

**ISOTRACK X** SERIES  
PROTECT – BE SAFE

# USER MANUAL



MEMBER OF *Constantia* INDUSTRIES



**ISOKON**  
INNOVATIVE PLASTICS SOLUTIONS



Isotrack X is manufactured by:

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SLOVENIJA

[www.isotrack.eu](http://www.isotrack.eu)



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## IMPORTANT NOTICE

This manual provides best practice guidance to help those involved in handling and installing Isotrack X mats for temporary roadway and ground protection purposes.

Health and Safety should always be top priority. Therefore, this user and guidance document should be read in conjunction with Health and Safety project site requirements.

Please also refer to Isokon's Standard Terms & Conditions and Warranty.

# 1. ISOTRACK X - INTRODUCTION

The Isotrack X composite mat system provides a safe, cost-effective temporary road and ground protection surface for year-round, all-weather performance. The mats are made of high performance thermoplastic material for a strong, durable, working surface that can be used for projects that require safe temporary access for heavy vehicles, equipment and site personnel.

Engineered for performance and strength, the connected mats help to distribute weight across their surface. The mats can be used in wide range of climate conditions. They are connected using the patented Four3 connector and the surface tread pattern provides traction and improves safety for load-bearing vehicles. Subject to recommended use and maintenance the mats will provide long life performance.

**The mats can be used on a wide range of project types:**

- Oil and gas
- Utilities
- Construction
- Petrochemical
- Transmission
- Pipelines
- Temporary helipads
- Wind farms
- Any project requiring safe temporary access for heavy vehicles and equipment



Patented Four3 Connector / Locking Pin - glass filled reinforced plastic frame with stainless steel metal parts.



Surface with raised nubs provides traction for safe movement of vehicles and personnel.

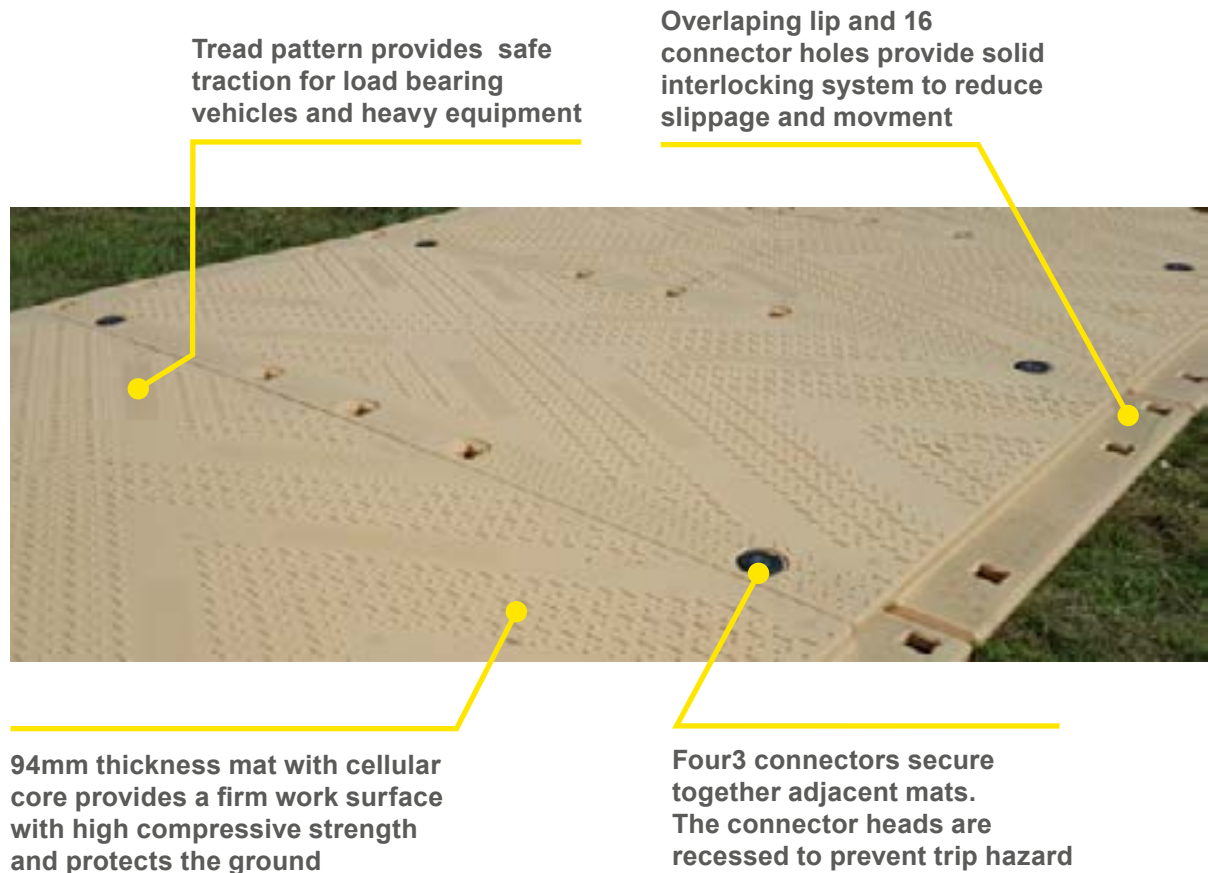




## 2. ISOTRACK X — KEY FEATURES

The Isotrack X mat is 2.0m x 4.0m x 94mm deep excluding nub height (refer Appendix 1) and weighs approximately 360kg. Each mat has a 200mm lap on two sides that are used to connect adjoining Isotrack X mats. The two laps incorporate a total of

16 connection holes (providing options for different configurations) into which the Four3 connectors can be inserted and engaged in order to securely fasten mats together.



- Chevron traction design surface.
- Can be used on a wide range of different ground conditions and soil types.
- High performance over a wide temperature range (-35°C to +60°C) and operating conditions.
- Fast and secure connection using the patented Four3 connector pin.
- Can be connected in different configurations to make roadways, pads, turning areas or passing places.
- Material is chemically inert and will not rot (refer to Appendix 2 for material and MSDS information).
- Cellular core for compressive strength and buoyancy.
- Foam fill virtually eliminates ingress of liquids in the unlikely event that the mat gets punctured during use.
- Each mat has unique identity number.
- Option to install RFID or GPS within special pocket located in one of the laps.

### 3. ENVIRONMENTAL AND CORPORATE SUTAINBILITY

**Isotrack X can be used to help protect the environment and also support corporate sustainability objectives:**

- Protecting the environment – the mats help to reduce ground damage and protect habitats.
- Supporting Health & Safety through safer movement of vehicles, equipment and project workers.
- Contribute to accident rate reduction and lost time incidents.
- The materials used to make Isotrack H are 100% recyclable at end of life.



## 4. TRANSPORT, HANDLING, STORAGE, CLEANING & MAINTENANCE

At depots and on site it is essential that:

1. Personnel involved in the transport, handling, installation, storage, cleaning and maintenance of Isotrack X should wear appropriate Personal Protective Equipment.
2. All Health and Safety requirements are complied with.

### 4.1 Transport

Isotrack X leaves the factory for delivery strapped on pallets of 5 mats (gross weight including pallet = 1875kg). The mats can be un-strapped at a depot or on site before first use.



**Dimension of packed 5 mats on pallet:**

- 4000 x 2000 x 660mm

**40ft high cube container loading:**

- 9 pallets of 5 mats
- 2 pallets of 2 mats
- 1 pallet of 1 mat

**Truck loading:**

- 12 pallets of 5mats

- It is good practice to ensure that mats are carefully stacked and aligned for transport.
- The mats must be safely loaded / unloaded using appropriate equipment (e.g. forklift, crane) of the required lifting and load capacity. As a general guide it is recommended that a maximum of one pallet of 5 strapped mats or 1 unstrapped mat is lifted at a time.
- Use appropriate straps or other fixing methods to safely secure the mats during lifting and transport.
- Ensure compliance with international, national and regional road directives and regulations (in particular maximum authorized dimensions and weights).





## 4.2 Handling

New mats are delivered on pallets from the factory: 5 mats securely strapped to each pallet. The straps can be removed after unloading at a depot or just before first use on site. The pallets, strapping and any other packaging should be disposed of responsibly.

The mats should be loaded / unloaded by fully trained personnel using the appropriate equipment for safe lifting and moving of the mats.







**Caution** – before first use the new mats can slide across each other (due to newness of the material) so for reasons of safety particular care needs to be taken when lifting and moving the mats if they are not strapped together.

### 4.3 Storage and Stacking

- Mats can be stored on pallets as delivered until used.
- Mats can be stockpiled without pallets after use. If required, the bottom mat can be placed on wooden posts of sufficient height to position forks under the stack for lifting. Posts can be placed at different heights within the stack for additional fork access.
- When storing the mats, care should be taken to ensure that the ground is level and stable within the storage areas. Clear any obvious obstructions from the surface before stacking the mats.
- The number of pallets or individual mats that can be safely stacked on top of each other will depend on the size of the storage area, site safety requirements and the equipment available for lifting and moving the mats.
- For ease of installation and connection it is recommended that mats are stored and stacked with surfaces and overlaps positioned in the same way.





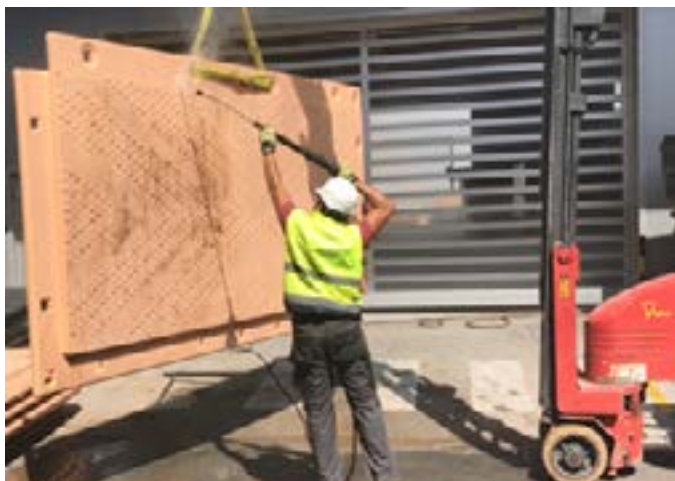




## 4.4 Cleaning

Isotrack X mats are constructed from a high performance thermoplastic material which prevents absorption of any contaminants into its structure and provides a barrier between the ground and mat surface.

1. It may sometimes be necessary to clean mats on site – before being re-used elsewhere on the same project or before loading for return to depot. This can be undertaken using water hoses, pressure washers or brush cleaning equipment.
2. Oil, fuel or other contaminants should be removed, contained and isolated for safe disposal in full compliance with statutory and site specific pollution prevention and waste management plans.



**Back at the depot and in preparation for the next project:**

1. The mats can be steam or pressure washed to remove dirt and mud and to restore optimal traction.
2. Any residual oil, fuel or other contaminants should be contained and isolated for safe disposal in accordance with statutory and site specific pollution prevention and waste management plans.



## 4.5 Removing Snow and Ice

In cold climatic regions the mat surfaces may sometimes require removal of snow or ice. The composite material used to make the mats can be damaged by steel equipment so where possible removal should be undertaken by sweeping using vehicles with stiff brush attachments. If absolutely necessary, vehicles with snow shovel or plough equipment can be used although extreme care must be taken to avoid damage to the mat surfaces and the heads of connection bolts. Risk of damage will be greater if mats are unevenly installed or not properly connected.

The mats will not be damaged by using salt or sand so can be safely used to prevent slip risk from ice, snow, vehicle oils etc. However, as always, such use must comply with statutory and site specific pollution prevention requirements.

## 4.6 Maintenance

The Isotrack X mats are designed to be relatively maintenance free. However, if mats are mishandled or used in ways for which they were not designed then they can get damaged. Periodic inspections on site and / or in the depot should be undertaken by a competent person to look for:

- Puncture of the mat surface. The mat can continue to be used but should be repaired by welding as soon as possible. Isokont can supply welding equipment and provide guidance.
- Cracks along the weld line between the two mat halves. Again this would not prevent the mat being used but could affect longer term performance. The damaged weld material should be removed and a new weld should be made extending beyond the length of the crack. Isokon can supply welding equipment and provide guidance.
- Damaged or missing bolts. The bolts securely hold the two mat halves together so continued use with severely damaged or lost bolts could adversely affect mat performance. Mats would need to be returned to depot for replacement.
- Damaged connector pins. The Four3 connector pins have low profile heads to minimize the risk of damage from tracked vehicles however, should significant damage occur, it is recommended that connector pins are replaced.



Temporary repairs can be made on site but it is recommended that damaged mats are returned to depot for full repair. If necessary damaged mats can be replaced on site.

## 5. SITE ANALYSIS AND PREPARATION

### 5.1 Site Survey and Inspection

It is expected that Isotrack X will be used only where it is able to safely meet site and project conditions as understood by project site managers and their geo-technical engineers.

**Careful consideration needs to be given to:**

- Current and expected ground conditions along the routes and areas where Isotrack X is to be used including ground bearing capacity. Ground conditions and bearing capacity can significantly change, for example, in response to periods of rainfall and flooding.
- Site survey along the routes and areas where Isotrack X is to be used. This is to identify where boulders, shrubs, tree routes, stumps or other obstructions may need to be cleared or managed ahead of mat installation.
- The duration of the project and the types, sizes and weights of vehicles and equipment to be used.

Isotrack X mats have some built-in flexibility allowing limited contouring to an undulating ground surface and small ground irregularities will not adversely impact on mat performance. However, it is important to note that the mats are not designed to be used for bridging over ditches or trenches so sufficient ground support must be in place before the mats are installed. This may necessitate some minor grading of the ground surface prior to installation – a more uniform surface will facilitate speed of installation and improve transfer of vehicle load across the mats.

It is good practice to use scaled site drawings to show the alignments and numbers of mats required to complete the temporary road and pad areas required for the project.



5.2 Ground Conditions

Isotrack X mats can be used across a wide range of ground conditions. As noted in section 5.1 it is important to obtain information and advice from the project site managers and geo-technical engineers.

Reference is often made to the CBR value of the sub-grade. The CBR rating was developed for measuring the load-bearing capacity of soils used for building roads. The harder the surface, the higher the CBR rating (refer table below). For example, a CBR of 3 may equate to tilled farmland, a CBR of 4.75 may equate to turf or moist clay, while moist sand may have a CBR of 10. High quality crushed rock has a CBR over 80. The standard material for this test is crushed California limestone which has a value of 100.

Isotrack X mats will respond differently according to the underlying ground conditions and vehicle load.

Typical CBR Ranges

General Soil Type	USC Soil Type	CBR Range	
Coarse-grained soils	GW	40 - 80	On sub-grades with high CBR values (e.g. almost solid ground) the load from the contact area (vehicle tyre) will tend to result in slight deformation to the mat core cellular structure with no or minimal deformation to the ground underneath the mat.  As CBR values decrease (ground becomes softer) the load from the contact area will start to lead to deformation of the ground beneath the mat. The amount of ground deformation will depend on the load per unit area on the mat surface, the CBR value of the sub-grade and the number of passes.
	GP	30 - 60	
	GM	20 - 60	
	GC	20 - 40	
	SW	20 - 40	
	SP	10 - 40	
	SM	10 - 40	
	SC	5 - 20	
Fine-grained soils	ML	15 or less	On very soft ground (or wet / boggy) it may be necessary to multi-layer the mats (refer section 6.5).
	CL LL < 50%	15 or less	
	OL	5 or less	
	MH	10 or less	
	CH LL > 50%	15 or less	
	OH	5 or less	

Standard CBR test methods are:

- AASHTO T 193: The California Bearing Ratio
- ASTM D 1883: Bearing Ratio of Laboratory Compacted Soils





## 6. DEPLOYMENT AND INSTALLATION

### 6.1 Lifting Equipment

The mats can be handled and installed on site using different types of equipment as long as they are fit for purpose and meet site health and safety requirements. Tele-handlers / other equipment with extended forks (minimum 1.8m in length), hydraulic grabs, vacuum lifting equipment, slings can all be used.

- Pallets of mats should only be handled by adequately trained and experienced operators.
- Pallets should be picked up and on the long side.



Telehandler with Extended Forks



Extended Forks



Hydraulic Steel Grab



Vacuum Lifting Equipment

#### It is important to note:

- Mats should only be handled by adequately trained and experienced operators.
- Mats should be picked up and held on the long side.

## 6.2 Installation Tools

- The waist-high locking tool is equipped with a hex-head designed to fit into the hex- receiver in the top of the pin. A one-eighth turn will engage the locking mechanism.
- The locking tool can also be used to help align the mats during the installation process (refer section 6.4).



## 6.3 Connector Locking Pin System

It is important that mats are ALWAYS connected together for safe and effective performance. The connectors are used to join multiple mats together to form roadways, working pad areas, turnouts, passing areas as required for the project. Only when the connectors are locked into position are the mats fully secured, thus ensuring they won't slip or drift under load.

- Each Isotrack X mat has a total of 16 connection holes located within the 200mm over and under laps. This number of holes provides options for different installation configurations.
- The connection holes are designed to help guide the connectors into position during installation so that the upper and lower laps can be locked together.
- The patented Four3 connector enables secure and safe connection for mats installed as roadways or pad areas.
- The Isotrack X locking tool or a standard 16mm across-flats hex Allen key tool is used to lock the connector by one-eighth turn clockwise.
- There are markings on the black part of the connector head to indicate when the connector is open or closed. The photographs below show the connector in the un-locked and locked positions. When locked, by turning the locking tool to the right, the line on the steel part should be aligned with closed padlock marking.



Unlocked Position



Locked Position



- Note – connectors need to be in the fully locked position to avoid risk of mats disconnecting.
- When connected the head of the connector sits within a shallow recess in the connection hole ensuring that it is more or less flush with the mat surface. The graphic below shows how the foot of the connector is aligned relative to the connector hole recess of the underneath lap of the mat.



- To remove, the connector is turned anti-clockwise until the unlocked position is reached. Sometimes it is possible to extract the connector from the connection hole simply lifting by hand but the heads of the pin have recesses to insert a screwdriver or similar tool to help lever the pin out of the connection hole. Also by exerting sideways pressure on the installation tool and lifting it can be possible to remove the connector from the connection hole.



The number of connectors used to connect the mats will depend on specific project requirements, ground conditions and mat configuration. Experienced installation teams will have knowledge of the minimum number of locking pins and which connection holes to use to ensure best performance of the Isotrack X mat system. However, as a minimum, it is recommended that two connectors are used on each connected side.



## 6.4 Installation and Connection Process

Experienced operators involved in the installation of heavy duty road mats will have their preferred methods of handling and installing mats.

- A minimum crew of three is recommended for simple installation - one crew member to operate the loader and bring mats to the area and two on the ground to guide the mats into place, insert then lock the connectors.
- For increased efficiency and speed, or where ground conditions are more difficult, larger crew sizes can be used.
- Crews of two can be used when vacuum lifting equipment is employed.

### Installing Isotrack X Mats

Isotrack X mats are designed to connect to each other to form continuous roadways, working pads or other areas. The basic process for connecting the mats with connector locking pins (described below) is used for the different road and site configuration options.



Mats can be installed and connected in the directions indicated

### Method Using Truck Mounted Extending Crane and Lifting Slings

1. Mats should be delivered to site neatly stacked on the truck.



2. Lifting slings are inserted through connector holes on the overlap and attached to the crane hook.

**Note:** The lifting sling should be rated for the weight of the mat (360 kg) allowing for any required factor of safety. Slings must comply with international Lifting Sling Standards.



3. The mat is lifted safely from the truck.



4. The first mat is positioned in the direction of the required temporary road alignment for the project. The bottom edge is carefully positioned before being completely lowered to the ground.

**Note:** Position the first mat down with the underlap lip exposed in order to connect to the overlap lip of the second mat. Make sure all the holes and underlap are free of any obstructions or debris prior to positioning and connecting mats.



5. The lifting sling is removed.



6. The second mat (and subsequent mats) is lifted from the truck. The crane jib is extended to the position the mat.



7. Working with the crane operator the installation crew carefully guides the mat into position.

**Note:** The second mat should be placed alongside the first mat with the overlap resting on the first mat's exposed underlap.



8. The installation tool is passed through the connection holes in the upper and lower overlaps.



9. The mat is lowered into position, continuing to use the installation tool to guide the mat into place and maintain alignment.



10. The installers then drop connectors into each of the connection holes to be used.

**Note:** As previously noted the number of connectors used will be determined by ground conditions, the type of loads, frequency of use and the duration of the project.





10. Using the installation locking tool, lock each connector in place with a one-eighth clockwise turn.

**Note:** Sometimes ground irregularities can prevent sufficient contact between the lower and upper laps when being positioned and the connecting pin cannot be readily engaged and locked. This can be overcome by applying pressure (using the forks of a fork lift or the weight of the installation vehicle) on the overlap mat to push the two mats together to achieve good connection for locking.



### Method Using Telehandler with Extended Forks

The process using a telehandler is broadly the same as that described above using extending crane and slings.

1. Mat is lifted from stack of mats.

**Note:** Note: when using forks it is usually necessary to first lift the near edge of the mat with the forks and have a wooden post inserted below the mat. The mat is then lowered onto the block. This then provides sufficient space to insert forks fully across the mat for safe lifting.



2. Working on the surface of the mats the next mat to be installed is taken to the end of the roadway for installation and connection.



3. The mat is positioned over the end mat. The installation tool is inserted through the connection holes for alignment.



4. When approximately aligned and in position the forks are withdrawn and the mat lowered onto the end mat with the connection holes finally aligned.



5. The mat is positioned over the end mat. The installation tool is inserted through the connection holes for alignment.



**Note** – in areas of boggy or very soft ground the mats must be placed sequentially in front of the loader while the loader moves on the previously placed mats. The installation crew also work from on the surface of the mats.

Information on different mat configurations is provided in Appendix 2.

## Removing Isotrack X Mats

The Isotrack X mats are removed in the reverse sequence to that used for installation.

1. Unlock and remove the connectors to release adjacent mats. Connectors should be safely stored for the next project.
2. A tele-handler, forklift or other suitable equipment is used to lift the mats for transport / stacking / storage (refer Section 4.3).
3. As always, the correct equipment should be used to ensure safe lifting and handling of the mats.

## 6.5 Double or Multi-Layering Mats

Over very boggy, muddy or soft ground (e.g. CBR 3 or less) it may be necessary to double or multi-layer mats to provide firm access or stable pad areas. A first layer, but double width or more, should be installed in the normal way (see above) before installing the second layer. For roadways the second or uppermost layer connects with the rest of the roadway to provide a uniform and continuous surface.

It is recommended that when stacking that the connection joints of the upper layer are not aligned with the connection joints of the lower layer. This 'brickwork' layering ensures optimum strength. Install and connect mats in multi-layers as indicated on the drawing below. Width and depth of layers will depend on ground conditions and vehicle weights.



**Important** – before implementation, double or multi-layer installation should be subject to competent risk assessment and project Health and Safety approval.

## 6.6 Using Geotextiles

The over and underlap system is designed to significantly reduce mud and surface water getting pumped onto the mat surfaces as vehicle loads move across the mats. On sites that are particularly wet, muddy or boggy it is recommended that a geotextile material is first rolled out over the ground before mat installation commences. Geotextile can provide a cost-effective barrier between the mats and the ground preventing water and mud being pumped up onto the mat surface. In turn this reduces the need for cleaning mat surfaces during (and after) the project and provides a safer working surface.

## 7. OPERATING GUIDANCE AND LIMITATIONS

### 7.1 Safe Speed

Isotrack X has been designed for the safe movement of worksite vehicles, equipment and personnel. Although the mats will provide temporary road-way access it is important to understand that the mats will not behave in the same way as a permanent road surface. It is therefore necessary to observe strict control over the speed of vehicles using the mat system. Subject to project site safety requirements it is recommended that vehicles and equipment **must not exceed 10 km/h (6 mph)**.



### 7.2 Bridging

The mats are not designed for bridging or spanning trenches (refer Section 5), even if double or multi-stacked (Section 6.5). The mats are intended to be used in contact with a sub-grade or underlying surface so sufficient ground support must be in place before the mats are installed (particularly under the overlaps / connection points). This may necessitate some minor grading of the ground surface prior to installation – a more uniform surface will facilitate speed of installation and improve transfer of vehicle load across the mats.

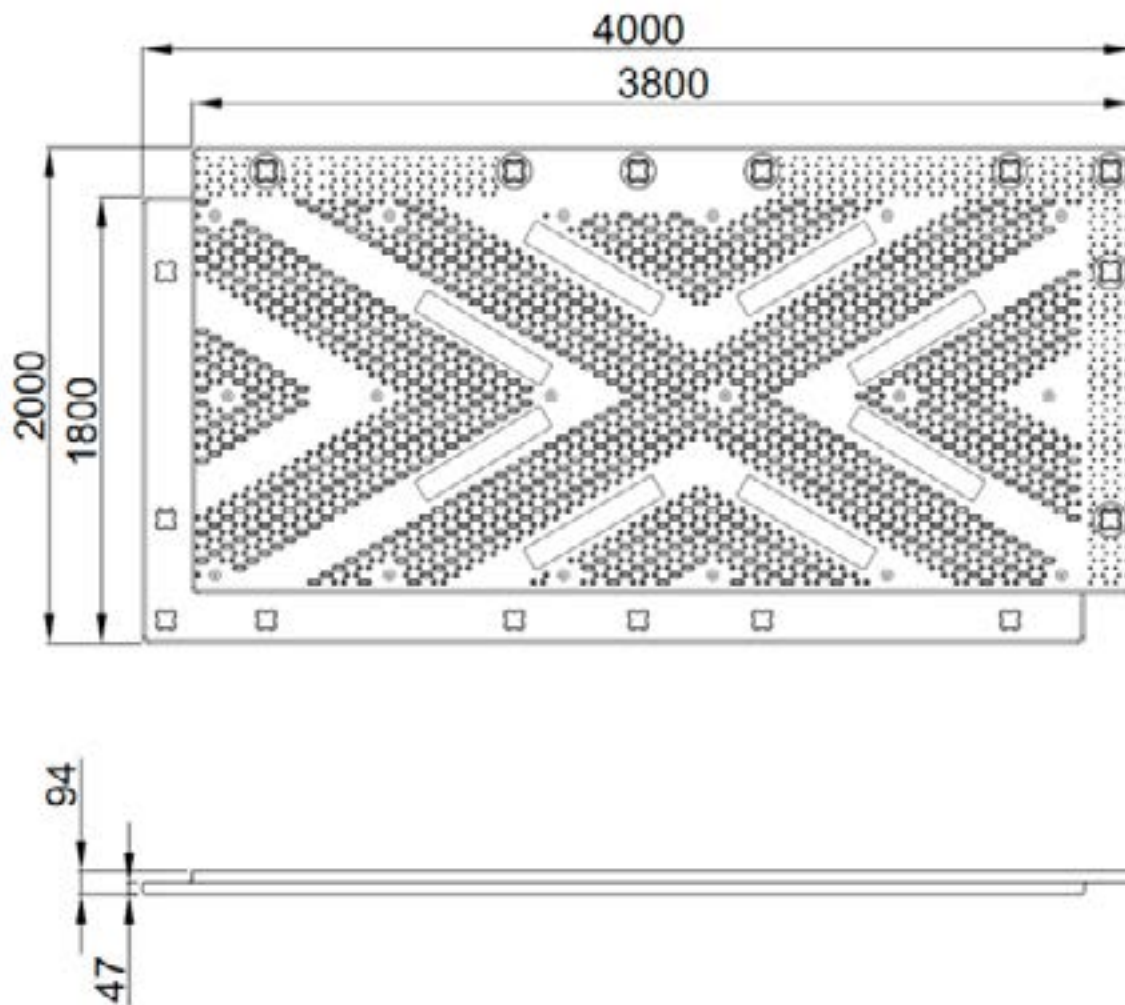
### 7.3 Steel Tracked Vehicles and Equipment

As already noted in Section 4.5 steel tracks and equipment can damage the thermoplastic material used to make the Isotrack X mat (this applies to any plastic / composite mats). In order to minimize risk of damage to Isotrack X when using steel tracked vehicles it is recommended that the use and movement of steel tracked vehicles and equipment is limited or very carefully controlled. If steel tracked vehicles or equipment are to travel over Isotrack X, it is essential that steel tracked vehicles and equipment only move in a simple forward or reverse direction and at a slow speed. Steel tracked vehicles or equipment should never turn or slide on Isotrack X. Please refer to Isokon Warranty.





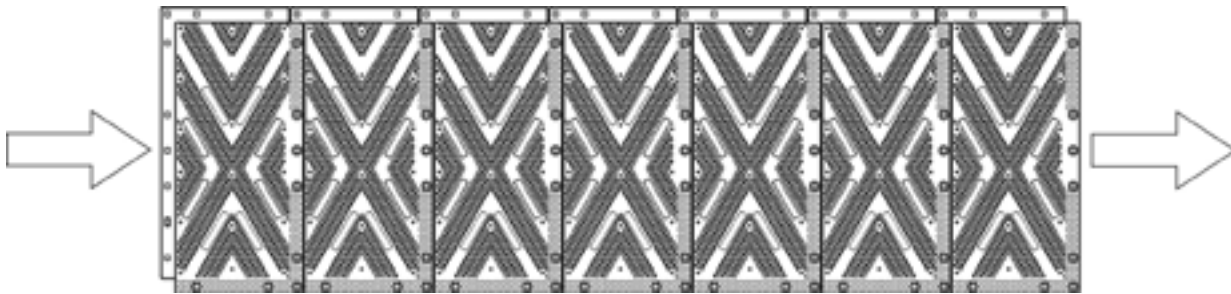
## Appendix 1 – Mat Drawings and Dimensions



## Appendix 2 – Mat Configuration Options,

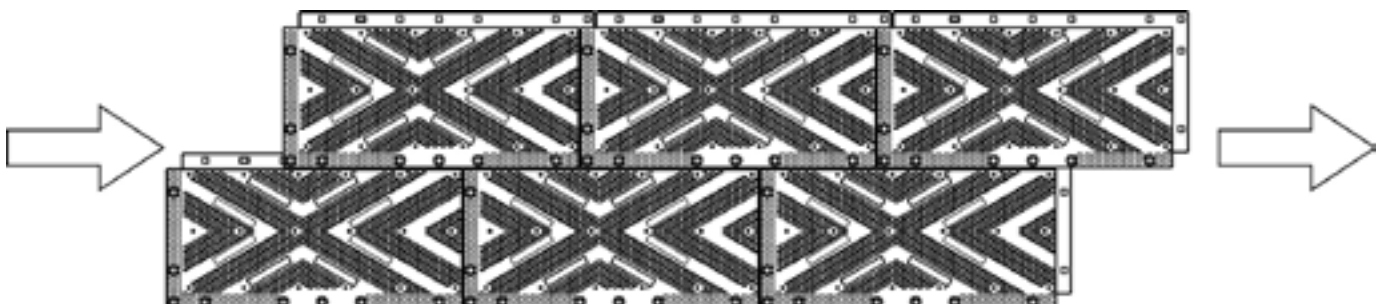
### Single Road

The single track (3.8m running road width) is formed by installing the mats long side to long side in the direction of the road. A minimum of two locking pins at each connection point is required. The arrows indicate direction of installation.



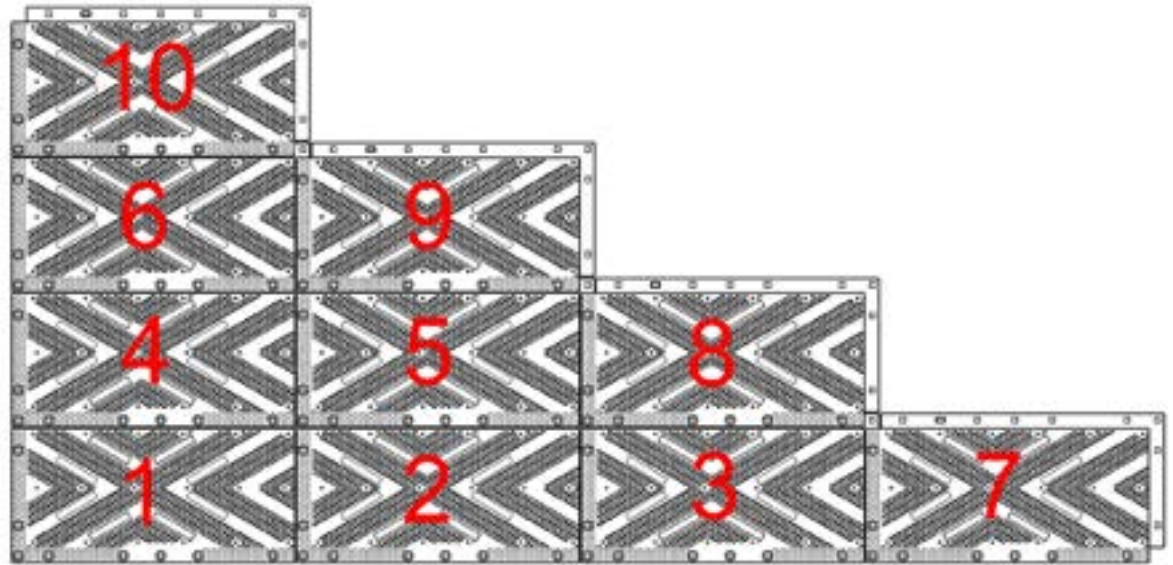
### Double Longitudinal Road

This configuration provides a slightly narrower (3.6m) running road width. The longitudinal configuration requires that the mats lay end to end in a straight line, with the edges of the two adjoining mats lined up evenly so that both will accept the two locking pins. Additional strength is gained from staggering the mats in a brickwork fashion. The arrows indicate direction of installation.



### Working Pad Areas

Isotrack X mats can be installed and fastened together to cover large surface areas to be used as work sites or pads. Once you have calculated the required area Installation commences and follows the sequence as shown below. The example below is for a 4 x 4 pad area and shows the sequence for the first 10 mats. Begin by laying one mat at the outside corner of the proposed site, nearest to the access road. The mat should be aligned with the edge of the site so that the pad, when constructed, covers the required area. By laying the mats from the corner outward, you will be able to work on the matted surface and have more room to manoeuvre.



## Bypasses, Passing Lanes & Turnouts

Where vehicles are moving in both directions over long straight road sections, passing bays may be required to facilitate movement of vehicles in both directions. A passing bay or turn-out can be configured by attaching one or more mats alongside and parallel to the main road alignment. Examples are shown below.

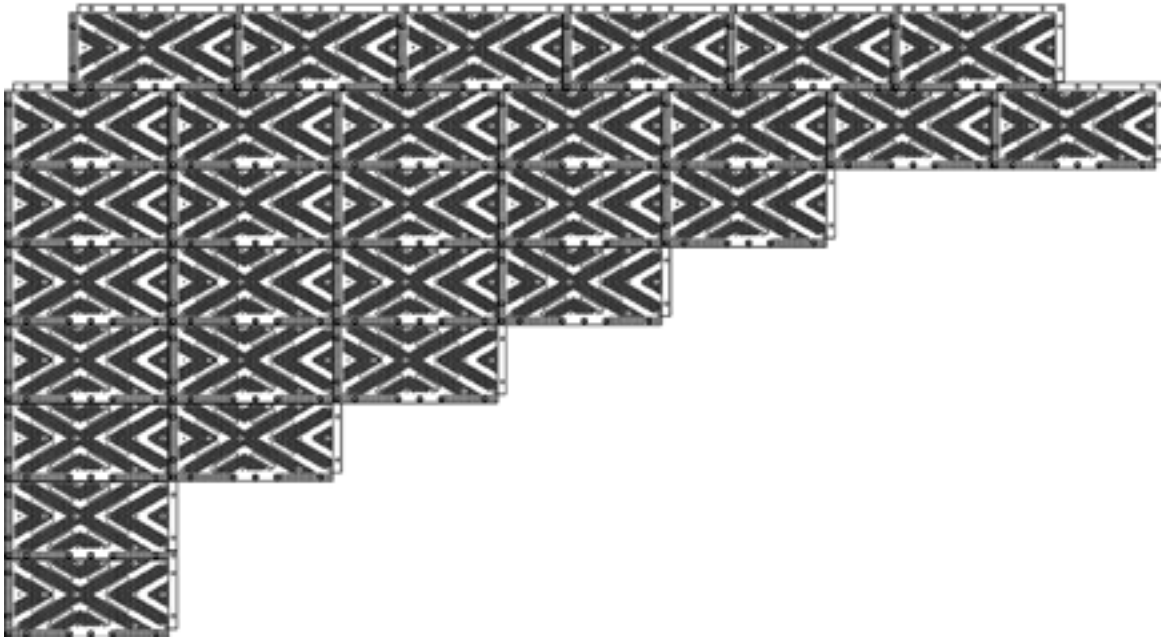


The staggered brickwork configuration provides more road strength.

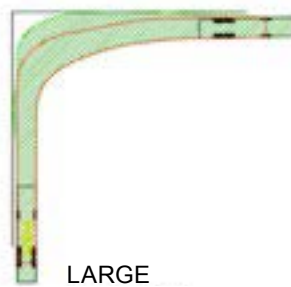


Turning corners for short and long vehicles can be formed using the mats. Longer vehicles require a wider turning area and knowledge of the path footprint (refer examples below) can be used to inform the mat configuration required.

## Turnout or corner



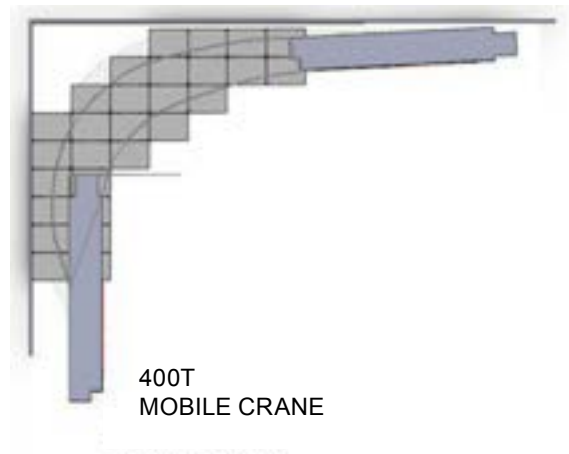
MEDIUM  
MOBILE CRANE



LARGE  
MOBILE CRANE



400T  
MOBILE CRANE



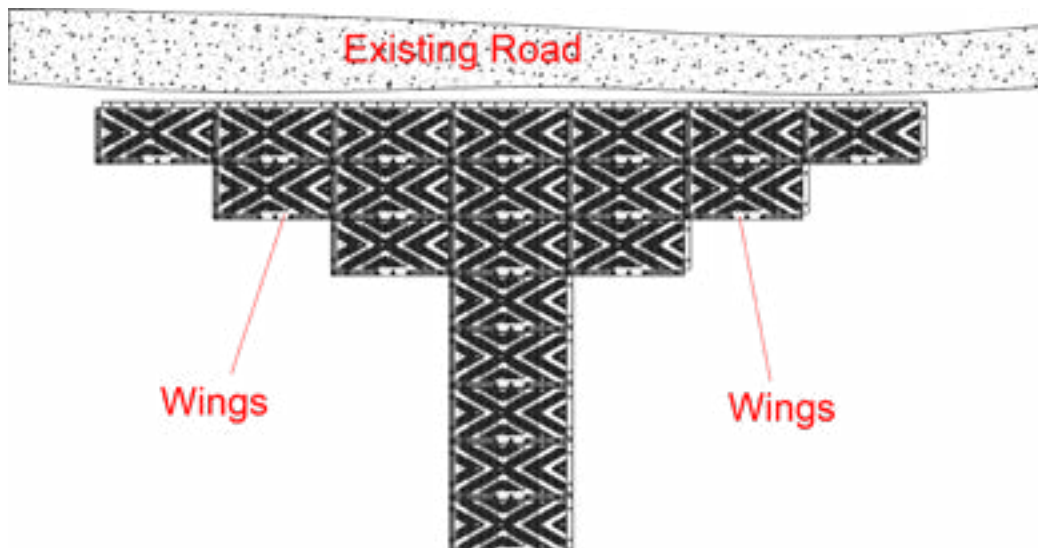
## Road Entrances & Transitions

Isotrack X mats have a 94mm core thickness and a lap thickness of 47mm. If the underlap is adjacent to the existing ground or road surface, then generally a transition ramp is not required (although care is required when driving onto the mat surface to avoid disturbance or damage).



To achieve a smooth transition from the ground to the mat surface when a mat overlap is adjacent to the existing ground or road then use ramp system. Provision of support underneath an overlap will prevent load stresses being imposed on the mat as vehicles pass.

When a Isotrack X road meets an existing road it may be necessary to install 'wings' to allow for the turning radius of vehicles.



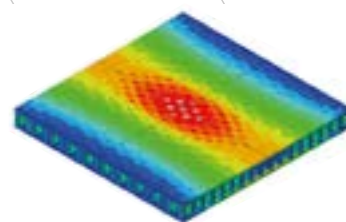
# SAFETY AND EFFICIENCY

Engineered for performance and strength, the interlocking mats distribute weight across a large surface area while remaining stable and strong through all operating conditions. The surface tread improves traction and safety for load-bearing vehicles, while the patented Four3 connection system reduces mat drift and slippage. The mats provide years of reusable performance with proper use and maintenance.

## ANALYSIS AND TESTING OF ISOTRACK X MATS

### FEA Analyses

Faculty of Mechanical  
Engineering Maribor  
Slovenia



### 3 POINT LOAD TESTS

Faculty of Civil and  
Geodetic Engineering/  
University of Maribor



### COMPRESSION TEST

Faculty of Civil and  
Geodetic Engineering/  
University of Ljubljana



### CYCLIC DEFLECTION TEST

Faculty of Civil and  
Geodetic Engineering/  
University of Ljubljana:  
**100.000 cycles no break**



### LOW TEMPERATURE TEST AT -40 DEGREES

IABG Munich-Germany  
**NO BREAK**



### BENDING TESTS AT AMBIENT TEMPERATURE NO BREAK



General information	
Overall Area	4000 x 2000 mm
Height	Total 102 mm, Core 94 mm
Useable Surface Area	1,8 x 3,8 m = 6.84 m <sup>2</sup>
Weight	360kg
Colour	Sand (standard), other colours optional
Logistic	Standard high cube 40 feet container 50 mats, Truck standard EU 60 mats
Handling	Designed for end users, 2-sided mat; for different type of vehicles
Recycling	100% recyclable
Safety	Nub structure prevents slips, trips, falls
Environmental	No liquid absorption, chemically inert, allows easy decontamination-cleaning
Compressive load capacity: 605 psi*	415 tonnes m <sup>2</sup>
Load bearing capacity	In excess of 200t*
Fire Rating	UL 94HB

\*Load capacity is dependent on ground conditions



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