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Designing Dairy Free Stalls

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It was about 1960 that Adolph Oien remodeled his Stanwood, Washington, loafing barn, installing the first free stalls. From this Pacific Northwest beginning, these "individual beds" for cows have become the most popular kind of cow housing.

Different designs work well on different farms. Some operators like stalls with a concrete base; others don't. Some use separated manure solids for bedding; others report increased mastitis when using them.

The common thread in successful free stalls—as in milking, feeding, and breeding—is good management. Careful thought in design and regular maintenance are keys to satisfaction.

A recommendation for one "best" design is impossible because of the great differences among farmers, their objectives, their management styles, and their farms. The following recommendations have been gathered from many successful operations.

Size

Stalls must be large enough to provide a comfortable bed and adequate room for cows to rise. As animals get larger, so must the free stalls.

Table 1 lists recommended stall sizes for dairy cattle. It is adapted from information reported by Cornell University, the Midwest Plan Service, and Oregon State University.

The width is center to center on 2-inch dividers; the length is outside of the back curb to the front wall or partition; and the height is from the bedding to the top of stall dividers or withers bar measured at the front of the stall (add about 3 inches at the back of the stall).

Table 1.—Recommended stall sizes for dairy cattle

Animal size (lb)	Width (in)	Length (in)	Height (in)
Less than 300	24	44	—
300-400	27	46	32
400-600	32	60	35
600-800	36	66	37
800-1,000	39	72	39
1,000-1,100	42	78	40
1,100-1,200	44	82	41
1,200-1,500	46	84	44
More than 1,500	48	90	44

Free stall base materials

Tamped soil, heavy in clay, is common as a base under bedding. It must be packed solidly before applying bedding and will need semiannual maintenance to fill holes and restore slope from front to back.

A gravel or sand base will improve drainage under bedding—but these don't pack well, so maintenance must be increased. Both will be kicked out into the alley, causing problems in a liquid waste handling system.

Soil, gravel, or sand should fill the stall to within 2 inches of the top of the back curb. The curb will help retain bedding. Avoid curbs that stick up more than 2 inches. Cow injuries can result, especially with square-edged curbs. Inside curb edges should always be sloped or rounded.

Three inches of concrete can replace the base material. It should be even with the curb at the back of the stall for proper drainage. Use some bedding on the concrete.

Pipes or boards fastened at the rear of the stall to retain bedding are not recommended. They require additional maintenance, they can cause injuries, and they can reduce moisture drainage from bedding on the rear surface of the stall.

Concrete reduces maintenance and bedding costs, but more cow injuries are reported, and cows use concrete-based stalls reluctantly if other base materials are available.

Burying used tires in stalls will reduce the amount of bedding and base material kicked into the alley:

- Drill large holes in the bottom walls of the tires for drainage.
- Place the tires horizontally on packed clay.
- Fill them both inside the "bead" and outside with soil or sand to prevent cows from working them out.

Researchers from Washington State University recommend installation according to figure 1.

One operator has placed a quarter of a tire (split lengthwise and then in half) in the fresh concrete poured in free stalls, placing the bead just above the concrete. The tires in the concrete are softer and warmer for cows than bare concrete and they have cut bedding use in half.

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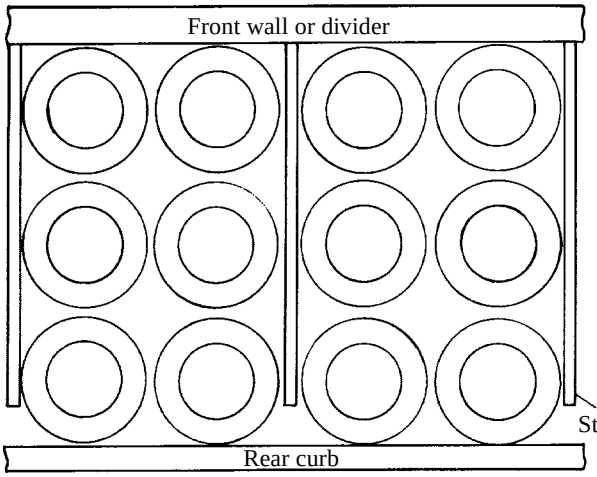


Figure 1.—Tire-surfaced concrete free stalls, showing approximate location of tires

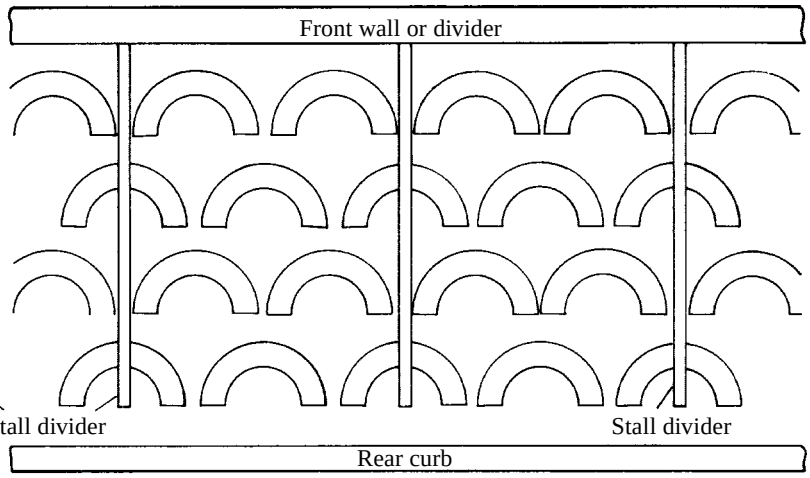


Figure 2.—Tire-surfaced concrete free stalls, showing approximate placement of tires sawed in half lengthwise and again across the tread

He placed the tops of the curves toward the front of the stall so they don't collect unwanted moisture (figure 2). The tire-concrete combination has been in use over 5 years, and very few tires have loosened.

The average slope of all base materials should be between 3 and 4 inches from front to back of the stall. Cows prefer lying uphill. The slope is necessary for cow comfort, to prevent animals from lying in the stall backwards, and to move moisture from the top or front of the stall to the alley.

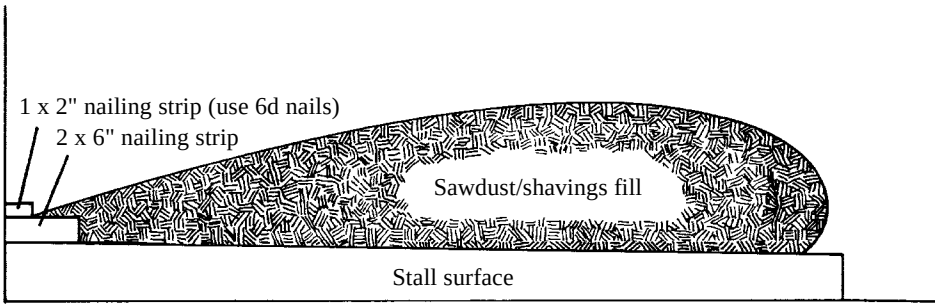


Figure 3.—Cross section of cow "mattress"

Bedding

Bedding is used to provide insulation and a cushion between the cow and the base material and to absorb moisture. Sawdust or shavings are the most common bedding in the Pacific Northwest. Cereal grain straw works well, but it should be chopped to increase absorbency, to make handling easier, and to reduce plugging of manure pumps.

Separated manure solids can be used as a bedding material. Stack them for at least 2 weeks and allow them to heat or compost. This produces temperatures of 140°F and kills mastitis-causing bacteria. During rainy months, compost them under a roof to attain the bacteria-killing temperatures.

Once composted, store them outside under plastic cover so the bedding is not excessively wet when you spread it in the stalls. Don't cover a fresh stack with plastic—it will reduce or stop the composting process.

Rubber mats fastened over a base material have been used to replace bedding, but they have some disadvantages. Cows prefer lying on other materials and adapt very slowly to the mats. They are slippery when wet. Bedding placed over them will reduce these disadvantages, but then you save little on bedding costs.

"Cow mattresses" are being tried in some western Washington dairies. These are made of sturdy, woven plastic material wrapped around conventional bedding and fastened to the front of the stall. They look promising in keeping cows clean and dry, and in saving bedding. A cross-section is shown in figure 3.

In a recent Oregon study, the average cost of bedding was $13 per cow per year. Labor costs for chopping, hauling, and filling are not included in this average.

Straw and separated solids had low material costs, but they may take more labor. One farmer purchased newspaper from a local service organization, chopped it, and bedded for $12 per cow per year.

Hydrated lime applied to the bedding near the back of the stall will reduce bedding moisture. Because it reduces the moisture level and raises the pH, it may reduce mastitis. Apply at least 1 pound to the bedding surface in the rear of each stall when you add or stir bedding.

Stall dividers

Divider design and performance varies widely on dairy farms. About half are made of wood, and half of metal. Pipe-loop stall dividers are gaining popularity. Look for sturdy dividers that require little maintenance and that you can remove easily in an emergency or for repair.

One divider that provides strength and removes easily is a heavy pipe loop that slips into a larger pipe sleeve, which is poured into a concrete head wall. You remove it by pulling a pin out of the sleeve and loop and slipping out the stall divider.

Loop dividers average 69 inches long. This is proper for stalls up to 84 inches long. The outside of the curb should not extend more than 15 inches beyond the end of the divider or be

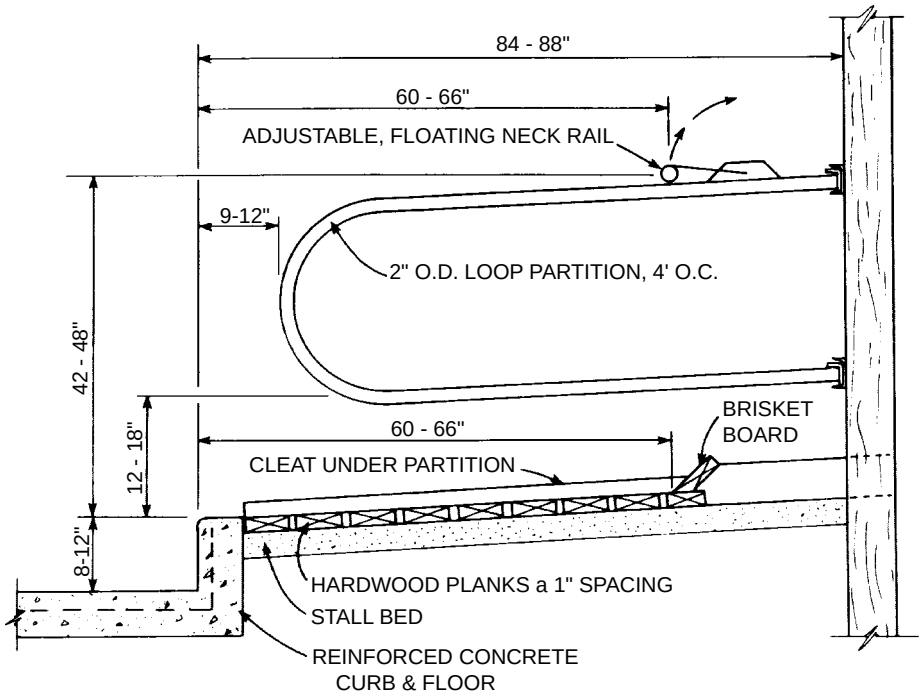
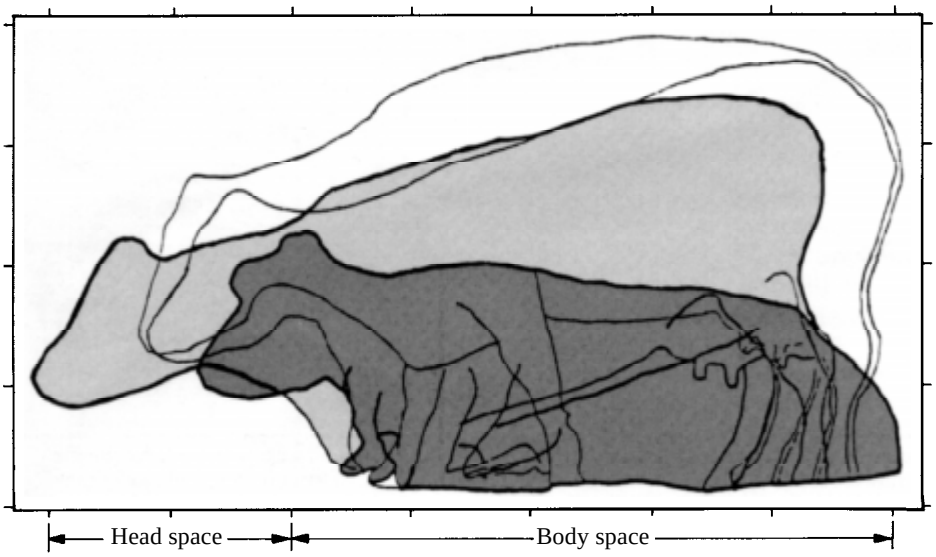


Figure 4.—Diagram of a free stall with open suspended loop partition; cleated plank bed and sloping brisket board; and adjustable floating neck rail (the dimensions are for mature Holsteins)



Your cow's "space envelope"
This diagram shows the different positions a cow takes when she moves from resting to standing. The body space indicates the length between the curb and the brisket board or withers bar in free stalls. The head space shows the area a cow uses when she transfers her weight from back to front in standing. These spaces are important considerations when you design comfortable free stalls for your dairy cattle.

lower than 14 inches at the curb, to discourage animals from walking over dividers or standing along the curb at the rear of the stalls.

Spring-loaded loops offer some advantages over regular loops in cow comfort and maintenance. However, there are complaints that cows learn they can move them and begin lying almost underneath the dividers. Like regular loops, they require very stout lumber or concrete for attachment.

Repairs are higher for pipe loops than for dividers attached at the curb and the headboard. However, there's no attachment in the rear curb to rust off or be damaged by equipment that scrapes alleys.

Completely rusted pipe or angle iron is a major disadvantage of metal dividers fastened at the curb. Filling the pipe set in the curb with concrete extends service life, but corrosion of metal exposed to manure and urine is inevitable.

Placing a heavy PVC pipe "boot" in the concrete curb and slipping the divider support within that during installation may reduce corrosion, extending the life of the metal divider.

The height from bedding to the bottom of a divider near the back of the stall should be 12 to 18 inches to prevent injury to hips and pins of animals. A board in the base material, running parallel with and immediately under the divider, reduces bedding requirements and the need to rake bedding into hip and leg holes created by cows.

Withers bar or cable

Placed above the divider to meet the cow's shoulders or withers, a withers bar or cable should discourage cows from lying too far forward in a stall and encourage backing out when standing up.

The average distance back from the headboard should be 18 to 20 inches, or 60 to 66 inches from the outside of the rear curb. You'll need to adjust the bar to fit your cows and stall length. The height of the bar or cable from bedding is included in table 1.

Use pipe, cable covered with PVC pipe, electrified wire, ½ inch rebar, or wood. The PVC-covered cable is durable and avoids the injury to cows' necks that's possible with uncovered cable or wire.

Pipe—clamped, welded, or bolted to the dividers—makes stalls more rigid. This is an advantage with lighter-gauge pipe loop dividers. Removal for downer cows is still practical with clamped or bolted withers bars.

A new method to reduce injury when cows get up is the "floating" withers bar. It's hinged on the stall dividers to swing up when pushed from below as a cow gets up.

Some operators run the bar over four stalls. This provides some weight, but it doesn't make one cow raise the bar the entire barn length. Figure 4 shows one design of the floating bar.

Brisket boards

These prevent cattle from moving too far forward in stalls while lying down. They're usually placed 20 to 24 inches from the headboard or about three-fourths of the stall length from the rear curb. Most are made of wood, are set at an angle toward the headboard, and stick out about 4 inches beyond the base material. They should flex slightly when bumped by the cow.

The cow's head will fit comfortably over the brisket board into the front of the stall, but the board will keep her body from coming forward.

Because the top of the brisket board is slightly higher than the bedding level in the stall, extra bedding can be stored in front of it and raked back to the laying area as necessary.

Curbs

Curbs at the back of the stall should be concrete. It's desirable to keep the base material even with the inside curb to promote drier bedding in the rear of the stall.

A tall curb (10 to 12 inches) will reduce manure in the back portion of the stall, whether you scrape or flush animal wastes. If the edges of the curb are rounded, cow injuries will be limited even with the tall curbs. Cows have no trouble stepping into or backing out of a 12-inch high stall.

Cow-to-stall ratio

Since dairy cattle spend 10 to 14 hours daily lying down, it's ideal to have one stall for each cow. This may not be practical. Northwest dairy operators are having no problems with 10 to 15 percent more cows than stalls. The ratio is an operator preference and is not related to other design factors.

Management

Good management and individual preference are the keys to satisfaction and performance of individual stall designs:

1. Remove manure at least once daily.
2. Replace wet bedding promptly.
3. Repair broken dividers as you find them.
4. Restore the base material to its original slope at least every 6 months.

After building or modifying stalls, spend time watching the cows use them. Do they lie where you want them? Can they get up easily? How much bedding are you using?

If 3 to 5 percent of the cows are reluctant to use the stalls after 2 weeks, there could be a flaw in the design or in your management. Using ample bedding will ease the transition to new facilities.

Visit other dairies to see what works before you make changes. Most operators are willing to share their experiences with you. Your Extension agent can provide you with ideas that other operators have found successful and can identify operators you should visit before you change your system.

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