Material Flow How®
Integrated in-mill logistics

Metal industry

PESMEL

Material Flow How® for metals

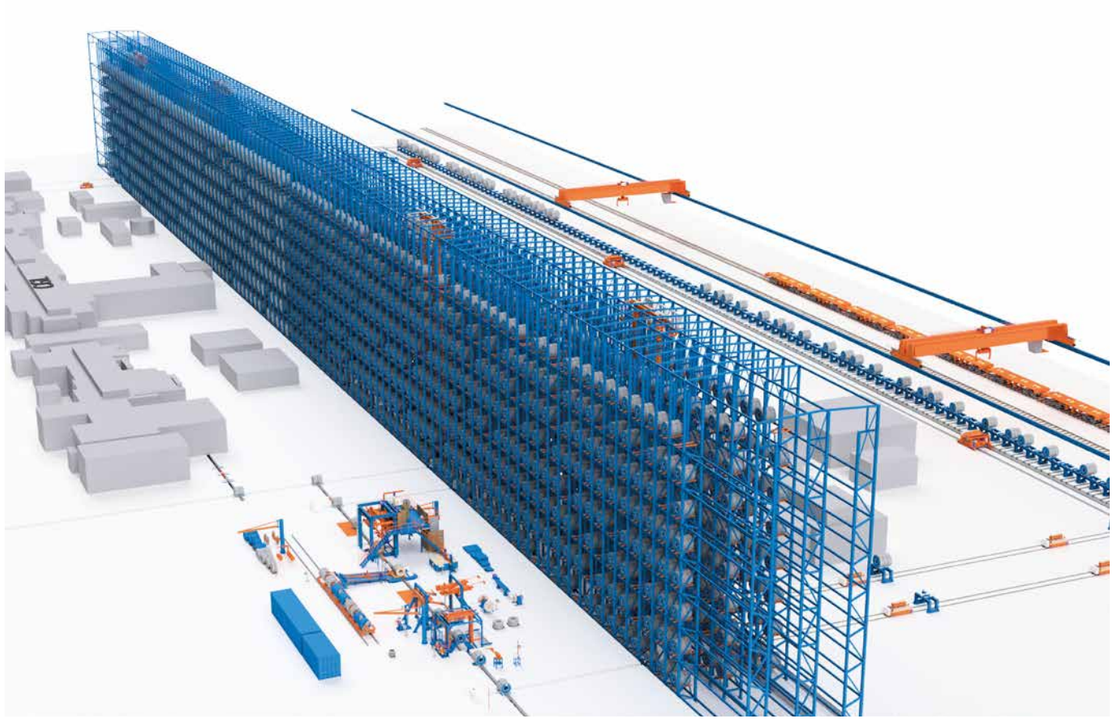
Pesmel's Material Flow How® concept integrates in-mill logistics, storing, packing, and shipping functions in a cost-effective way. The main idea of integrated logistics is to effectively eliminate bottlenecks between processes, ensure smooth material flows throughout the facility, and shorten transportation vehicles' turnaround times.

With automated material handling systems integrated into production processes, steel producers can achieve maximum efficiency with shortened lead times, real-time tracking, full traceability, work safety, as well as accurate sorting and loading of products.

Pesmel's Material Flow How® concept covers needs all the way from intelligent simulation, engineering, and system implementation to lifecycle services and maintenance. The concept, centered around a high-bay warehouse, is always custom-built to meet customers' specific needs and requirements.

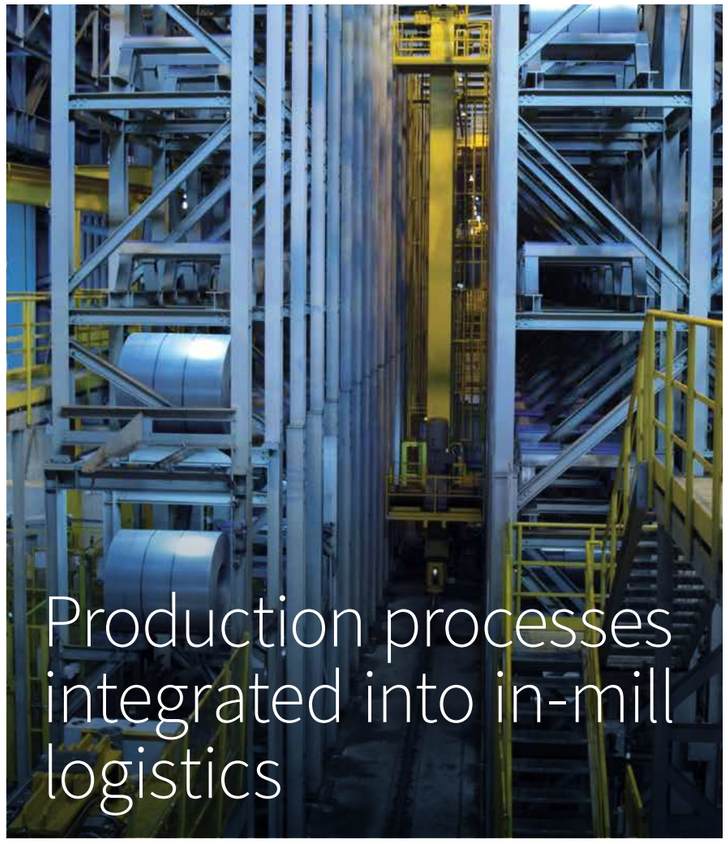
Mill operations can be boosted through integrated in-mill logistics:

- High efficiency and flexibility to run main mill processes
- Shortened lead times
- Real time control and inventory visibility
- Improved space utilization
- Improved operational safety
- Shortened transportation vehicle turnaround times



Customer reported results

from Material Flow How® vs. traditional solutions:



Over 50%
increased storage density

Less than 0,3 USD/ton*
OPEX/ton over a 25-year lifetime
*metric ton

< 20 mins
load availability for loading

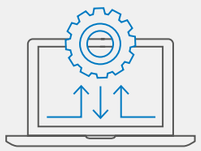
< 3 mins
coil from storage to process line

The two Material Flow How® concept cornerstones:

High-bay storage and in-house developed WMS

Manufacturing or distribution management

- Production data
- Order information

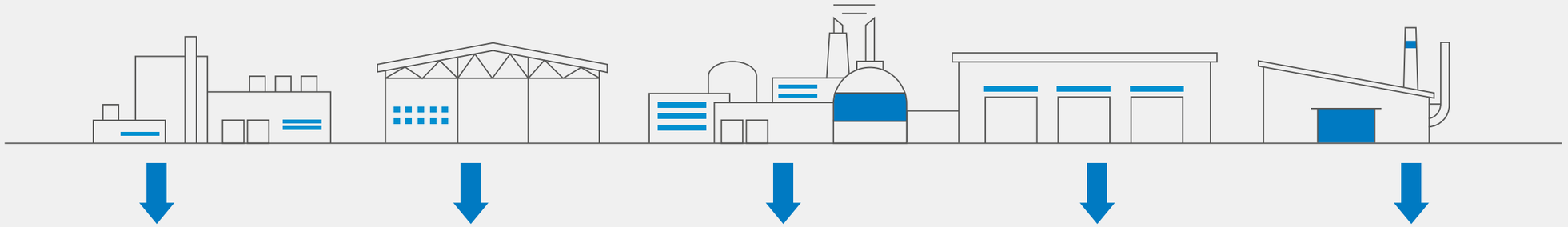


Warehouse Management System (WMS)

- Inventory management
- Material flow management
- Order picking
- Shipment and loading plans

Logistics management

- Identification
- Waybills



Coils

High-bay storage suitable for coils of up to 50 metric tons.

Wire rod

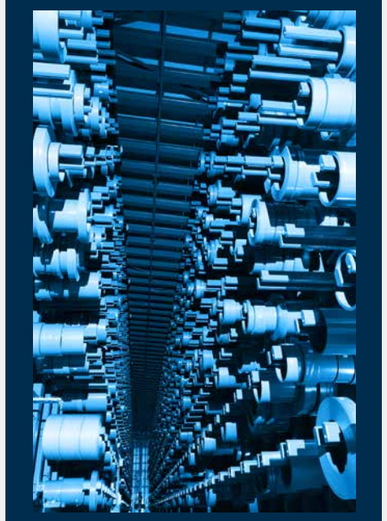
High-bay deep lane storage for wire rod coils with almost limitless handling and sorting capacity.

Sheets / plates

High-bay storage for plates and sheets with flexibility to handle all product sizes.

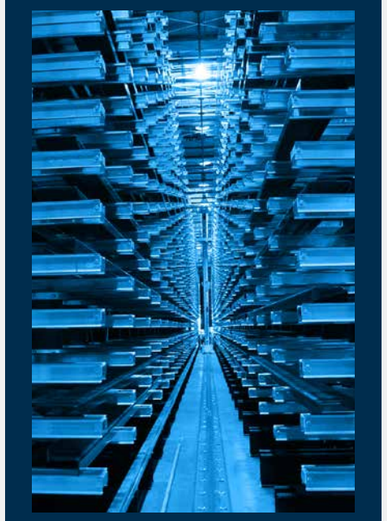
Strips

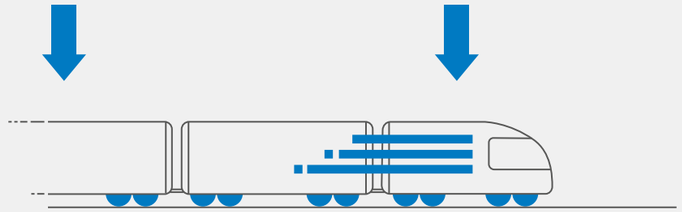
High-bay storage with efficient storing and sorting of various strip product combinations.



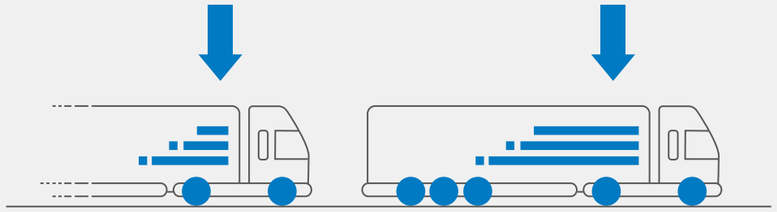
Long products

High-bay storage suitable for all kinds of profiles and bars.





External logistics



Smooth material flow throughout the mill

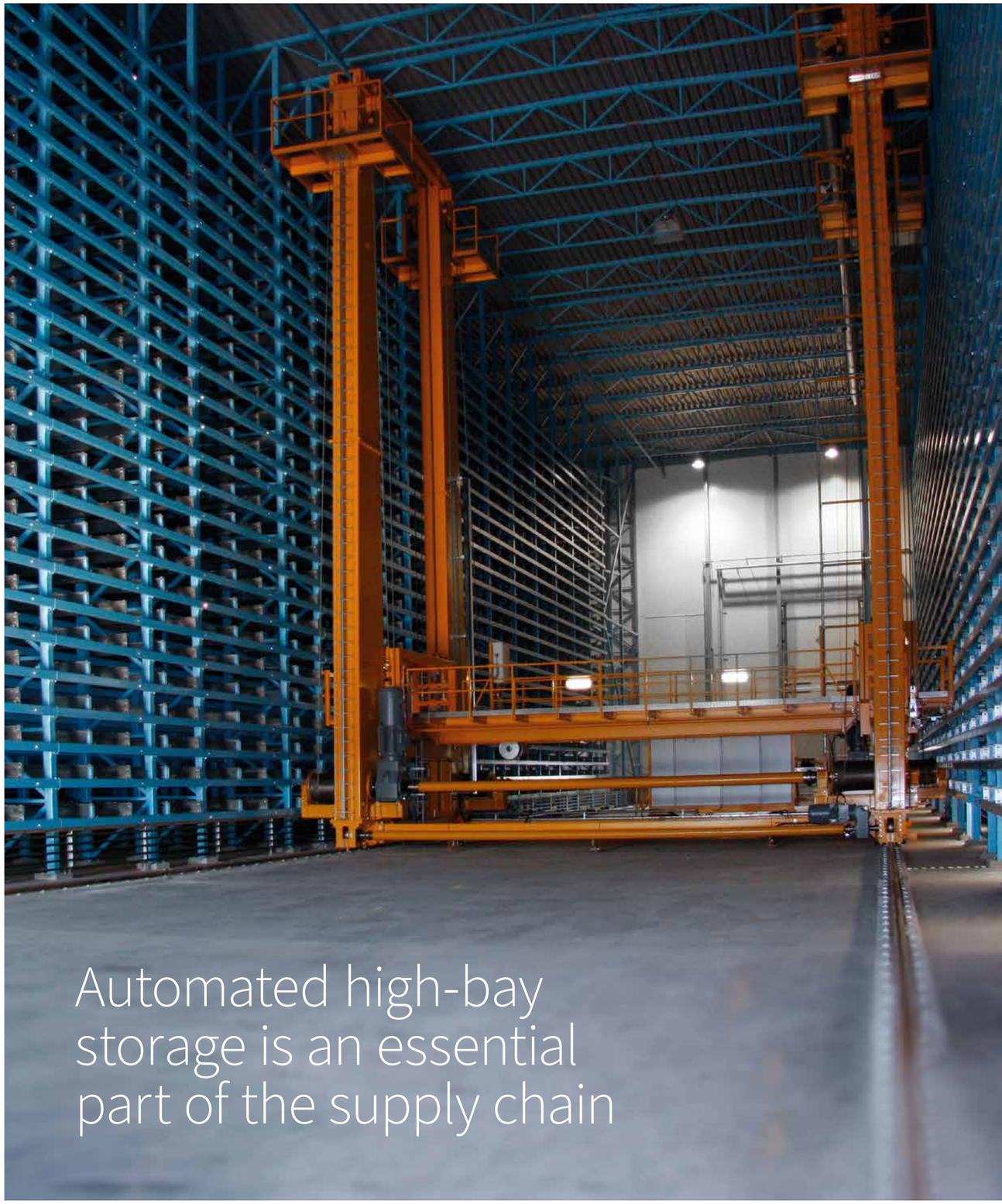
The Material Flow How® concept covers the entire automated journey for transferring coils between process lines, receiving them for packing and storage, and delivering them for loading and transportation. Pesmel provides customers with new perspectives and helps develop in-mill logistics operations. This offers great potential on the journey towards smooth and efficient production.

By optimizing in-mill logistics, traditional storage areas can be turned into an automated distribution center that will serve production processes and streamline deliveries to customers. The key to optimally functioning in-mill logistics is an intelligent, well-engineered mill layout where the storage forms an integral part of the production process and ensures a fast and flexible material flow throughout the mill.

New perspectives through simulation
The implementation of the Material Flow How® concept starts by building a simulation model, analyzing the material flows and potential bottlenecks, as well as optimizing the need for equipment. The process provides a model of a seamless combination of all material and information flows. Simulation acts as guidance for implementing a fully functional and optimized system. It enables pre-construction testing and verification of large and complex systems, and is a systematic approach to designing and implementing solution functionality.

The simulation process creates a digital twin, a virtual representation that serves as the digital counterpart of a physical process. It is used in development and maintenance of the customer's material flow solution. In addition to allowing overall analysis and development, a digital twin can be used in daily operations for continuous optimization of automated storage, estimation of near future occurrences, and support for operator decision-making.

Low carbon footprint
A low carbon footprint is central, both in construction and operation. High-bay warehouse components, mainly made of steel, are fully recyclable and reusable, offering an opportunity to greatly reduce CO_2 lifecycle emissions. The stacker crane drives have a regenerative braking function that feeds power back into the grid.



Automated high-bay storage is an essential part of the supply chain

Greater storage, smaller footprint

At the heart of Pesmel's Material Flow How® concept is the automated AS/RS (Automated Storage and Retrieval System) that allows coils to be stored to a height of over 30 meters, providing greater storage capacity with a much smaller footprint than with traditional storages. Automated stacker cranes handling the products inside the storage area can execute 30-40 productive moves per hour per stacker crane, ensuring high handling capacity.

The storage capacity can be flexibly adjusted for various product types and coils at different stages of the production process. The same storage can house hot-rolled coils of up to 350°C used as raw material, cold-rolled coils waiting for the next processing phase, as well as finished and packed products ready for delivery. This removes the need for many separate storage units located around the mill complex.

Comprehensive information flow

The entire system – logistics, storage, and packing – is controlled by an intelligent Warehouse Management System (WMS), which tracks and tasks coils from arrival to departure. The main function of the WMS is to control material flow, optimize storage and logistics functions to increase total handling capacity, and reduce operating costs. Full control of material flow also means no damage to products, no lost products, and no errors in deliveries. The order pickup process is guaranteed to be both fast and accurate.

With the WMS, the various functions contained within the mill can be integrated into one logistic entity. All levels of production and logistics control – from electrification to automation, monitoring, material flow planning, management, and logistics – can be integrated into one comprehensive platform.

Total cost of ownership, example mill
1 million metric tons' production, 1,500 coil storage

Parameter	Automatic High Bay Storage	Automatic EOT Floor Storage	Manual EOT Floor Storage
Equipment/ construction	Required area 10,000 m² 2 stacker cranes 2 EOT cranes Coil cars WMS	Required area 25,000 m² 6 EOT cranes Bay to bay transfer Cars YMS	Required area 25,000 m² 6 EOT cranes Bay to bay transfer Cars YMS
Construction (civil, structure, building)	USD 25M	USD 30M	USD 30M
Equipment	USD 12M	USD 14M	USD 8M
Equipment and construction total	USD 37M	USD 44M	USD 38M
CAPEX/metric ton	USD 1.48	USD 1.76	USD 1.52
OPEX/metric ton for 25-year lifetime	USD 0.30	USD 0.65	USD 1.39
Savings over the course of the 25-year lifecycle	**USD 28.25M**	**USD 12.5M**	**Reference**

CAPEX: Stacker cranes, coil cars, other equipment, racking, cladding, other building construction, and civil works

OPEX: Manpower, electricity, utilities, lifetime service incl. maintenance, spare parts, and upgrades

Engineering guidelines for high-bay storage design

High-bay warehouses and related software are custom built to meet customers' specific logistics needs and requirements. System design requires versatile methodology and knowhow, and certain engineering guidelines are provided to facilitate efficient design implementation.

Engineering variables and norms

Product temperature
- Maximum 350 °C (662 °F)

High-bay warehouse types
- Single deep
- Double deep
- Deep lane

Stacker Crane
Types and maximum load
- 1 mast up to 5 metric tons
- 2 mast up to 50 metric tons
- 2 frame up to 50 metric tons

Performance data
- X movement 3,5 m/s
- Y movement 1,2 m/s
- Z movement 1,0 m/s
- FEM cycles 30-40/hour

Design norms and regulations
- FEM 9.221 Performance data of SRM
- FEM 9.831 Tolerances and clearances in the high-bay warehouse
- FEM 9.851 Performance data of SRM, cycle times
- FEM 9.222 Demonstrating availability levels for SRM and other facilities
- FEM 9.311 Rules for the design of SRM, structures
- FEM 9.512 Rules for the design of SRM, mechanisms
- EN 12100-1/-2 Safety of machinery, basic concepts, general principles for design
- EN 418 Safety of machinery, emergency stop equipment
- EN 528 Storage and retrieval machines, safety
- DIN 15018 Cranes, basis for supporting steelworks, calculation
- DIN 15350 Rules for calculation of steel structures
- EN 60204-1 Safety of machinery – electrical equipment of machines
- EN 619 Continuous handling equipment and systems

Electrification
- High industrial standards
- Customer-specific electrification solutions
- Regenerative drives

System control
- System control by Pesmel WMS
- Machine control PLC Simatic S7-1500
- PC workstations
- OP panels for local machine operating
- Diagnostics

Racking
Types
- Free-standing > built inside building
- Rack-supported building > storage and building integrated

Design norms and regulations
- EN1993: (Eurocode 3) Design of steel structures
- IBC (North America)
- IS (India)
- EN1090: (EXC 2) Execution
- Consequence class CC2
- Fire class P0 (functional fire design)
- Combination of external loads (based on national regulations)
- Earthquake load
- Wind load
- Snow load

Logistic equipment
2-way and 4-way coil cars
- Speed up to 4 m/s
- Weight up to 50 metric tons
- Variations:
  - Rotating
  - Weighing
  - Cross saddle

Special equipment according to customer needs

Through-eye wrapping technology	Traditional packing with folding
Moisture protection by TEW technology	Traditional moisture protection by folding
Airtight package	Not airtight, VCI disappears
Storing time more than 24 months	Storing time less than 6 months
Fully recycable packing materials	Laminated packing materials
Operator-safe packing, no VCI	Operators involved with VCI
Automated, no operator involvement	Manual/dangerous working phases

Environmentally friendly packing

Environmental issues such as recycling and saving materials and energy are increasingly important today. Packaging can be done using non-toxic reclaimed materials, increasing quality whilst lessening material use.

An important part of new packing methods development is environmental sustainability. Pesmel's packing systems use materials that match today's requirements. Coil packing using through-eye wrapping (TEW) technology gives coils optimum moisture protection and is VCI-free.

High level of rust prevention

Rusty or damaged products are costly, with the journey from production to delivery humid. Guarding steel products against humidity and rust is a matter of thorough, fully automated packing technology comprised of two phases: moisture and mechanical protection. Through-eye wrapping with crêpe paper and PE film is the hallmark of TEW technology. It makes an airtight package that gives effective protection against humidity.

On the production line, the first layer is wrapped with crêpe paper and the second with stretch film. The crêpe paper absorbs humidity inside the coil, whilst the PE-film protects it from external moisture such as rain.

The product also needs to be mechanically protected against damage during handling and transportation, with the scale and type of these processes determining the mechanical protection level.

Flexible and efficient packing through automation

Pesmel's fully automatic coil packing line with pre-programmed (or manually-fed) packing codes is highly efficient and flexible. It can pack different package sizes and types, requires no setup, and can serve several slitters or production lines simultaneously.

The automated packing line produces over 20 packages/hour with just one supervisor, and only requires material filling per shift/machine at full capacity. Automated packing lowers expenditure on packing materials by up to 30 percent by optimizing material usage.

Pesmel's solution cuts the packing materials according to coil size instead of using pre-cut packing materials. This means considerable savings on packing material management, as the need for differently sized packing materials and storage space for them is reduced considerably.

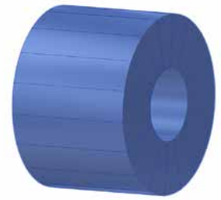
Packing levels

Pesmel has a selection of internationally approved, most common and recommended packing codes. The packing levels define different moisture protection alternatives and different packing codes for mechanical protection.

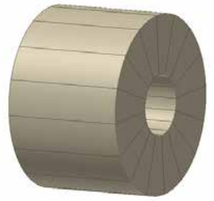
More information on packing levels is available in the Pesmel Packing Book

Moisture protection

Stretch film

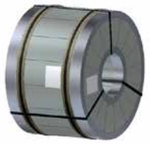
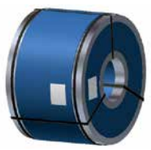
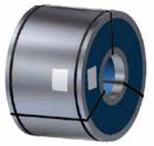
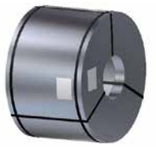


VCI + stretch film



Crep paper + stretch film

Mechanical protection

Series	 **10**	 **20**	 **30**	 **40**
Handling method	Handling with hooks	Handling with hooks	Handling with hooks	Handling with hooks
Handling times	1-3, automatic handling	2-4, automatic handling	3-6 handlings	3-6 handlings
Transportation	Internal use in mill or location nearby	Standard transportation vehicle with stands	Truck/train transportation horizontally	Truck/train transportation horizontally
Series	 **50**	 **60**	 **70**	 **80**
Handling method	Handling with hooks or chains	Handling with hooks or chains	Handling with hooks or chains	Handling with hooks or chains
Handling times	4-8 handlings	4-8 handlings	4-8 handlings	4-8 handlings
Transportation	Truck/train transportation horizontally or vertically, maritime transportation, continental and intercontinental	Truck/train transportation horizontally or vertically, maritime transportation, continental and intercontinental	Truck/train transportation horizontally or vertically, maritime transportation, continental and intercontinental	Truck/train transportation horizontally or vertically, maritime transportation, continental and intercontinental

Rev. 01, 2023

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