Alignment and level of crane rail tracks.

For the location of the complete crane rail system we are provided with a geodetic survey datum point on the site. Since we are dealing with relative short distances in a range from about 25 m for a workshop crane to about 2500 m for a new quay crane track, we can set up our own local coordinate system.

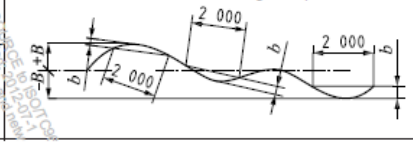
For crane rail systems we several norms that define the geometrical limits. The most frequently used internationally is the ISO 12488-1, whereas in North America the CMAA specification 70 is used as a reference. For warehouses with automatic stacking cranes the FEM guidance is used as a reference.

These norms and guidance are used by many manufactures as a basis to define their own requirements. In general the norms lag behind the standards set by industry leaders in their respective fields.

Horizontal straightness

The drawing from the **ISO 12488-1 2012** below is self-explanatory and in measurement terms clearly defined by the 2 m point to point interval. The max. deviation for a class 1 crane or trolley is only 5 mm, whereas the **CMAA** allows max, $^{3}/_{8i}$ inch and a ¼ inch over a distance of 20 feet. The **FEM 9.832** allows for +/- 2 mm on the entire length of the stacker / retriever but only 0.5 mm over the wheelbase distance.

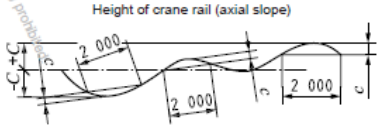
Table 2 — Construction tolerances for travelling tracks of tolerance classes 1 to 4

Tolerance parameter			Tolerance				
Symbol	Description with respect of this table	Graphical representation	Class 1	Class 2	Class 3	Class 4	Unit
B	Tolerance of horizontal straightness of rail head at each point of travelling track	Position of crane rail in ground plan 	±5	±10	±20	±40	mm
b	Tolerance of horizontal straightness related to test length of 2 000 mm (sample value) at each point of rail head		1	1	2	4	mm

Vertical Straightness

A mirror image of the drawing of horizontal values for the **ISO 12488**-1 The **CMAA** allows max, $^{3}/_{8i}$ inch and a ¼ inch over a distance of 20 feet. The **FEM 9.831** defines elevation changes in T21 as +/- 1.5 mm over the length of the rail and 0.5 mm for the distance of the wheelbase.

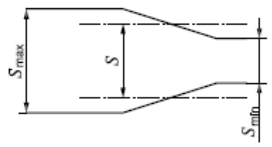
Table 2 — Construction tolerances for travelling tracks of tolerance classes 1 to 4

Tolerance parameter			Tolerance				
Symbol	Description with respect of this table	Graphical representation	Class 1	Class 2	Class 3	Class 4	Unit
C	Tolerance of straightness related to height of crane rail centre at each point of travelling track	Height of crane rail (axial slope) 	±5	±10	±20	±40	mm
c	Tolerance of straightness related to test length of 2 000 mm (sample value) at each point of height of crane rail		1	2	4	8	mm

Rail span

ISO 12488-1, for a Ship to Shore crane, where the ground track has been specified as a class 1 and the span has the typical 30.480 m width it would mean that the permissible deviation is +/- 7.14 mm. S_{min} = 30.473 m and S_{max} = 30.487 m.

Table 2 — Construction tolerances for travelling tracks of tolerance classes 1 to 4

Tolerance parameter			Tolerance				
Symbol	Description with respect of this table	Graphical representation	Class 1	Class 2	Class 3	Class 4	Unit
A	Tolerance of span *S* of the crane rails related to rail centre at each point of travelling track	$+A = S_{max} - S$ $-A = S_{min} - S$ 	±3 Valid for all spans $S \leq 16$ m $\pm[3 + 0{,}25(S-16)]$ ±10 max. Valid for spans $S > 16$ m, S in metres	±5 Valid for all spans $S \leq 16$ m $\pm[5 + 0{,}25(S-16)]$ ±15 max. Valid for spans $S > 16$ m, S in metres	±8 Valid for all spans $S \leq 16$ m $\pm[8 + 0{,}25(S-16)]$ ±20 max. Valid for spans $S > 16$ m, S in metres	±12,5 Valid for all spans $S \leq 16$ m $\pm[12{,}5 + 0{,}25(S-16)]$ ±25 max. Valid for spans $S > 16$ m, S in metres	mm

In the **CMAA** the following tolerances are defined :

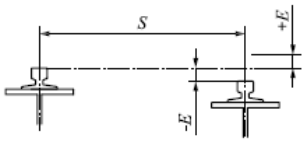
Crane with a span of 50 feet or less S = +/- $^{3}/_{16}$ inch
50 - 100 feet S = +/- $^{1}/_{4}$ inch
➢ 100 feet S = +/- $^{3}/_{8}$ inch

The maximum rate of change is ¼ inch in 20 feet.

Height difference rail to rail.

ISO 12488-1, if we consider the trolley rail (class 1) of the same STS as before, with a typical span of 6.550 meter, then E_{max} = 3 **mm.**

Table 2 — Construction tolerances for travelling tracks of tolerance classes 1 to 4

Tolerance parameter			Tolerance				
Symbol	Description with respect of this table	Graphical representation	Class 1	Class 2	Class 3	Class 4	Unit
E	Tolerance of height related to opposite measuring points at right angles at each point of travelling track	Height of travelling track (lateral slope) 	±0,5S S in metres $E \leq E_{max}$ ±5 max.	±S S in metres $E \leq E_{max}$ ±10 max.	±2 S S in metres $E \leq E_{max}$ ±20 max.	±4 S S in metres $E \leq E_{max}$ ±40 max.	mm

The **CMAA** allows the for the following :

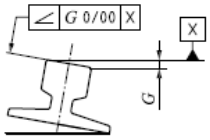
Crane with a span of 50 feet or less E = +/- $^3/_{16}$ inch
50 - 100 feet E = +/- $^1/_4$ inch
- 100 feet E = +/- $^3/_8$ inch

The maximum rate of change is ¼ inch in 20 feet.

Chamber of the rail

ISO 12488-1, class 1. If we consider a rail profile where the foot has a width of 200 mm, eg. DIN 536-1, rail A 100, then G = 0.4 mm, Therefore the gap between the foot of the rail and the supporting structure will be 0.8 mm.

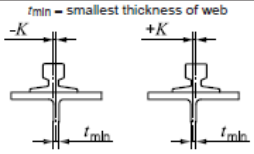
Table 2 — Construction tolerances for travelling tracks of tolerance classes 1 to 4

Tolerance parameter			Tolerance				
Symbol	Description with respect of this table	Graphical representation	Class 1	Class 2	Class 3	Class 4	Unit
G (see Table 3)	Tolerance of angularity related to crane rail cross-section at each point of travelling track with angularity symbol ∠		4	6	9	12	0/00

Parallelism, rail and girder web

For the **ISO 12488-1** the difference between the centerline of the girder web and the centerline of the rail may differ $^1/_2$ the thickness of the girder web.

Table 2 — Construction tolerances for travelling tracks of tolerance classes 1 to 4

Tolerance parameter			Tolerance				
Symbol	Description with respect of this table	Graphical representation	Class 1	Class 2	Class 3	Class 4	Unit
K	Tolerance of parallelism of crane rail to web at each point of travelling track	t_{min} – smallest thickness of web 		$\pm 0{,}5 t_{min}$		—	mm

CMAA does not stand alone and AISC and AIST must be consider. A precise definition by the designer for the structural support of the crane rail track will determine to performance throughout the track lifetime.

The runway beam / girder is the wide-flange structural shape that supports the runway, while the rail ASCE or CR profile rail North America, is the track upon which the end wheels traverse. It is a common misconception that the runway beams have no particular installation tolerance and that only the rail is at issue. This assumption seems to be confirmed by the lateral adjustment of the rail clips. The tolerance of the beam installation is governed by the tolerance of the rail installation. This is because, according to AISC Design Guide 7, paragraph 19a, the centerline of the rail should be within 3 ⁄ 4 of the girder web thickness.