Current Trends in Horse Stall Design for Equine Housing: A Case Study of Commercial Centers in Peninsular Malaysia

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ABSTRACT

Horse stall design plays a vital role for every horse owner and equine center. In early planning stage, it is crucial to decide the factors that may affect the design of the horse stall as poor construction stall which reduces horse performance. Hence, it raises number of injury cases and lower the horses confident. The objective this study is to investigate the current design component of commercial equine center. The chosen five (5) commercial equine centers are well-known equine center with criteria including active operating livery services and frequent conducting equestrian competition. Data collection using the checklist in observation to six (6) main component which are dimension, door, ventilation and lighting, partition, interior (watering and feeding) flooring, and drainage. The results of study shown that the stall dimension typically used in commercial equine centers is 12 x 12 ft in stall size, 7 ft in wall height, and 15 ft in ceiling height. Galvanized iron material for door, approximately 5 ft and 6 ft door width, 4 ft door height, placing the door on the left of the horse stall with door hinges and bolt were used. The air circulation fan and natural ventilation as well as electric light fixtures and natural lighting from outside. Combination of brick or concrete with metal for partition material for stall at height of 7ft or 8 ft. Heavy-duty yellow plastic for water and feed were used and placed front side of stall. The flooring are used concrete with cement along with rubber matt for absorption. Overall, the current stall design trends for equine housing in commercial centers in Peninsular Malaysia prioritize enhancing the well-being and performance of horses. The key characteristics of these trends involve roomy and well-ventilated stalls, high-quality construction materials, and features that enhance natural light and airflow. Moreover, there is an increasing focus on ergonomic design features intended to improve horse comfort and minimize the likelihood of damage. These patterns highlight the changing comprehension and emphasis on equine welfare among facility managers and owners in Malaysia's equine industry.

Keywords: Equine, commercial center, stall design, design components

INTRODUCTION

Malaysia’s horse industry is not a new industry in Malaysia even it has been introduced since 19th century but not yet attract public involvement (Bashir, 1993). In the late 1980s, the equestrian activities and sport staggeringly increase although the development was quite slow (Fadilah Darmansah, 2017). Factors like high cost of feeding and management, restricted clientele and lack of knowledge and interest among the community made the development of the equine industry more challenging (Fadilah Darmansah, 2019). A prevailing tendency in the horse business indicates that an increase in service provision correlates with a broader range of facilities offered to clients. As equine proprietors become increasingly discerning, there is a consistent trend towards enhanced amenities in various stall and stable configurations (Eastwood et al., 2008; Extension Horses, 2019; Dai et al, 2023).

According to Batty Smith (2015), maximum form building can be converted into looseboxes or stalls, which building is sound and the roof is sufficient in height. Stumpy roof is hard and expensive to alter. The roof height

is important for both ventilation and clearance for the horse's head. Few buildings provide sufficient space to incorporate feed and tack rooms. The ventilation might be more difficult to organize, as the farm roof are often tiled or slated. Horse stalls offer effective housing for numerous animals, minimizing labor and bedding expenses. However, these stalls limit the horses' mobility and fresh air access, potentially leading to boredom and stereotypical behaviors like wall-kicking, especially when they face bullying from nearby stalls. This setting may also worsen respiratory issues due to inadequate ventilation and exposure to ammonia accumulation from suboptimal bedding selections. Effective stall design, appropriate bedding selection, and administration are crucial to alleviate these concerns and enhance equine welfare (British Horse Society, 2023).

Stalls are separately enclosed compartments for horses, where they are tethered and often confront unadorned walls. This design may inhibit natural movement and social connection, potentially resulting in stress or stereotypic behaviors like cribbing or weaving (Horse Care Naturally, 2024; British Horse Society, 2023; Hi-Hog Farm & Ranch Equipment, 2024). Typically, the stall places water, feed, and hay in front of the horse for easy access by both the caretaker and the animal. This configuration reduces waste, enhances feeding efficiency, and facilitates meticulous observation of the horse's consumption (American Stalls, 2023; Horse Journals, 2024; Penn State Extension, 2023). While some horses experience confinement anxiety and resist settling in stalls, the majority exhibit contentment when afforded enough care, enrichment, and exercise chances. (Horse Journals, 2024; British Horse Society, 2023; International Society for Equitation Science, 2023). The advantage of stalls is allowing more horses to be housed in a smaller space. They are warm, practical, save labor and bedding also the cheapest type of stable to build. They are specially appropriate as day standing for horses and ponies from the training and can be very useful in riding schools (Batty Smith, 2015).

DESIGN COMPONENTS OF HORSE STALL

Based on previous study Lesimple et al., (2019)**,** Fadilah Darmansah (2017), Batty Smith, (2015) and Wheeler (2006), Figure 1 shown the six (6) main components in horse stall which are dimension of stall, interior, partition or wall, ventilation and lighting, flooring and door.

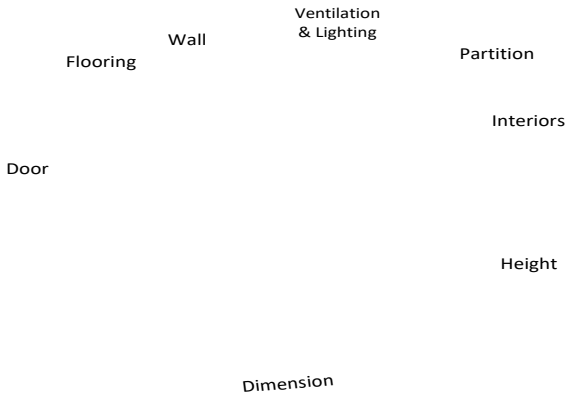

Figure 1: Horse Stall Component

Dimensions of Stall

The size, breed, time spends and abnormal behavior of the horse help to identify the horse stalls size. To be able to turn around, lie down, and get up safely, it is recommended to have a larger space for a larger horse. A 12 x 12-foot stall is the most suggested size for 500 kilogram and above horse. The stall structure that smaller and wall less than 10 feet in length are not recommended due to lack of ventilation and lighting inside the stalls (Wheeler, 2006). The securely contained stalls in two rows, with an aisle in the middle.

Commonly the stall length is one and half times the horse's length. The stall size is justified by the time and horse routine. A divider between two regular stalls can be removable to allow more space for a mare and foal or a draught horse. A split height needs to be at least seven and half feet to keep horses from having legs over the wall. It can be assumed that a typical eight-foot high stall partition (Wheeler, 2006).

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For years, there has been a suggestion for opening doors four feet wide by eight feet high. But this is not always found inside building stalls. The stalls were 0.20 meters lower than the aisle and were divided by 1.30 m of hardwood walls with 1 m of vertical lattice bars, 6 cm at the top of the stalls. (Werhahn, Hessel, Bachhausen, & Van den Weghe, 2010). A side door open slightly over 7 feet with a 42 to 45 inch width stall door producers normal furnished (Wheeler, 2006). This is the percentage of the real open space that the horse can freely move through in and out of the stalls. The front sliding doors are 1.5 meters tall with the same material construction. The door bars had windows 0.70 meters wide that allowed the horses to place their heads in the hallway. (Werhahn et al., 2010).

According to Wheeler, 10 to 12 feet height is normally constructed with 8 feet being the lowest ceiling for stable. The stable ceiling height was 3 meters, windows at a height of 1.50 meters and a range of 1.20 meters provided light and ventilation. (Werhahn et al., 2010). If a low ceiling is applied, which causes wind circulation cramps inside the stalls, the risk that a horse can cause dehydration. There is open ceiling or ceiling roof construction in most stables. In this subject, the lowest height is the clearance to the lowest item on which a horse may strike its head to create the structure.

Doors of stall Design

As compared to the stall, the side swing door has to open into the hallway. Furthermore, they needed less hardware to fit perfectly, but heavy-duty hangs could avoid sagging (Wheeler, 2006). Furthermore, overhead track sliding doors need to avoid forestalling door from opening too far and dropping off the track. Doors also require floor-level guides to protect the reduction portion in the vicinity when the horse kicks, bends, or paws at the sliding (Wheeler, 2006).

It should have less than 3 inches of space to forestall to prevent having a hoof or leg trapped under open doors. Both doors and doorjambs need to be invulnerably attached and free of sharp edges. Place door connect from reaching horses who can also find joy in learning how to operate them and horses can also aspire to leap over half-height doors as shown in Table 1.

Table 1 Types of doors with material and description

Type of Door	Material	Description
Swing	Wood Metal Plastic Mix	Swing toward corridor Heavy-duty hardware, open Door 42-25 inches
Sliding	Wood Metal Plastic Mix	Slide door on corridor side, Three inches opening on forestall Durable doorjambs

Lighting and Ventilation of the Stall Design

When the lighting is fine, appropriate management of stalled horse is necessary. Ungainly cleaning of stalls and inhibiting observation and care caused by shadows and poorly drained areas in the stalls. It may be advantageous to have the smallest of four rectangular window spaces for natural lighting in each stall. Glass windows must be either over 7 feet or covered by robust bars or mesh to prevent glass breakage. Plexiglas is a precise alternative for window glazing. Fresh air is accessible to each horse for healthy respiratory. Ventilation designs, including those featuring no ceiling or a high ceiling, along with open windows for each stall, provide clean air exchange and boost air circulation within horse barns. (Wheeler, 2006; Penn State Extension, 2023; Horse Racing Sense, 2024).

Storing hay and bedding above the stalls is not recommended. These are a fire hazard also increase the horses' allergies and cramp air circulation. When opening panels on the tops of stall dividers and mesh doorways are open, airflow inside the stall interior can be accomplished. Stalls also suffer from immovable air that is stormed by the use of damaged air circulation within the secure aisles. (Glenn & Vergara, 2016).

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Stall Partition or Wall Design

Plywood may place a gap up to one and a half inches away to boost air flow between stalls while discouraging encounters between stall occupants. Use vertical middle bracing with gap plywood to support the 12-foot-long wall and if kicked, prevent the plywood from fracturing. Unless capped with metal, horizontal wooden edges are vulnerable to being chewed by horses. There is no need for stall partitions to be secure all the way to the top. (Wheeler, 2006). An open panel layout at the top allows for better ventilation and easy commentary of the horse. It additionally allows horses to see their companions and different equine center things to do to decrease boredom and vices.

An open panel partition has strong materials alongside the bottom 50 to 60 inches with an open panel on top. Bars of up to one-inch diameter pipe, or equivalent, are common. Bars with a pipe diameter of up to one inch, or similar, are popular. Place bars no more than 3 inches aside or use a heavy gauge wire mesh with openings of around 2 inches. The metal electrical conduct is now not robust sufficient for bars (Wheeler, 2006). Make sure that the bar cloth is reinforced to prevent hooves from getting stuck between the holes, so it will not bend when kicked and cause the hoof to go through and be trapped. If they cannot see their neighbors some horses act differently, in which case a short solid frame, such as plywood, can be placed over the bars or mesh.

Interiors Stall Design

The design of stall interiors, including hardware, must emphasize smoothness, durability, and the elimination of sharp or hazardous elements. Standard stall fixtures often comprise a drinking bin or motorized waterer; a feeding bin; a metal ring for confining horses; and optional components such as a hay grill or hay net (Wheeler, 2006). The design of these fittings, along with accessories like toys, aims to enhance the horse's welfare and safety in the stall. It is advisable to segregate food and water locations to avert contamination resulting from a horse unintentionally combining food with the water container while feeding. Place the water and feed containers at the horse's breast height for convenient access, and affix them to the wall to prevent spills and contamination. Moreover, hardware should provide rapid disassembly to enhance cleaning efficiency (Hartmann, 2010).

Feeding hay on the floor is beneficial as it corresponds with horses' innate foraging instincts, although it heightens the danger of contamination from soil or waste. Attach a metal ring for restrained feeding to a side wall, above the horse's withers, and place it away from feed and water containers. This configuration ensures the horse's restraint during cleaning, while also preserving the structural integrity of the wall and fasteners to withstand potential resistance. Prioritising durable, readily accessible hardware is essential for safety and user-friendliness (Batty Smith, 2015).

Recent studies underscore the significance of integrating practical, safety-enhancing attributes. Stalls equipped with swing-out feed doors facilitate effective feeding without necessitating direct entry, thereby minimizing the danger of accidents. Moreover, social doors that allow horses to engage visually or physically with their neighbours promote emotional well-being. Illuminated areas featuring windows or Dutch doors provide ventilation and natural illumination, fostering well-being and comfort (System Equine, 2024; Penn State Extension, 2024).

Stall Flooring Design

A variety of stall flooring solutions exist, with the majority needing to satisfy essential criteria for safety, comfort, and longevity. The flooring of horse stalls must withstand the impact of pawing or kicking and bear the weight of a horse, often 500 kilograms or greater. It is highly advisable to use materials that can absorb impacts and reduce stress on the legs and hooves. Rubber mats offer cushioning and alleviate joint stress, but concrete flooring, when paired with substantial bedding or mats, can mitigate hardness and enhance safety (Wheeler, 2006; Horse Racing Sense, 2024). Non-slip flooring is essential for safety, particularly while transitioning from a laying to a standing position, which exerts considerable stress on the horse's body. Effective drainage and materials such as rubber or sloped concrete improve cleanliness by inhibiting the accumulation of bacteria and moisture (Justus Horses USA, 2024). Moreover, incorporating flooring, such as asphalt or dirt,

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customized for the horse's requirements can enhance comfort and minimize maintenance efforts (Amish Co., 2024).

Slippery surfaces can result in injury to horses when they attempt to lie down. Given that horses predominantly have their heads near the ground during the day, using a non-chemical material for stall flooring is optimal. Utilizing low-maintenance materials for the smoothing and upkeep of the stall grounds is efficient; nonetheless, no singular substance exhibits all the requisite attributes (Wheeler, 2006). Proper bedding mitigates scrapes and injuries, whereas rubber mats or deep bedding on rigid concrete surfaces offer supplementary cushioning. Nevertheless, when floors are damp, rubber mats may shift, presenting hazards. Recent research indicates that the integration of rubber mats with suitable bedding diminishes slipperiness and enhances joint health, especially in older horses or those susceptible to arthritic conditions (Rubber-Cal, 2024; Penn State Extension, 2024). Additionally, mats featuring rough surfaces can facilitate fluid drainage, thereby mitigating dangers related to water collection and respiratory problems stemming from moisture buildup (Robata, 2024).

METHODOLOGY

Location & Population of Study

We conducted this research in five commercial equestrian centres located in Johore, Selangor, and Kuala Lumpur. These horse centres actively provide livery services to owners and are renowned for hosting equestrian competitions either annually or semi-every year. The commercial horse facilities include Selangor Turf Equestrian Club, Perak Turf Club Equestrian and Training Centre, Bukit Kiara Equestrian & Country Resort, Terengganu International Endurance Park, and Putrajaya Equestrian Park.

Instruments

All the information such as horse stalls design component was collected through structured observation. The structured observation was designed to determine stalls design component to five commercial equine centers (see Table 2: Checklist for observation). Observation checklists not only give an observer a structure and framework for an observation but also serve as a contract of understanding with the structure design of horse stalls, who may as a result be more reliability, and will get a direct result on horse stalls structure been used by the commercial equine center.

Table 2 Checklist for observation

Component of Horse Stalls	Num.	Item in Checklist
Dimensions	1	Stalls size
	2	Wall height
	3	Ceiling height
Doors	1	Type of material
	2	Opening type
	3	Position of door
	4	Door’s width
Lighting and Ventilation	1	Type of ventilation
	2	Type of lighting
Partitions or walls	1	Type of material
	2	Thick of partition
	3	Height of partition
Interiors	1	Watering material
	2	Feeding material
	3	Watering position

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	4	Feeding position
Flooring	1	Type of material
	2	Type of surface

Data Analysis Method

This study uses statistical analysis that shows the horse stalls design component by using collected data in the form of checklist. Statistical analysis includes collection, visualization, and interpretation of data using most up to date software, Microsoft Excel. This study used statistical analyses from complete data to find conclusions from the same data by selecting different equine center using graph and percentage.

RESULTS AND DISCUSSION

Dimension of the Horse Stall Design

The stall size has been measured as shown in Figure 2. 60% at three centers has the same size, which is 12 x 12 feet, and another 40% at two centers with 13 x 12 feet. The horse stall wall with 60% at three centers at height of 7 feet and 20% at one center at height of 13 feet. The rest is 20% at one center with 14 feet. Dimension of horse stall design like ceiling, it shows 60% at 15 feet height, 20% height at 18 feet and 20 % ceiling height at 21 feet. Those sizes are according to the horses that place in the stall to ensure sufficient space for horse to move around in the stall (Fabian, 2016). The ceiling of horse stall requires double height of stall wall to prevent any injuries due to horse rearing or bucking in the stall.

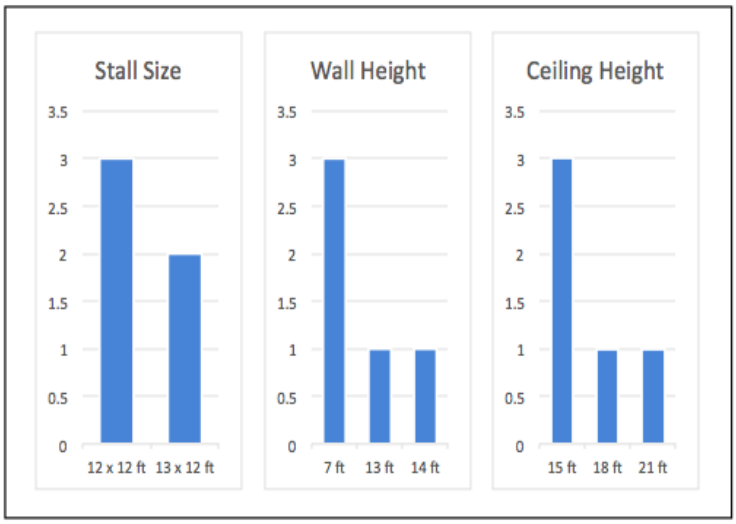

Figure 2 Dimension of the Horse Stall Design Result

Component and Measurement of Horse Stall Door

Horse stall door component divided into five subs which are material, opening style, position, width, and height. This study shows that 60% are using galvanized iron and another 40% are using cast iron. Material used as well important that will prevent any injuries and disease occur during cut wound (Bulens, Sterken, Van Beirendonck, Van Thielen, & Driessen, 2015).

Analysis on the door opening style shows 100% equine center has the same style which is swinging door. The size of stall door with 40% of center are for both 5 feet width and 6 feet width door. The full-length door opening is at 20% of equine center.

Next, stall door height on 60% center with 4 feet height and 40% center in 3.5 feet height. The placement of the horse stall door with left side position is 40% of equine center and the rest is 20% for each three positions

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on center, right side and full-length door. Horse stall doors require adequate space for horses to step in and out of the stall without causing injuries. (Fabian, 2016).

It is 100% hardware usage door hinges and bolt to support the door opening system on commercial center. Requirement of hardware are additional as some structure don't need those hardware or base on the owner required at their rented stall (Werhahn et al., 2012).

Component of Horse Stall Ventilation & Lighting

The same ventilation that is normal and air circulation fan hanging on the ceiling or on the wall in the horse stall has been used from the acquired observation checklist of ventilation form at the selected center with 100% equine center used. The lighting is then used in the same way as natural lighting and electrical fixtures. Usage of natural lighting during daytime because of the open style stable and stall. Previous study, stated that ventilated stall require to ensure any dehydrated for horse and air pollution in the stall itself (Werhahn, Hessel, & Van den Weghe, 2012). Using electrical fixtures typically used during the night compare daytime for lighting and resolution which helps for night observation (Hartmann, 2010).

Component and Measurement of Horse Stall Partition or Wall

Figure 3 shows the horse stall partition height and thickness. 40% of which stall A and C have the same height at 7 feet tall partition. Then, 40% with 8 feet tall partition in stall D and E. The only one center with 20% has the height of 6 feet tall partition which is stall B. The thickness of the partition has been measuring and come out with all the same half feet thickness partition. Adequate thickness of wall will help horse leg stuck when kicking (Batty Smith, 2015).

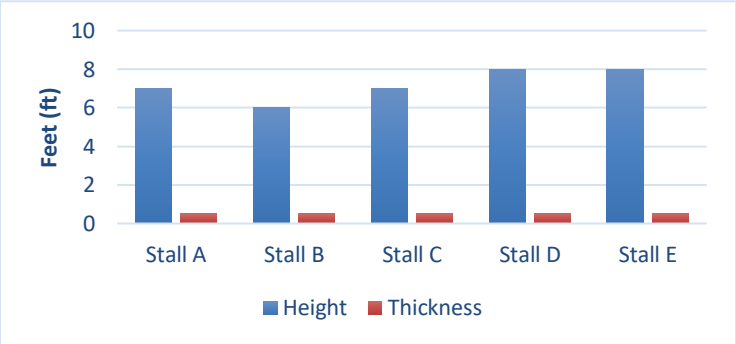

Figure 3: Horse stall partition height and thickness

Table 3 shows the observation on the material used on the partition at the horse stall. 40% used mix material which is brick and metal on their stall partition while other 40% stall using only brick material in stall partition. The rest 20 % used concrete and another half metal pipe in horse stall partition. The material of partition very important to decide due to horse socialize behavior. Material is concerned as it will endure durable to horse abnormal behavior when they kick (Werhahn et al., 2012a).

Commercial Equine Center Stalls	Partition/Wall Material
A	Brick, Metal
B	Brick
C	Concrete, Metal
D	Brick
E	Brick, Metal

Table 3 Material used on horse stall partition

Interiors in Horse Stall Design (Watering and Feeding)

The result of observation checklist towards stall interior design shows that 100% using the same heavy-duty plastic bucket material to serve water and feed. 60% shows the placement of the water and feed bucket on the floor at front of the horse stall. Water bucket has been placed at front right on the floor in three stalls while other two stalls placed on the front center on the floor. Next, 20 % is feeding bucket at the front right on the floor positioned only at one center. At four centers placed feeding bucket at front left on the floor. Wherever the feeding and watering bucket position is not particular, as long as the horse is comfortable to drink and eat in the stall. (Cooper & Mcgreevy, 2003).

Flooring Component in Horse Stall Design

The results for the horse stall flooring portion show that 80% of the equine center use concrete with cement coating on the top of the floor. The rest 20% is using rubber matt. The research by Resample et al. (2019) showed that the best flooring is capable of absorbing horses' weight, ensuring that horses are relaxed for a long time in the stall.

CONCLUSION

As a conclusion, the current horse stall design component of commercial equine center has six (6) main components which is dimension, door, ventilation & lighting, partition, interior (watering & feeding) and flooring as in Table 4.

Component of Horse Stalls	Item	Description
1) Dimensions Stall	Stalls size	12 x 12 ft
	Wall height	7ft
	Ceiling height	15ft
2) Doors	Type of material	Galvanized iron
	Type of door	Swinging door
	Position of door	Left
	Size	5 ft to 6 ft (w), 4 ft (h)
	Hardware	Door hinges and bolt
3) Lighting and Ventilation	Type of ventilation	Fan & natural ventilation
	Type of lighting	Electric light fixture and natural lighting
4) Partitions/ walls	Type of material	Mixture of brick or concrete with metal
	Thick of partition	0.5 ft
	Height of partition	7ft to 8 ft
5) Interiors	Watering material	Heavy-duty plastic yellow bucket
	Feeding material	Heavy-duty plastic yellow bucket
	Watering position	Left of right front on the floor
	Feeding position	Left of right front on the floor
6) Flooring	Type of material	Concrete

	Type of surface (Finishing)	Rubber matt or Soda bedding

Table 4 Description of horse stall component

The dimension of stall frequently used in commercial equine center is 12 x 12 ft of stall size, 7ft height of wall and 15ft height of ceiling. The door components and measurement commonly used in horse stall design are galvanized iron material for door, between 5 ft and 6 ft width of door, 4 ft height of door, positioning the door on the left of the horse stall and those doors using door hinges and bolt has the door hardware. Commercial equine center has been using air circulation fan and natural ventilation in their horse stall design and for lighting used electric light fixture and natural lighting from outside from the stall. Horse stall partition components and measurements often used mixture of brick or concrete with metal for partition material and at height of 7ft or 8 ft to separate with other horse stall. Some of horse stall partition has built in cross-tying ring to restrain the horse inside the stall. Next, watering and feeding in horse stall design used in commercial equine center are heavy-duty plastic yellow bucket and placed at the front on floor of horse stall. Both are positioned on either left of right front on the floor. Lastly, commercial equine center flooring used concrete with cement finishing on top and absorption can be added by applying the rubber matt.

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