Slack Loops

It is generally safe to assume that a feeder can respond much more quickly than most unwinders can. That's because the unwinder is starting and stopping the coil which represents a much larger inertial load. In some cases the unwinder is also required to do the work of straightening the material as well. For it to have enough power to respond as quickly as the feeder does, it would require a much larger drive and the ability to position, as is the case with a combination unwinder/feeder/straighttener. This explains why most systems have a slack loop.

The purpose of the loop is to provide a reservoir of slack material that the much quicker feed can draw from upon start up while the less responsive unwinder accelerates to line speed and in turn to absorb the material that is unwound while the unwinder decelerates at its slower rate when the line stops. It also allows the unwinder to run at a fairly constant speed during continuous operation even though the rate of consumption is constantly changing due to the intermittent feed motion.

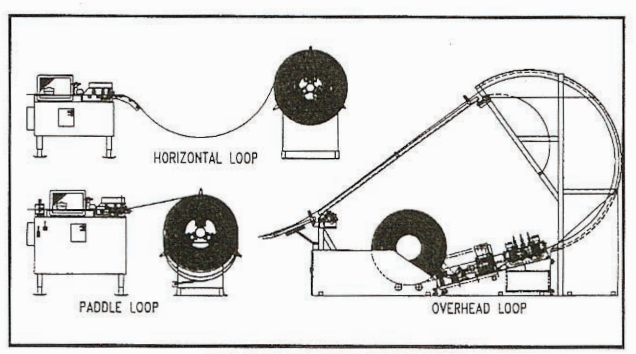
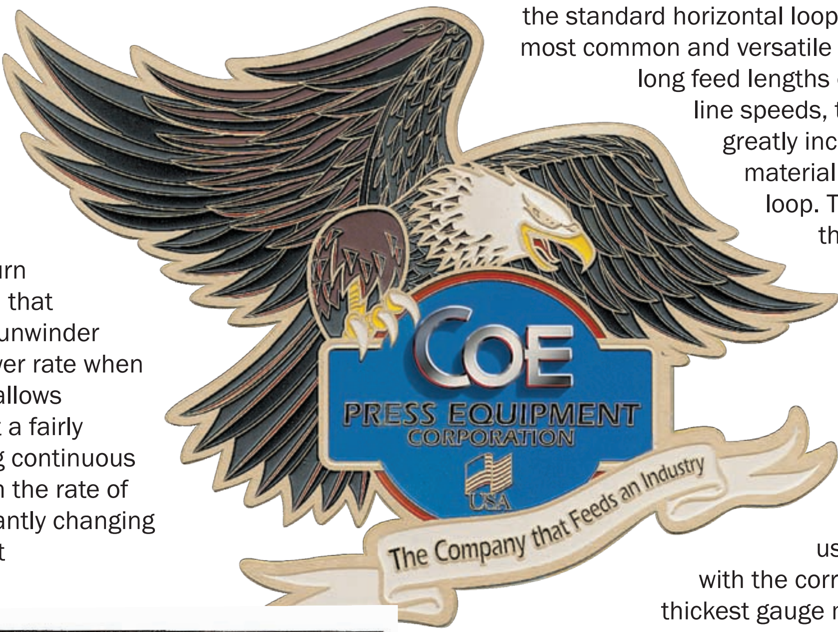


FIGURE 4

Slack loops can take a variety of forms, the most common of which are shown in Figure 3. The overhead loop configuration is used to conserve floor space by storing material vertically and above the unwinder. This method is generally used with either inline cradles, or with centering reels in cases where the material is of heavier gauge and would require considerable floor space if it weren't stored overhead. The material must also be stiff enough to resist buckling under its own weight as it's pushed up and overhead, which can be a limiting factor in the amount of storage.

The paddle loop configuration stores material in the form of loose wraps around the coil and may be used in conjunction with a feeder/straightener combination, or with a pull through straightener at the feeder or when straightening isn't required. This style requires the unwinder to be located as close as possible to the feed and that the material be stiff enough to resist buckling or looping between them. Since storage is somewhat limited with a paddle loop it is generally used only when shorter feed lengths are the norm.



Although it consumes the greatest amount floor space, the standard horizontal loop configuration is by far the most common and versatile variety. To accommodate long feed lengths or aid in achieving higher line speeds, the addition of a pit can greatly increase the amount of material storage in a horizontal loop. To avoid inducing set in the material it is extremely important that the strip be supported in the correct radius entering and exiting the loop if straightening is done prior to the loop. This is accomplished by using a series of catenary support rollers, or by using a chute arrangement with the correct minimum radius for the thickest gauge material.

The loop storage requirement for any application is equal to the amount of material that is consumed by the feeder while the unwinder accelerates to line speed, minus the amount of material that is unwound during that acceleration period. For example, an operation requiring a 12 inch feed progression running at 120 strokes per minute results in a net line speed of 120 feet per minute or 24 inches per second. If the unwinder is capable of one foot per second squared acceleration then it will take 2 seconds to accelerate to the 120 FPM line speed. During that acceleration period only 12 inches of material will be unwound while the feeder will use 48 Inches. The result is that 48 inches of material will have been consumed but only 12 inches will have been replenished leaving a deficit of 36 inches. If there isn't already more than 36 inches of material stored in the loop before starting, then the system can never reach line speed without first depleting all of the material in the loop. Of course there must be some additional buffer beyond the 36 inches required to overcome the deficit of material in order to avoid having the loop become completely tight before reaching line speed. This means that the total storage requirement should probably be at least 48 inches for smooth operation. If the loop contains less material star- age than that, it will necessitate that the press speed be reduced to allow the unwinder to keep up.

The amount of material in the full loop, minus the straight line or tight length of the loop. The actual storage is determined by the depth of a loop, not by its length. In fact, the longer the length of a loop, the less material that is actually stored in it for a given depth. The shortest loop length for a given depth yields the greatest amount of material storage.

The minimum permissible length of a horizontal loop is determined in part by whether straightening is done prior to the loop or if it is done after the loop. If straightening is performed after the loop, as in the case of a feeder/ straightener combination, or a pull through straightener at the feeder, then the minimum loop length is determined by the minimum distance that the heaviest gauge of material will loop into without being forced. This will probably result in the material taking some additional set but it really doesn't matter because it will be straighttened at the feeder anyway.

On the other hand, if straightening is done before the loop, as is the case with power straighteners, the minimum permissible length of the loop is determined by the maximum material thickness that will be run on the line factored with the depth of the loop. This is due to a factor called the "minimum bend radius" or MBR for that material. MBR is the minimum radius that pre-straightened material can be bent into, not exceeding its yield point, so that it will return to a flat condition, after exiting the loop. If material is bent beyond its yield point into a radius smaller than its MBR then it will take set and won't return to a flat state when it exits the loop. This is true regardless of the loop configuration. With a horizontal loop the entry and exit cascade sections must be configured for the M BR of the thickest material to prevent the weight of the loop from bending the material around the exit straightening roll as it enters the loop or over the lower feed roller as it exits.

The MBR for a loop is determined by the composition and maximum thickness of material that will be run in the loop. The thicker or softer the material, the larger it's M BR will be. It will vary with the material composition, but a good rule of thumb is the MBR for mild steel will be approximately 360 times its thickness. For example, with 1/4 inch thick mild steel the MBR is .25 x 360, or 90 inches. If it is bent into a radius smaller than 90 inches it will retain some set after it exits the loop which means that it may not easily slide through the die, or produce a good part. Given that the MBR for a material cannot be exceeded then the length of the loop will be determined by it. Therefore, for a given loop depth, the greater the maximum material thickness, the longer the loop length must be. And in turn the greater the depth, the longer the length requirement. This is true until a depth of two times the MBR is reached. At this point the length of the loop will be equal to four times the MBR. Once this length and depth are reached any added depth results in optimum vertical storage with no further horizontal length being required. At this point every added inch of loop depth yields two additional inches of actual stored material.

Once the storage requirement has been calculated based on the maximum progression and strokes per minute factored with the response time of the unwinder, use the loop storage chart in Figure 5 to determine the space requirement for a standard horizontal loop. The "Length" figure is the loop length requirement for that material thickness and loop depth. The "Stored" figure indicates the amount of material that will be stored in a full loop. With overhead or paddle loop configurations it is somewhat more difficult to determine the actual storage in the loop. Consult the equipment manufacturer to make certain that the storage available will be adequate for the system performance.

MATERIAL THICKNESS	LOOP DEPTH FROM FEEDLINE													
	36"		42"		48"		54"		60"		66"		72"	
	LENGTH	STORED	LENGTH	STORED	LENGTH	STORED	LENGTH	STORED	LENGTH	STORED	LENGTH	STORED	LENGTH	STORED
0.032"	3.8'	56"	3.8'	71"	3.8'	87"	3.8'	103"	3.8'	120"	3.8'	137"	3.8'	155"
0.063"	7.3'	31"	7.5'	41"	7.6'	57"	7.6'	69"	7.6'	81"	7.6'	93"	7.6'	105"
0.090"	9.6'	27"	10.1'	35"	10.4'	43"	10.6'	51"	10.7'	57"	10.8'	76"	10.8'	88"
0.125"	12'	22"	12.6'	28"	13.2'	35"	13.7'	43"	14.1'	50"	14.4'	59"	14.6'	65"
0.156"	13.7'	20"	14.5'	25"	15.3'	31"	15.9'	37"	16.5'	44"	17'	52"	17.4'	59"
0.187"	15.2'	18"	16.2'	23"	17.1'	28"	17.9'	34"	18.6'	40"	19.3'	47"	19.8'	53"
0.212"	16.4'	17"	17.5'	21"	18.5'	26"	19.4'	32"	20.2'	37"	20.9'	43"	21.6'	50"
0.250"	18'	15"	19.2'	19"	20.3'	24"	21.4'	29"	22.3'	34"	23.2'	40"	24'	45"
0.312"	20.3	13"	21.7'	17"	23'	21"	24.3'	25"	25.4'	30"	26.5'	35"	27.4'	40"
0.375"	22.4'	12"	24.1'	16"	25.6'	19"	27'	23"	28.2'	27"	29.4'	31"	30.5'	36"

FIGURE 5