhood communities, etc.) to negotiate.

4 Hybrid systems

Hybrid systems demonstrate connections with the previous two systems. To a certain extent, developers can independently evaluate the mixed-use land for more dominant use, and delineate certain areas as related or irrelevant for these purposes^[5]. The dominant use must be chosen in line with the provisions of government guidance and it must fully accept all planning documents. Finally, it is also uncertain. How to develop, and how to develop the government has not put forward a clear regulation. Certainly It is necessary for developers to make decisions on the basis of market autonomy. Such investment is bound to have a certain risk, but at the same time it also makes the maximum use of the land, and thus it is possible to build a prosperous city.

As early as the 1960s, Jacobs strongly advocated the diversity of the city in her book, *The life and death of the great cities of the United States*. She believes that the city is a product of human settlement. Thousands of people live in cities, and people's interests, abilities, needs, wealth and tastes are all different. She pointed out that, from an economic point of view or from a social perspective, cities need to be as complex as possible and support each other's functions to meet people's needs.

5 Potential impact of planning practice

5.1 "Central cities" in Germany

Germany is a typical example of a country with a regulatory planning system. Its planning is achieved through a vertical, consensus-oriented institutional framework^[6]. In response to the social and economic consequences of unity and European integration, the German plan has tried new regional associations. The main goal of the German government is to make the whole society more equitable and sustainable under the framework of reasonable planning. However, the realisation of this goal requires different levels of planning. In order to achieve this goal, the German government first established a federal-state relationship to foster redistribution to poorer and more remote rural areas. The measures that need to be strengthened include: infrastructure, financial

incentives, tax preferences and the priority of federal contracts. This undoubtedly strengthens the design of Germany inspatial terms, not only for investment, but also in the areas of urban development and protection.

In order to minimise social differences in the use of space, the German government has also defined and planned a hierarchical system of "central cities". According to the importance of different regions at the city level, the "centre" is planned to provide services and infrastructure for the surrounding areas so that they may obtain more service functions^[7]. In spite of this, it does not rely on the private sector to perform planning functions in Germany. The federal building law requires municipal authorities to formulate local land use plans, which are both vertical and horizontal. They prepare, discuss and modify the unconstrained preliminary plan, and there is then a vote on the final plan by the local legislature.

5.2 The town and country planning in Britain

The Town and Country Planning Act of 1947 established a very important feature for the British planning system, that is to separate ownership and development rights for land. Ownership of land can be private, but the right to develop belongs to the government. Any development construction requires a planning licence and the approval of the government. This important rule has not changed since 1947, and continues to this day. Specifically, the Town and Country Planning Act stipulates that, except for special provisions, all development projects must apply for planning permission. That is to say, developers (or investors) need to apply for planning permission to satisfy local planning and management departments according to the "development plan".

A "development plan" is the legal plan of the UK. Since 1960s, the "development plan" has included "structural planning" and "local planning", as well as the corresponding "unified development plan" suitable for metropolitan areas after adjustment by government institutions. "Structural planning" is compiled by county government. "Local planning" is compiled by the local government. The local government can be either a city or a town government or a rural area government^[4]. According to the new British planning law, a "development plan" features two kinds of planning. One is the "Regional Spatial Strategy", compiled by regional governments and institutional organisations. The other is the "Local

Development Framework" compiled by local government. An important feature of the local development framework is also a key point in the transformation of the development planning system, which is a clear mechanism for planning to respond quickly to the uncertain world and development^[4].

5.3 The "white-site" planning concept in Singapore

According to the amendment of the 1964 Planning Act of Singapore, under a planning permit, the development activity may exceed the prescribed development intensity or the changes specified in the zoning use^[5]. The "white-site" planning concept in Singapore is a potential impact of a hybrid planning system. Under the premise of clear dominant use, the government allows developers to build for some mixed purposes related to their main purpose, in order to improve the flexibility of land use. Started by Singapore's URA in 1995, white-site planning allows developers to provide more flexible space for construction and development. The proportion of land use nature, land-related other mixed use, and land for various uses is permitted by the government as long as the development and construction conform to the construction requirements. During the rent period of the "white site", the developer can freely change the nature and proportion of the mixed land according to the requirements of the contract, without paying an additional premium^[5].

For example, the developer can decide at the beginning of the business land of "white site". In the future, if market demand is increasing, some other types of land can be flexibly converted to retail business, without a special application and land premium. This point same as the conclusions of the case study by Emily Talen, she purposed that after the implementation of the plan, the zoning relationship between the residents and the public facilities should be similar to that of the planning^[8].

6 Conclusion

The planning system needs to provide a mechanism with a rapid reaction capability and an ability to grasp opportunity and make decisions in a short time^[9]. These three types of planning systems have advantages and disadvantages, and it is hard to say which one is superior to another. A country's planning system is closely linked to the country's specific legal system, its historical culture and its political

background. At different stages of development, different planning management methods can be adopted for different regions. First, we need to ensure that the public interest should emphasise the optimisation and function of land use overall, to ensure the urban function of public facilities of the space implementation, reasonably determine the scale and layout of the relevant facilities, and to implement the land. At the same time, in-depth study is required to meet urban public health standards and public safety needs in relevant elements, such as sunshine, lighting, ventilation, and fire protection, and make detailed provisions, with implementation under the guidance of management. At the same time, flexibility in land control should be improved by increasing the mixing function of land use.

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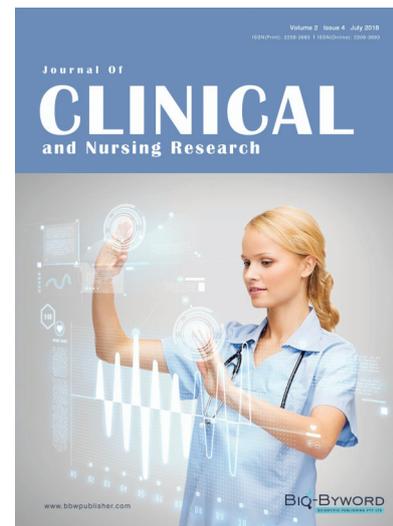
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