COE

SLACK LOOPS

WHITEPAPER

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Slack Loops

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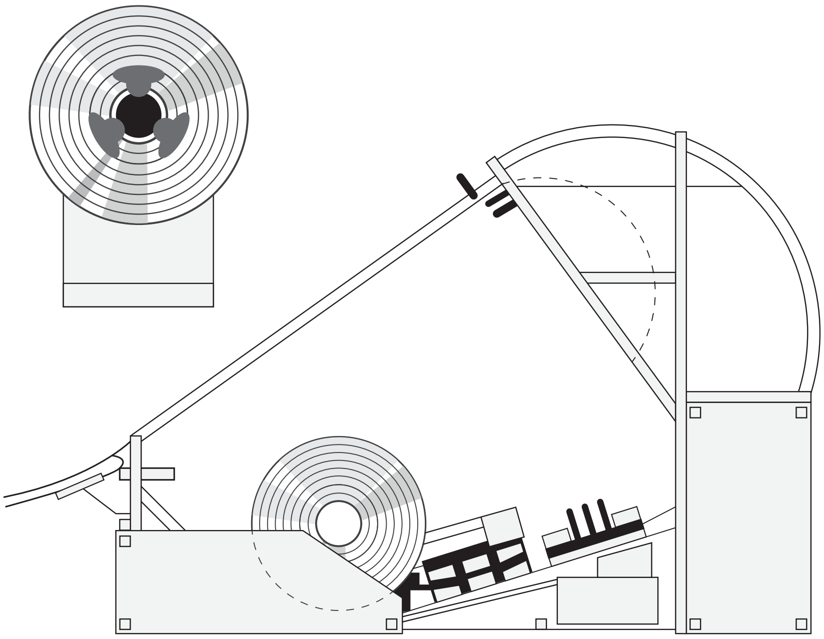
With coil processing equipment, feeders can generally respond much more quickly than most uncoilers, also known as coil reels. This is due to the fact that uncoilers are responsible for starting and stopping the coil, which has a larger inertial load than the feeder. In some cases, the uncoiler is additionally required to straighten. For an uncoiler to respond as quickly as a feeder does would require a much larger drive as well as the ability to position, as is the case with a combination coil reel/feeder/straightener. This is why most systems have a slack loop.

WHY A SLACK LOOP?

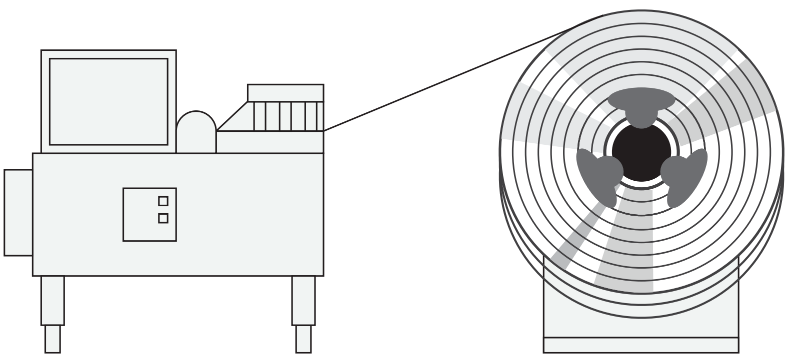
The purpose of a loop is to provide a reservoir of slack material for the quick-response feed to draw from at start-up, while the slower uncoiler gains velocity to match line speed. And, conversely, a loop allows the straightener to absorb material that is unwound while the coil reel decelerates at a slower rate when the line stops. The loop also allows the coil reel 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.

Types of Configurations
Slack loops can take a variety of forms:



Overhead Loop

Overhead: The overhead loop configuration is used to conserve floor space by storing material vertically and above the coil reel. This method is generally used with inline cradles, or with centering reels if the material is a heavier gauge that would require considerable floor space for storage. If being 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 storage.



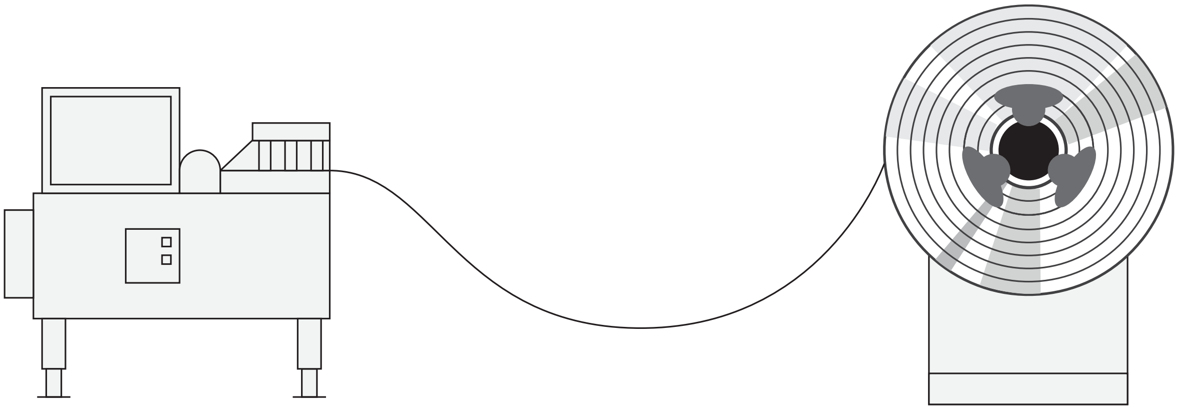
Paddle Loop

Paddle: 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
- Pull-through straightener at the feeder
- When straightening isn't required.

This style requires the coil reel to be located as close as possible to the feed, and that the material be stiff enough to resist buckling or looping between the two machines. Since storage is somewhat limited with a paddle loop, it is generally used only when shorter feed lengths are being employed.

Paddle Loop



Horizontal Loop

Horizontal: Despite consuming the greatest amount floor space and requiring a looping pit, the standard horizontal loop configuration is the most common and versatile approach. To accommodate long feed lengths or help achieve higher line speeds, a pit can greatly increase the amount of material storage in a horizontal loop.

To avoid coil set in the material, it is extremely important that the coil 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.

Horizontal Loop

Calculating Loop Storage

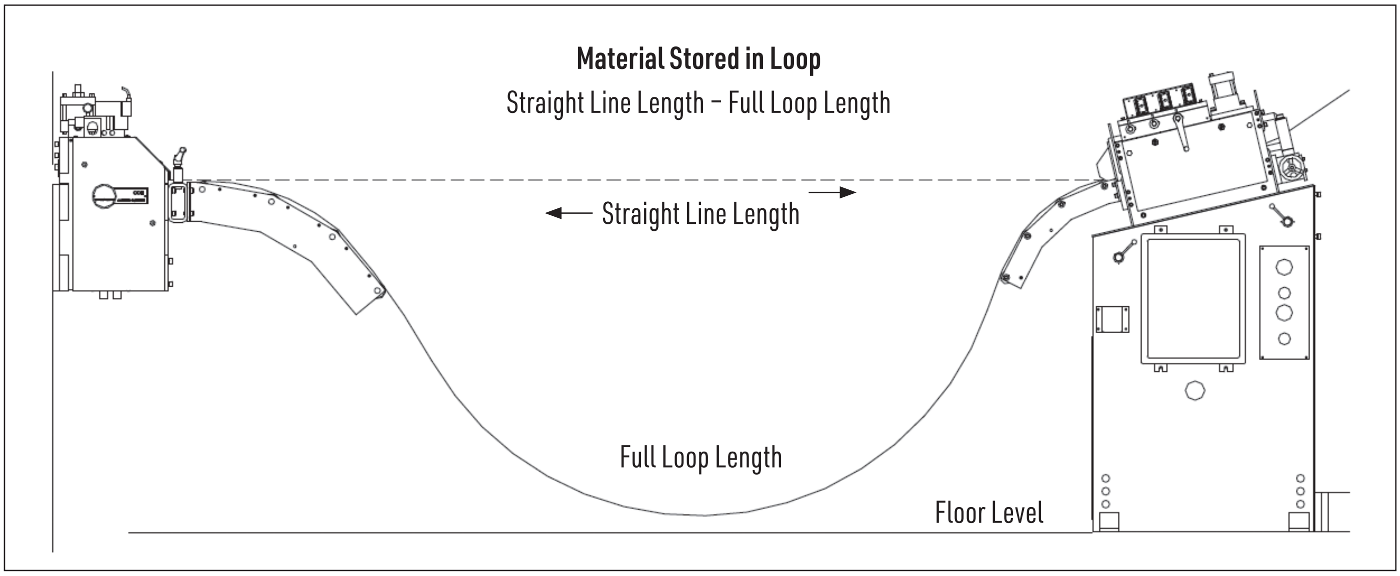
The loop storage requirement for any application is equal to the amount of material that is consumed by the feeder while the coil reel accelerates to line speed, minus the amount of material that is unwound during that acceleration period. For example, an operation requiring a 12" feed progression running at 120 strokes/minute (SPM) results in a net line speed of 120 feet/minute (FPM) or 24" per second. If the coil reel is capable of one foot/second squared acceleration, then it will take two seconds to accelerate to the 120 FPM line speed. During that acceleration period only 12" of material will be unwound while the feeder will use 48". The result is that 48" of material will have been consumed but only 12" will have been replenished, leaving a deficit of 36".

Loop Storage Requirement =
Material Consumed by the Feeder While Coil Reel Accelerates to Line Speed
- Material Unwound During Acceleration

If there isn't already more than 36" of material stored in the loop before starting, then the system will be unable to reach line speed without depleting all of the material in the loop. And, there must be an additional buffer beyond the required 36" 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" for smooth operation. If the loop contains less material storage than that, it will necessitate that the press speed be reduced to allow the coil reel to keep up.

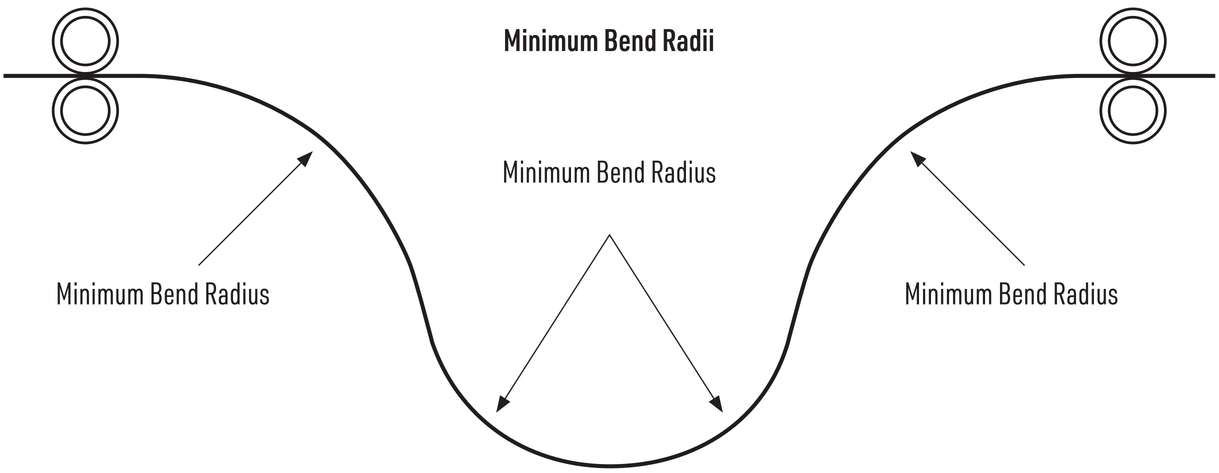
The actual storage is determined by the depth of a loop, not by its length. In fact, the longer the length of a loop, the less material that is actually stored in it for a given depth. The shortest loop length for a given depth yields the greatest amount of material storage.

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 coil set, but it really doesn't matter because it will be straightened at the feeder anyway.



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 without 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 retain the bend and will not 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 MBR 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.



MBR Calculation

$$\text{MBR} = 0.50 \left(\frac{\text{Material Thickness x Modules of Elasticity}}{\text{Yield}} \right)$$

Understanding Minimum Bend Ratio

The MBR for a loop is determined by the composition and maximum thickness of material being used; the thicker or softer the material, the larger its MBR. It will vary with the material composition, but a good rule of thumb is that the MBR for mild steel will be approximately 360 times its thickness. For example, with 0.025" thick mild steel the MBR is .25 x 360, or 90". If it is bent into a radius smaller than 90" it will retain some set after it exits the loop. This 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. 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. Loops this deep usually require a pit.

Determining Space Requirements

Once the storage requirement has been calculated based on the maximum progression and SPM factored with the response time of the coil reel, you can refer to his chart to help determine loop depth and length. This chart is based on steel with a yield strength of 40,000 PSI. For materials other than steel or material yields other than 40,000 PSI, refer to the MBR calculation tool.

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"

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.

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