FACE CONSULTANTS LTD
Global Flooring Consultants

Face Fact on VDMA Guidelines.

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Superior Floor Technology

design > consultancy > Q.A. > surveying > testing

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Face Consultants (Face) are now able to offer floor surveys to the recently introduced VDMA guidelines with the introduction of the Face 'Fx'-meter as an attachment to its current Face Digital DIN 15185 Profileograph. This now enhances the family of Face Digital floor surveying equipment which already covers TR34 (FM and DM), The American F number system (including F min), EN 15620, DIN 18202 and Din 15185.

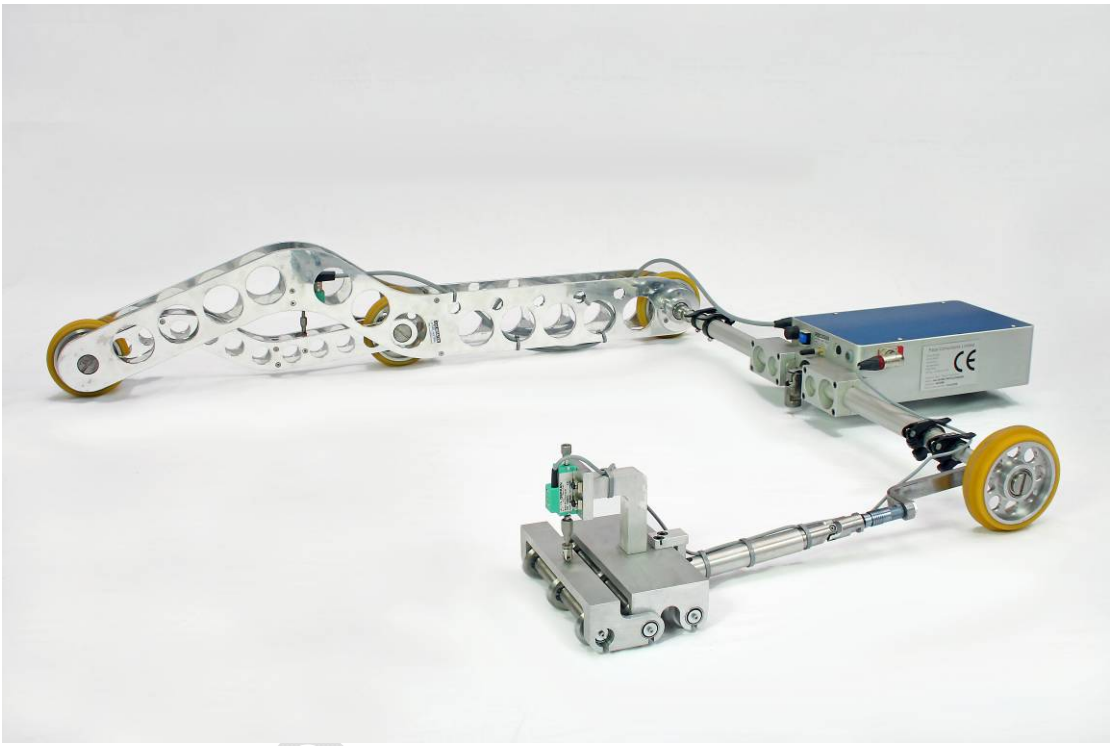

Photo 1: *Face Digital DIN 15185 Profileograph fitted with 'Fx' meter (VDMA)*

Although Face can now survey the VDMA guidelines they do not currently endorse the recommendations as they have yet to be validated and peer reviewed.

In 2009 / 2010 FEM drafted a guidance document (FEM 4.007) with recommendations for surface regularity which was based on the DIN 15185 specification but introduced a very small short wavelength control called ''Fx''. These recommendations were presented to the BITA - WITI Working Group (WG) on 14th July 2010 by members of the FEM Working Group 4. It was the decision of the BITA WG that it could not approve the FEM guidance note in totality and that further validation was required. Shortly after this meeting the FEM WG decided that the FEM 4.007 guidance note be removed from the table and the working group closed.

In September 2010 VDMA introduced a guideline “Floors for use with VNA Trucks” which is a slightly amended version of the FEM Guidance note rejected by FEM a few months earlier.

Face, with the assistance of BITA and their members, have started carrying out a number of surveys on existing installations where Very Narrow Aisle (VNA) trucks are operating at differing levels of performance. Each of the floors will be surveyed to TR34, EN 15620 and DIN 15185 as well as the VDMA Guidelines. Face are hoping that this study will help either validate the VDMA Guidelines or put forward recommendations from its findings.

Constructing, testing and grinding floors to a standard of flatness to ensure a degree of performance is not new and floor flatness specifications to control surface regularity for VNA, defined forklift traffic has been around since the late 1970’s with the introduction of the ACI - F number system and in particular the F min numbers for VNA applications.

In the late 1980’s the UK took a slightly different approach with the introduction of a floor flatness standard in The Concrete Society’s Technical Report No. 34. (TR34). The terms; Superflat, Category 1 and Category 2 were born.

The DIN 15185 standard was developed specifically for VNA applications in the early 1990’s from the general building tolerances standard DIN 18202.

In the third edition of TR34, a new surface regularity specification was introduced which looked at the floor profile as the truck actually saw it and based on the same principles of measurement used in the USA. This new specification is found in Appendix C of TR34.

In 2008 EN 15620 “Steel static storage systems – Adjustable pallet racking – Tolerances, deformations and clearances” was developed which included a surface regularity standard for floors with VNA applications. This European Norm is tested using the same principles as TR34 Appendix C recommendations with some slight modifications to the limits.

The VDMA Guidelines have three properties of surface regularity:

1. **Transverse** – *The elevational difference in mm between the centres of the front load wheels of the forklift truck.*

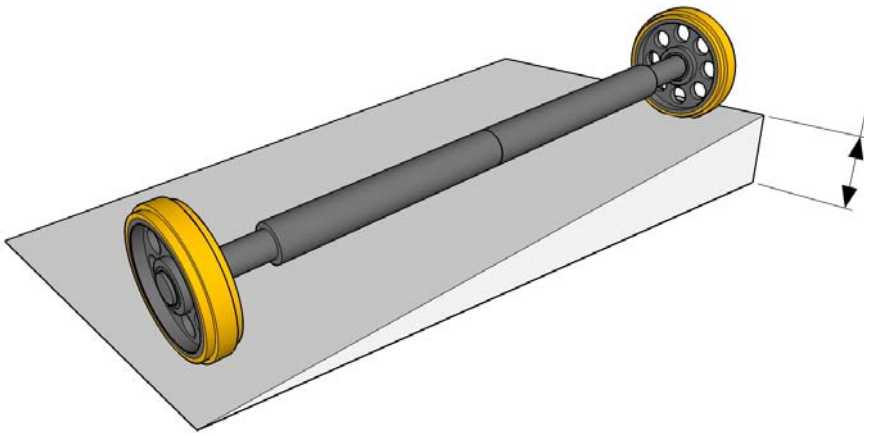

Fig 1: *Transverse Elevational Control*

The transverse method of measurement is the same in all defined movement traffic specifications. However the VDMA Guidelines do not have a rate in change of elevation control as specified in TR34 Appendix C, F min and EN 15620.

The transverse limits set out in the VDMA guidelines are however considerably more onerous than any other current specification.

Specification	Height to top beam (m)										
	5	6	7	8	9	10	11	12	13	14	15
TR34, 4.3 (95%/100%)	3.5 / 5.0			2.5 / 3.5					1.5 / 2.5		
TR34 App C (95%/100%)	3.3 / 5.0			2.6 / 3.9					1.7 / 2.5		
ACI Fmin	3.2			2.9		2.8	2.6		2.4	2.2	
EN 15620	3.2			2.6					1.7		
DIN 15185	2.5	2.0									
VDMA	2.6	2.4	2.3	2.1	2.0	1.8	1.7	1.6	1.4	1.3	1.2

Table 1*: shows maximum transverse elevation in mm for wheels set at 1.3 metres centre to centre*

2. **Longitudinal** – *In accordance with DIN 15185*

The longitudinal property of DIN 15185 is derived from the DIN 18202 specification being based around a straight edge of variable lengths.

Distance between measurements (l)	Gap under straight line (t)
1m	**2mm**
2m	**3mm**
3m	**4mm**
4m	**5mm**

Table 2: *longitudinal limiting values*

The DIN specification gives you two methods to check the floor; a gap under a straight edge or deviation at the mid point from a mean line

between two points a given distance apart. Having two different methods of checking the specification can lead to dispute where one method states the floor to comply and the other fail.

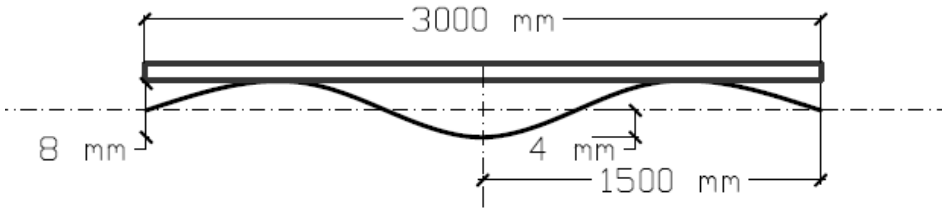

Fig 2: *of straightedge on bump with 8mm gap but +/- 4mm to a mean line. Pass and fail?*

The other issue with the DIN specification is that it does not have a control of either the long or short wavelength of the floor:

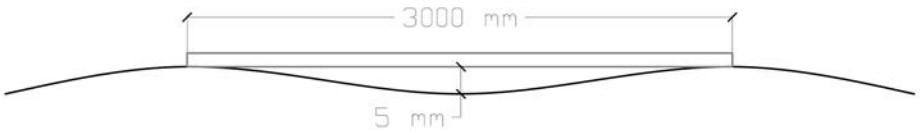

Fig 3: *5mm under a straightedge*

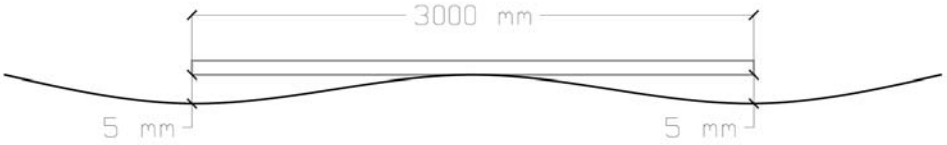

Fig 4: *0mm under a straightedge??*

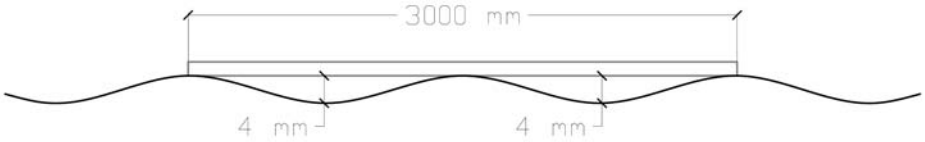

Fig 5: *4mm under a straightedge*

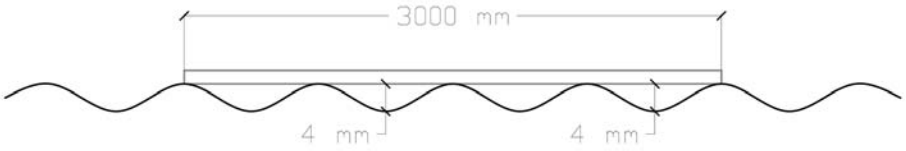

Fig 6: *4mm under a straightedge*

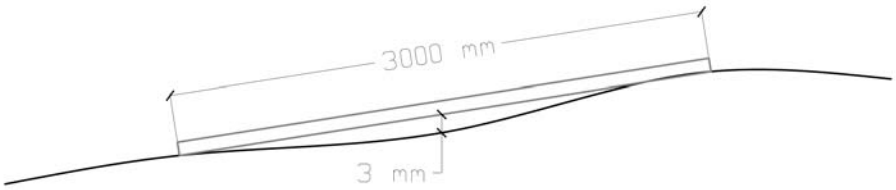

Fig 7: *No control over elevation*

In reality, the transverse requirement of the VDMA guideline is so onerous that any contractor constructing a floor to comply with the transverse requirement will automatically achieve the longitudinal requirements of DIN 15185 and therefore make the longitudinal properties of the guideline superfluous.

3. **Longitudinal micro small wavelength** – *'Fx' number.*

   The VDMA Guidelines have introduced a surface regularity property that controls a micro short wavelength of the floor profile. This property controls the rate in change of slope over two elevation readings 50mm apart to fractions of a millimetre.

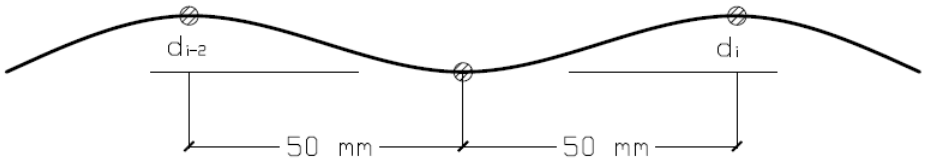

Fig 8: *qi = rate in change of slope over 100mm (di – di-2)*

The Guidelines go further to describe in detail a specification of the instrument that must be used which incorporates 9 wheels on three axles and each wheel being 40mm diameter. The wheels must be made of steel and the edge is tapered to a width of only 0.5mm.

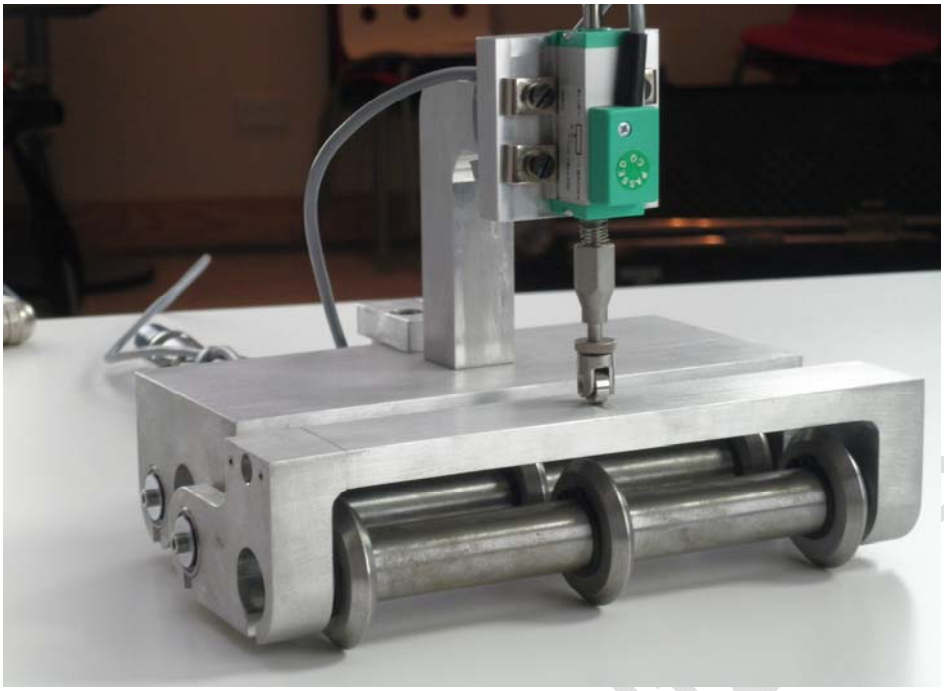

Photo 2: *Face Digital 'Fx' meter – 40mm dia wheels tapered to 0.5mm wide at rim.*

Rate of change readings are taken every 50mm of travel down the wheel tracks and an 'FX' number is calculated from 38 such readings (total distance travelled being 2 metres). Every 2 metres travelled, an 'Fx' number is calculated for each wheel track. The higher the 'Fx' number the smoother the floor surface.

Summary

We are currently very close to having an international standard for floor surface regularity for Defined Movement traffic in particular floors that will have VNA trucks operating on them.

The UK's Concrete Society's Technical Report 34 (TR34) Appendix C, The American ACI F min numbers and the European Normative standard EN 15620 all have the same method of measuring the floor, albeit all three standards have slightly different property limits.

All three standards have four properties of surface regularity that need to be complied with, that being:

Transverse

1 The elevational difference in mm between the centres of the front load wheels of the forklift truck (Property A).

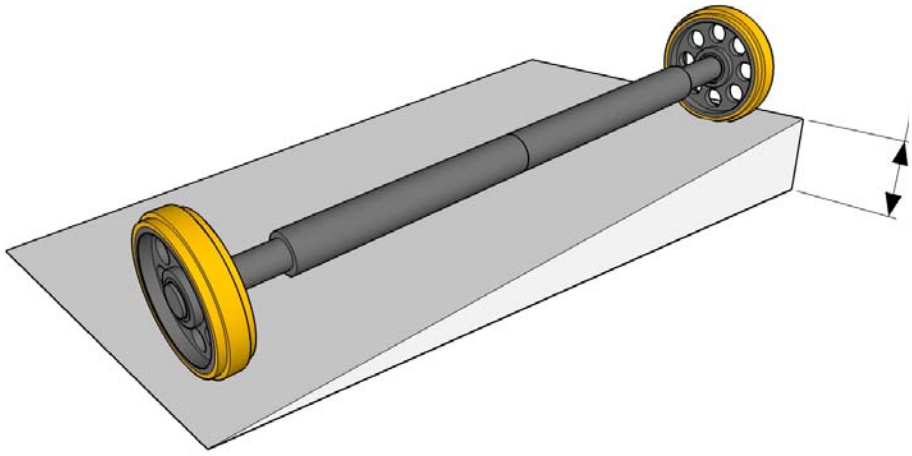

Fig 9: *Transverse Elevational Control (Property A)*

2 The transverse rate of change for every 300mm of forward travel (Property B).

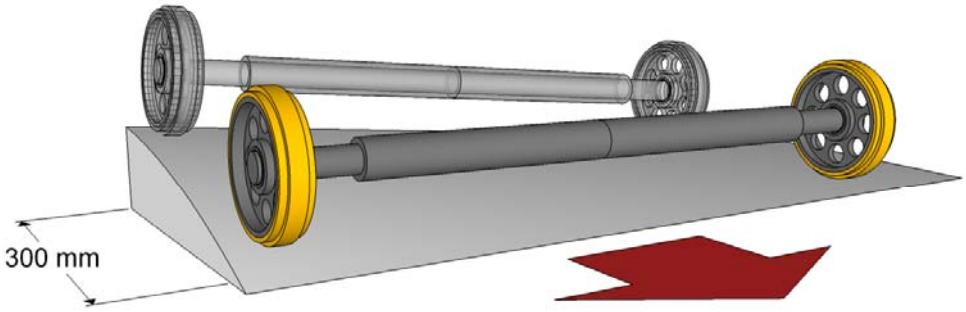

Fig 10: *Transverse Rate of Change (Property B)*

Longitudinal

3 The longitudinal elevational difference between the front and rear axle of the truck (Property C).

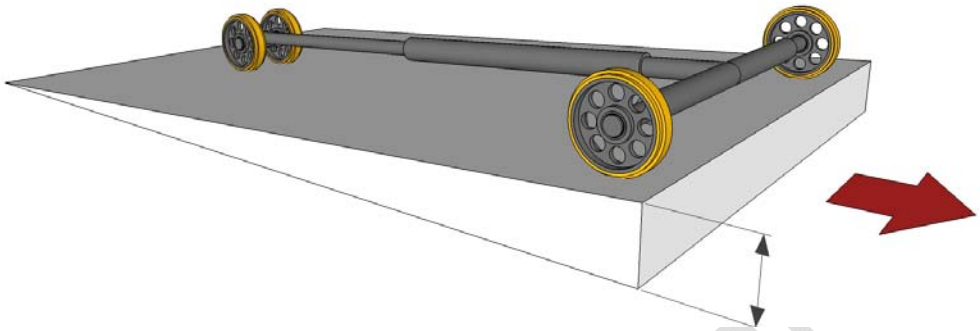

Fig 11: *Longitudinal Elevational Control (Property C)*

4 The longitudinal rate of change for every 300mm of forward travel (Property D)

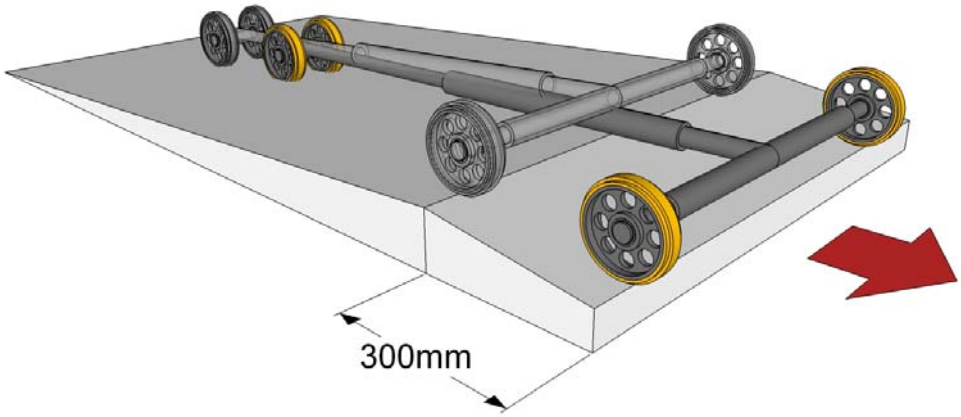

Fig 12: *Longitudinal Rate of Change (Property D)*

In essence the standards control elevation difference of the wheels of the forklift truck both transversely and longitudinally and also the rate in which that elevation difference can change for every 300mm of travel down the aisle checking both the long wavelength and short wavelength profiles of the floor as the truck actually sees the floor.

All three standards are checked with the same instrument; the Digital Profileograph.

Photos 3: The Face Digital Profileograph testing TR34 App C, F min and EN 15620

The VDMA Guideline has an equivalent property A and is measured the same as the above mentioned standards but the requirements are more onerous.

The Guideline does not have a rate of change in elevation control transversely.

The longitudinal requirement of the Guideline is based on DIN 15185 which has been proved to be contradictory with the two methods that can be used to check compliance and in reality has no real control over elevation longitudinally or short wavelength control. However, the transverse requirement is so onerous that when constructing a floor to meet that particular property a satisfactory longitudinal profile of the floor will inevitably be produced.

The 'Fx' numbers have been derived from the ASTM E1155M standard of measuring free movement floors where a statistical analysis of the general floor quality is qualified. The ASTM clearly states that such statistical analysis should not be used for checking the suitability of floor profiles for Defined Movement traffic.

Conclusion:

The main concerns that Face Consultants have with the 'Fx' number property are:

1 The size of the short wavelength when we consider the size of the wheel of the forklift truck and the footprint it creates when under load.

Photo 4: *Compare the size of a forklift truck wheel and 'Fx' meter*

2 A rate in change of elevation of 0.1mm or less has a huge impact on the 'Fx' number. Does a VNA truck really feel rates in change of 0.1mm or less?

3 The instrument described in the Guideline has nine wheels. Six wheels are fixed on a chassis and three wheels on a fixed axle which move about the fixed chassis. Unless the floor is extremely flat not all nine wheels are sitting on the floor together at any one time because of the mechanics of the device.

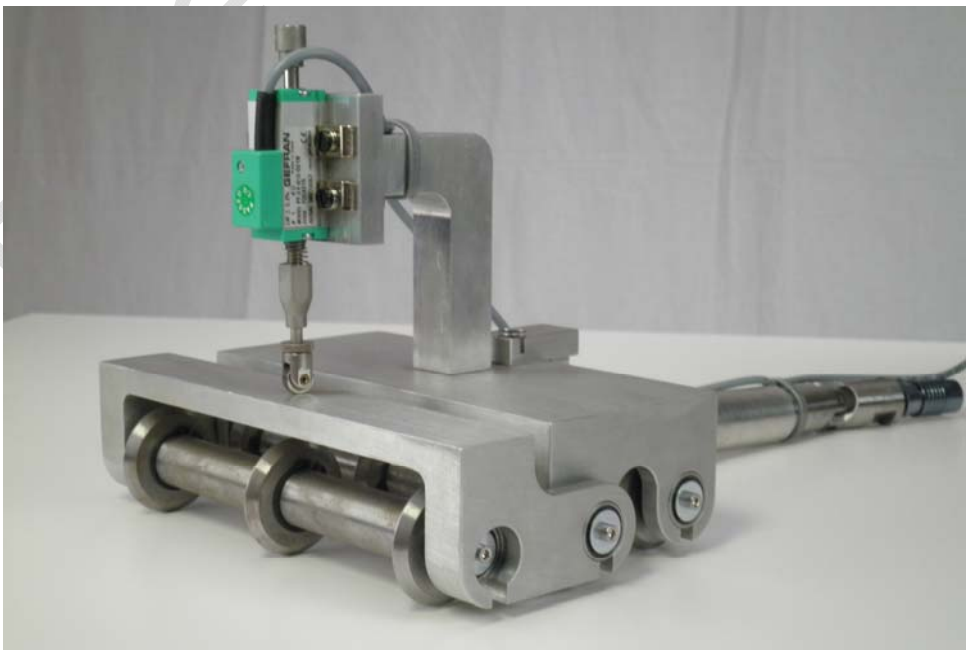

Photo 5: *The front 3 wheels are on a fixed axle. The rear 6 wheels on a fixed chassis*

4 The steel wheels on the device are 40mm in diameter and are tapered to a 0.5mm wide outer rim. The wheels will be susceptible to damage from debris, small holes and joints in the floor. A small dent in the wheel will have a severe consequence on the results. The measurement instrument is just not robust to use other than in a laboratory.

Photo 6: *close up of wheels of 'Fx' meter*

5 To date the VDMA Guidelines have had very little validation, unlike the other Defined Movement specifications described above. TR34 Appendix C property limits were based on a series of surveys on thousands of metres of floors and referral to the F min standard that had been around since the late 1970's.

References:

VDMA Guideline – Floors for use with VNA Trucks – Sept. 10
The Concrete Society's Technical Report 34 – 3rd edition 2005 – *Concrete Industrial Ground Floors – A guide to design and construction.*
DIN 15185 – 1991 – *Warehouse systems with guided trucks. Requirements for floors and racking and other requirements.*
DIN 18202 – 1997 – *Tolerances for Buildings - Structures*
BS EN 15620 – 2008 – *Steel static storage systems – Adjustable pallet racking – Tolerances, deformations and tolerances*
ASTM E1155M – 2001 – *Standard Test Method for determining Ff Floor Flatness and Fl Floor Levelness Numbers (Metric).*
ACI 306R – 10 – *A guide to the design of slabs on ground.*
FEM 4.007

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