Optimal Concrete Mix Design and Finish for Skateboarding Performance

Lohgan Spencer
California Polytechnic State University
San Luis Obispo, California

Abstract

While concrete has been used in construction for hundreds of years, the introduction of concrete to skateboarding is a relatively new development. Concrete and concrete finishes are very well studied in the context of buildings and building design. Shotcrete is also very well understood as it has been in use for over 100 years. Because it is a relatively new sector of the industry, concrete skatepark construction is an area that has plenty of room for research and development. This research paper will describe the finish methods and mix designs used for concrete skatepark construction by leading skatepark construction companies and professionals. Professionals from both the project management side and the field side will be interviewed. The interviewees also identify some other factors that affect concrete skatepark surfaces. This paper will also describe the results of data gathered in the field from surveys at two skateparks. This data will compare the theories of concrete skatepark construction methods with the results of the finished product and its performance as viewed by the actual users. Overall this research aims to discover the optimal mix design and finish methods for concrete skateparks based on skateboarding performance on the concrete surface.

Key Words: Concrete, Skatepark, Finish, Method, Performance

Introduction

Skateboarding is a relatively new sport that only gained popularity in the early 1960’s. Skateboarding originally developed as a way for surfers to practice their moves on land (Public Skatepark Development Guide 2023). In the early days of skateboarding, the only place to ride was on the streets and sidewalks. As the sport got bigger the concept of a “skate park” was created, a place built only for the purpose of skateboarding.
The first concrete skatepark was built in 1965 and was called Surf City skatepark, located in Arizona (Jeff G. 2023). There are almost no pictures of the skatepark besides some advertisements. The second concrete skatepark was built in 1976 and was called Carlsbad Skatepark, located in Carlsbad, California. This skatepark was well documented for its time and there are multiple photographs of the construction of the skatepark as well as the finished surfaces.

![Figure 1: Photograph of the Carlsbad skatepark showing concrete surface and joints](Source: Dose Skateboarding 2022)

As seen in Figure 1, the surfaces of the earliest concrete skateparks were not very flat nor were they very smooth. The skatepark had just been invented, the optimal finishing methods and concrete mix designs for skateboard performance were not known or even necessarily considered yet. However as the sport progresses and the skill of skateboarders increases, the need for a quality concrete surface becomes highly important. When a concrete skatepark is designed and built now, it requires an experienced construction team that specializes in skatepark-specific concrete construction. A selection of these professionals were interviewed as part of the research for this project.

**Literature Review**

When researching this topic, little to no existing literature was found that encompasses the questions of this paper. However, the topic of concrete mixtures and finishes as they relate to typical slab and
building construction are well researched. This literature review will go over some of the basic properties of concrete mix designs and concrete finish methods.

A concrete mixture is made up of three main ingredients; cement, water, and aggregates. There are also many other chemicals and additives that can be used in the concrete to produce different effects such as speeding up curing time, increasing strength, and improving the workability. A very common type of cement used in concrete is Type II Portland cement. This type of cement is used in normal structures and in places where the concrete might be subjected to groundwater containing sulfates (Kosmatka & Wilson 2011). Figure 2 shows the visual ratings of concrete made with different types of portland cement in sulfate soil over time. The aggregates used in concrete vary in size depending on the type of structure and the type of pour. Aggregate size can range from rock that is 1-2 inches all the way down to sand. There are many grades of aggregates that are defined by ASTM (Kosmatka & Wilson 2011). Shotcrete is a type of concrete application where concrete is sprayed out of a hose at a high velocity. Shotcrete generally uses smaller sized aggregate because of this application method and to ensure that the concrete flows through the hose smoothly (Kosmatka & Wilson 2011). Shotcrete is mainly used on vertical and slanted surfaces because it can be applied quickly without sagging since the impact force helps to consolidate and compact the concrete (Kosmatka & Wilson 2011).

Fly ash is a substance that can be added to concrete to improve its workability and increase its strength and durability when cured. Fly ash is the most widely used supplementary cementitious material (SCM) in the industry (Kosmatka & Wilson 2011). Fly ash is a recycled material which is a byproduct of the combustion of coal in electric power plants (Kosmatka & Wilson 2011).

There are many different methods of finishing concrete depending on the type of finished surface that is required. The type of surface that concrete skateparks require is a hard trowel finish. It is important to time the troweling well during the curing process to ensure the best results. The concrete should be finished with a steel trowel either by hand or with a power trowel (Daskolov 2015). The fifteenth edition of “Design and Control of Concrete Mixtures” states that the density, wear resistance, and smoothness of the surface can be improved by implementing multiple trowelings. Allowing a period of time between the successive trowelings will mean that the concrete is harder and the trowel can create a smoother surface (Daskolov 2015).

**Methodology**

**Interviews**

The first part of the research conducted consists of interviews with industry professionals. The interviews were held in a casual conversation style which allowed for ideas and information to be shared beyond the confines of the questions. These professionals were chosen based on industry standing, concrete knowledge, skateboarding knowledge, and years of construction experience. Three separate industry professionals were interviewed, all with slightly different backgrounds in skatepark construction. The interviewees were all presented with the same set of ten interview questions. These questions aimed to establish skateboarding experience, establish construction experience, and to gain information on concrete-specific skatepark construction materials and methods.

The interview questions are:

1. How many years have you been in construction?
2. What is your position/area of expertise?
3. Do you skateboard?
4. How many skatepark projects have you worked on?
5. Is there an optimal/standard concrete mix design for skateparks?
   a. Aggregate size
   b. Cement type
   c. Additives
6. Is there an optimal/standard finish method for skateparks?
   a. Method or surface coat
7. Is there a difference in mix design and finish method for shotcrete vs. poured concrete?
8. Can you explain the variation in different skatepark surfaces?
9. Are there different surface types requested by customers?
10. How much does wear/weathering over time affect skatepark surfaces?

**Surveys**

The second part of the research conducted is a survey taken of individuals at two local skateparks in the San Luis Obispo County area. The survey was printed on paper and given to the participants to be filled out by hand, and sampled random skateboarders at these skateparks who have agreed to participate in the research survey. The survey consists of five questions that aim to establish skateboarding experience, establish level of familiarity with the specific skatepark, evaluate the concrete surface of the skatepark according to performance, compare the concrete skatepark surface to other skateparks, and evaluate the impact of the concrete skatepark surface on the performance of the skateboarder.

The survey questions are:
1. How long have you been skateboarding?
2. How many times have you been to this skatepark?
   - Less than 10 times
   - 10 to 30 times
   - Over 30 times
3. How would you describe the concrete surface of this skatepark?
   - Smooth
   - Slippery
   - Average
   - Rough
   - Other: ________
4. How would you compare the surface of this skatepark to other skateparks?
5. Has the surface of this skatepark affected your speed, ability, or way you skate at all?

**Results**

**Interviews**

The first professional that was interviewed is a project manager at one of the largest skatepark construction companies in the United States. He has been working in construction for over 20 years and has completed over 120 skateparks across the country. He stated that the industry standard mix
design for skatepark concrete would be a 4000 psi concrete or shotcrete with ⅜” minus pea gravel and a hard trowel finish. One additive that was identified to improve the finishability of the concrete surface is fly ash. Some of the factors that he believes are responsible for the variation in the surfaces of different skateparks are age, craftsmanship, and trowel finish method. Sealants can be applied to the surface of the skatepark after construction to preserve the concrete finish. One type of sealant is a topical sealant that sits on top of the surface and provides a shiny surface coat. The other type of sealant is a penetrating sealer which penetrates the concrete and binds with the top layer of concrete. The penetrating sealant can be applied as needed throughout the years of a skatepark life to preserve its surface quality. In his professional experience he finds that the surface of the skatepark is at its best after about a year of the skatepark being used and worn in.

The next professional that was interviewed is a concrete contractor that places and finishes concrete who has been in the construction industry for 22 years. He has skateboarded his whole life and has worked on over 25 skatepark projects throughout his career. His area of expertise is in the troweling and finishing of concrete. The concrete that he has worked with for skateparks is mostly air entrained 6000 psi concrete with ¾” minus gravel. The air entrainment of the concrete makes it easier to shoot out of the shotcrete pump and is useful for shooting the ramps and transitions of skateparks. He stated that the finishing of the concrete and the timing are the most important factor in getting a desirable surface. The industry term of “light fuzz” was used to describe the optimal finish method for skatepark concrete. To achieve a light fuzz the finisher would have to run the trowel flat over the concrete while it is still wet before the concrete has cured too much. In contrast to this, the method of running the edge of the trowel over the concrete while it is still wet would give it a slick finish and could result in a slippery skatepark. Older concrete skateparks generally have a rougher surface, which is due to the deterioration of the concrete over time by the elements such as rain and sun.

The final professional that was interviewed is an avid skateboarder who has been working in the construction industry for 11 years, specializing in concrete for 7 of those years, and has been a certified shotcrete nozzleman for 2 years. He has worked on about 15 public city skatepark projects and a number of private backyard skateparks. The standard mix design that he has worked with for shotcrete is a six sack mix that has ⅜” minus aggregate and heavy sand. Using a blend of 60/40 sand to aggregate mix helps stack the concrete on the transitions and bring up the “cream” of the concrete. Depending on the location of the skatepark, some areas require air entrainment to protect against freeze-thaw cycles. The air entrainment allows for the concrete to heat up and cool down while controlling the expansion and contraction of the concrete, which prevents cracking in the concrete surface. This professional also identified the optimal finish method for a concrete skatepark as being a “light to medium fuzz”. This fuzz is accomplished by limiting the number of passes during the finishing process to keep the surface from getting too smooth or slick, and by using the flat face of the trowel rather than the edge. The vertical transitions use shotcrete and are done first while the flatwork is done after the verticals and uses regular concrete. This ensures that the flat surface of the skatepark is not marked up or scratched by shotcrete hoses or tools, and keeps the skatepark surface smooth. The variation in different skatepark surfaces was explained by new sealant methods, more skateboarders being involved in the skatepark construction as opposed to crews that did not skate, and the skill and methods of the finishers.

**Surveys**

The plans and specifications for the Santa Rosa Skatepark in San Luis Obispo, CA were obtained from the San Luis Obispo City Planning Department. These documents are public record because the project is a public city project. Upon examining the documents the concrete mix design and finish methods were identified. The 4000 psi concrete mix design included type II moderate portland
cement, clean water, \( \frac{3}{4} \)" minus aggregate, fly ash class C or F (City of SLO PWD 2014). In terms of the concrete finish method, the plans stated “All skate park concrete shall have a smooth hard trowel finish unless otherwise noted” (RRM Design Group 2014).

The random survey was conducted with 9 individuals at the Santa Rosa skatepark using the 5 questions listed above. The amount of years that the individuals had been skating for ranged from 2 months to 16 years. The calculated average number of years of skateboarding experience was 10.01 years. The percentage of participants that had been to the Santa Rosa skatepark less than ten times was 11%, while 11% had been to the skatepark 10-30 times, and 78% of the participants had been to the Santa Rosa skatepark over 30 times. The majority of participants rated the surface of the skatepark as smooth as seen in Fig. 3, only 11% of the participants gave the skatepark a rating of average. Comparing the Santa Rosa Skatepark to other skateparks, the responses were all positive. Some of the responses were; better than most other skateparks, just as good as other skateparks, one of the best skateparks, and this park is preferred. 33% of the respondents answered that the surface of the concrete skatepark did not affect their performance, while 67% answered that it positively affected their performance as seen in Fig. 2. One respondent said that the surface made it easier to balance on the skateboard. An unexpected response was that the smooth surface made falling less painful, which two participants said. Lastly, three of the participants responded that the surface of the skatepark allowed them to skate with more speed.

![Skateboarding Performance Affected by Concrete Surface](image)

*Figure 2: Graph showing percentage of skateboarders whose performance was affected by the concrete surface at each skatepark.*

*Source: Author Lohgan Spencer*
The mix design documents for the brand new skatepark in Nipomo, California were obtained from the company that performed the concrete work on the project. The shotcrete mix consisted of cement, water, ¾" minus aggregate, sand, air, and class F fly ash (Patrick W. Imhoff 2022). Also added to the mixture were two chemical compounds called Zyla 625 and Darex II AEA (Patrick W. Imhoff 2022). Zyla 625 is a product added to the concrete to give the concrete greater plasticity, higher compressive strength, and to produce a concrete with a lower water content. The product also improves the finishability of the concrete and makes the texture more homogenous and more creamy (Patrick W. Imhoff 2022). Darex II AEA is an admixture that entrains air in the concrete. Air entraining is mainly used to prevent damage from freezing and thawing. The finish method for this skatepark is unknown.

The survey at the Nipomo skatepark was conducted with 8 individuals selected randomly. The number of years of skateboarding experience that the participants had ranged from 7 to 23 years, with the average number of years being 11.5. Of the individuals surveyed, 37% of them had been to the skatepark less than 10 times, 13% of them had been to the skatepark between 10 and 30 times, and 50% of them had been to the skatepark over 30 times. The majority of the participants (67.6%) rated the skatepark’s concrete surface as smooth as seen in Fig. 3. One participant rated the surface as both smooth and average, 10.8% rated the surface as slippery, and one participant rated the surface as “perfect”. The participants compared the concrete surface of the Nipomo skatepark to the concrete surfaces of other skateparks in a variety of ways. Some of the responses received were that the concrete surface was smoother than other skatepark surfaces, that the surface was sticky compared to other surfaces, the surface was better than other surfaces, and that the concrete surface was standard. As shown in Fig. 3, when asked if the concrete surface affected their skateboarding in any way, 50% of the respondents said that it did not affect their skateboarding while 50% of the respondents said that it did. Of those that said that the concrete surface of the skatepark did affect their skateboarding, 100% of them said that it improved their ability on the skateboard.

**Analysis**

With the information and data gathered from the interviews, skatepark plans, and surveys, it seems like there is a very standard mix design for skatepark concrete in the industry. The optimal mix design is a concrete or shotcrete with a strength of 4,000-6,000psi, ¾ -5/8 inch aggregate, portland cement, and fly ash. Some of the factors that were determined to improve the concrete either for smoothness, workability, or durability purposes were the various chemical compounds added to the mix. Fly ash is used in the concrete to improve the workability and thus create a better finished surface overall. Air entrainment in the concrete not only increases the durability of the concrete but also helps the
shotcrete flow through the hose easier. Chemical water-reducing admixtures can be used in the concrete mix to obtain a more complete hydration of the portland cement, which can increase flatwork finishability.

The optimal finish method for a concrete skatepark is a hard trowel finish. All of the professionals that were interviewed identified this as the optimal finish and also stated that it was one of the most important determining factors of a smooth concrete surface. The data gathered from the surveys also concluded that a hard trowel finish is best as the Santa Rosa skatepark surface was rated smooth by 89% of the participants. The term “light fuzz” was used to describe a nuance of concrete finishing that helps create a smooth surface without making it slippery. Putting a light fuzz on the concrete surface involves running the flat face of the trowel over the concrete rather than the edge of the trowel. This helps give the concrete surface a slight texture for grip while remaining smooth and fast for skateboarding performance.

When comparing the data collected in the surveys at the Santa Rosa skatepark in San Luis Obispo with the skatepark in Nipomo, California there are many similarities. Both skatepark mix designs used ¾” minus aggregate for the shotcrete. This is a standard size used in shotcrete because of the restraints due to the size of the hoses. Both skateparks also used fly ash in the concrete mix. Fly ash was used to improve the workability of the concrete and to create a better surface finish overall. Both skateparks had a majority rating of smooth for the concrete surface. However the Nipomo skatepark did receive one rating of slippery while the Santa Rosa skatepark received none. This is most likely due to the fact that Nipomo is brand new and has not been worn in much. One participant in the Santa Rosa survey made a verbal comment that the skatepark used to be more slippery when it was first built, and got worn in over time. So this seems like it is a normal process for skateparks. Both survey results showed that about half of respondents said that the concrete surface affected their skateboarding and about half said it did not. Of those that said the skatepark surface did affect their skateboarding performance, they all claimed that it impacted it in a positive way, either by improving their speed or ability.

The main factors that influence the differences in concrete surfaces between different skateparks are maintenance and upkeep, quality and experience of the finishing crew, and the troweling method. Maintenance of the skatepark surface is important because concrete naturally deteriorates over time due to factors like sun, rain, and wear. Sealant coats can be used to protect the concrete surface shortly after the skatepark is completed, and can be applied about once a year to maintain the surface quality. The quality of the finishing crew and troweling method are important because there are small techniques used that can have a large impact on the final surface, such as giving the concrete a “light fuzz”.

The concrete surface of a skatepark is very important for skateboarding performance, as shown in the results of both surveys. About half of all survey participants said that having a smooth surface to skate on positively affected their skateboarding performance in various ways such as balance, fall risk, speed, and overall ability.

**Conclusion**

This research has helped identify the standard mix designs and procedures used in the concrete skatepark industry. It has also noted the variables that are responsible for variations in different concrete skatepark surfaces. Finally, it has gathered data on skateboarding performance on the concrete surfaces of two skateparks. Through this research the optimal mix designs and finish methods for high performance skateboarding were discovered. For future research on this topic, a study of a concrete skatepark over time would be valuable. A study over multiple years of a skatepark’s life would be able to better understand how weather and wear affect the concrete
skatepark surface over time. It would also provide an opportunity to study the results on performance from applying a sealant coat to the concrete surface throughout its life.

References


City of San Luis Obispo Public Works Department, Engineering Division. (January 2014). Contract Documents for City of San Luis Obispo Santa Rosa Skatepark. Specification No. 90752


Imhoff P.W. Proposed Concrete Mixture Design Nipomo Skatepark, October 13, 2022


3 Anonymous Interviewees