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Method and device for determining the rectilinearity of guide rails

The invention relates to a method and a device for determining the rectilinearity of guide rails according to the definition of the patent claims.

Guide rails serve for guidance of objects, for example guidance of lift cages. Usually several guide rails are connected into a rail strand. Lift cages are usually conveyed while suspended at cables and are guided by way of guide elements along the rail strand. In that case the rectilinearity of the guide rails is of significance, since the travel comfort depends thereon. Departures from rectilinearity of the guide rails lead to vibrations in the lift cage. - Such vibrations make themselves strongly noticeable not only in the case of a long rail strand, but also in the case of fast lift cages, for example in high buildings, and are regarded by passengers as detrimental.

As closest state of the art the document EP 0 498 051 discloses a method and a device according to which the spacing of a guide rail from a frame is measured by a spacing detector. The frame is in contact with the guide rail by way of two mutually spaced guides and is moved over the guide rail. The spacing detector and frame are connected together. The spacing detector is in contact with the guide rail by way of a roller and measures changes in spacing between the guide rail and frame. This measuring device is mounted on the lift cage and checks installed guide rails in special test travels. A downstream straightening device corrects specific non-rectilinearities in the guide rail system, for which purpose the respective guide rails are detached from their mounting in the lift shaft.

The high cost connected with the checking and straightening of the guide rails is disadvantageous in this method and this device.

It is the object of the present invention to provide a method and a device for determining the rectilinearity of guide rails, the method and device being simple, fast and accurate and compatible with proven techniques and standards of mechanical construction.

This object is met by the invention in accordance with the definition of the patent claims.

The invention relates to a method and a device for determining the rectilinearity of guide rails, wherein a guide rail is oriented substantially parallel to a reference axis. At least one light beam is emitted along the reference axis by a light source. The light beam is



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detected by a light detector. The light source or the light detector is displaced on the guide rail. The guide rail and reference axis have a constant spacing from one another and the structural dimensions of the guide rail are standardised. A warping of the guide rail is ascertained as a change in the spacing between the guide rail and the reference axis. A result with respect to warping of the guide rail allows detection of the dimensional accuracy of the guide rails and, if necessary, a correction or reprocessing of the dimensions of the guide rail before mounting.

The invention is explained in the following by reference to embodiments, by way of example, according to Figs. 1 to 4, in which:

- Fig. 1 shows a schematic side view of part of a first embodiment of a device for determining the rectilinearity of guide rails,
- Fig. 2 shows a schematic view of part of a second embodiment of a device for determining the rectilinearity of guide rails,
- Fig. 3 shows a locally resolved diagram, which is ascertained by the device, of the change in the spacing between the guide rail and the reference axis and
- Fig. 4 shows a block diagram of the detection, transmission and evaluation of image data and travel data.

The device for determining the rectilinearity of guide rails measures individual guide rails FS before mounting, for example before mounting in a lift shaft. The guide rails are, for example, T-section girders of steel with known standard dimensions. The length of the guide rails FS is known and amounts to, for example, 5000 mm. The height and width of the guide rails FS are similarly known and amount to, for example, 88 mm and 16 mm respectively. The guide rail FS is placed by way of at least one support point on at least one support A1, A2. In the exemplary embodiment of a device for determining the rectilinearity of guide rails in accordance with Fig. 1 the guide rail FS to be measured is placed by way of two support points on two supports A1, A2, wherein the two support points are near the two ends of the guide rail FS. Advantageously, the guide rail FS lies substantially parallel to a reference axis AA' on the two supports A1, A2. Between the support points the guide rail FS bends due to its own weight under gravitational force G. The reference axis AA' and the force lines of the gravitational force G are preferably

disposed perpendicularly to one another. With advantage, the spacing of the supports A1, A2 relative to one another is known and, for example, fixedly preset and the spacing between the support points and the ends of the guide rail FS is known and, for example, fixedly preset. The spacing of the support points from the ends is advantageously selected so that the bending caused by the gravitational force G is as small as possible. Compensation for the theoretical bending caused by the gravitational force G can be made by means of an evaluating unit AE. The exemplary embodiment of a device for determining the rectilinearity of guide rails in accordance with Fig. 1 is not obligatory for realisation of the invention. Thus, it is also possible to place the guide rail by way of a single support point on only a single support or by way of more than two support points on more than two supports.

The device for determining the rectilinearity of guide rails comprises a light source LQ which emits at least one light beam. The light beam is preferably sharply focussed and of small diameter. The light source LQ is preferably a laser, for example a laser in the range of visible wavelengths or an infrared laser.

The twisting of a guide rail in longitudinal direction can be determined with use of two light beams. The twisting can also be ascertained by one light source and an involved algorithm in that the geometric form and focal point of the light point on the diffusing disc BS is continuously detected or calculated.

In the exemplary embodiment of a device for determining the rectilinearity of guide rails in accordance with Fig. 1 the light source LQ is rigidly mounted at a first end of the guide rail FS. The light source LQ is advantageously mounted on the guide rail FS by way of a slide R, wherein the slide R is pressed against two lateral guide surfaces FS of the guide rail by way of, for example, screws R10, R11. The light beam from the light source LQ is preferably emitted at a constant spacing d_{LQ} from the guide rail FS and along the reference axis AA'. The spacing d_{LQ} is defined as, for example, the distance between the reference axis AA' and a face SF of the guide rail FS. Other forms of definition are possible. The exemplary embodiment of a device for determining the rectilinearity of guide rails in accordance with Fig. 1 is not obligatory for realisation of the invention. Thus it is also possible to mount the light source not on the guide rail, but at a spacing from the guide rail. It is also possible to mount the light source on the guide rail to be movable and/or fixable at freely selectable positions.

The device for determining the rectilinearity of guide rails comprises a light detector LD. In the exemplary embodiment of a device for determining the rectilinearity of guide rails in accordance with Fig. 1 the light detector LD is mounted on a carriage S and is movable by way of the carriage S on the guide rail FS between a second end of the guide rail FS and the light source LQ at the first end of the guide rail FS and/or fixable at freely selectable positions. The light detector LD is advantageously mounted on the carriage S so that the spacing d_{LD} between the light detector LD and the guide rail FS is constant for all freely selectable positions on the guide rail FS. The light detector LD enables detection of the light beam emitted by the light source LQ. The spacing d_{LQ} of the light beam, which is emitted by the light source LQ, from the face SF of the guide rail FS and the spacing d_{LD} of a reference point of the light detector LD from the face SF of the guide rail FS are advantageously of the same size, for example the two are disposed in alignment on the reference axis AA'. The reference point is, for example, a centre of the diffusing disc BS or a zero point of the photoarray AY. The exemplary embodiment of a device for determining the rectilinearity of guide rails in accordance with Fig. 1 is not obligatory for realisation of the invention. Thus, it is also possible to mount the light detector not on the guide rail, but at a spacing from the guide rail. It is also possible to rigidly mount the light source on the guide rail. In that case it is to be noted that at least one of the two units, either the light source or the light detector, is to be mounted on the guide rail to be measured.

Since the bending of the guide rail FS by virtue of its own weight takes place along the force lines of the gravitational force G, one-dimensional or two-dimensional light detectors LD can be used, wherein the light detectors LD detect changes D in the spacing between the guide rail FS and the reference axis AA'. In the exemplary embodiment of the device for determining the rectilinearity of guide rails in accordance with Fig. 1 the light detector LD consists of a two-dimensional diffusing disc BS with a downstream photo apparatus PA or photo camera as a recording instrument. This enables determination of rectilinearity in horizontal and vertical direction. In the exemplary embodiment of a device for determining the rectilinearity of guide rails in accordance with Fig. 2 the light detector LD is a one-dimensional photoarray PY with an elongate opening SZ. With advantage, the light detector LD digitally detects the light beam, which is emitted by the light source LQ, with a resolution of, for example, 1024 x 1024 image points (diffusing disc BS and photo apparatus PA) or 1024 image points (photoarray PY) as image data BD. Other, for example higher or lower, resolutions are possible. In addition, the expert can use other

known light detectors, which are not shown here in detail, of digital or analog form, such as charge-coupled-devices (CCD), photodiodes, etc.

Advantageously, the carriage S has a two-dimensional roller guide which runs in longitudinal direction on the guide rail FS to be measured. The roller guide comprises at least one roller R1, R2, R3, R4, R5 which keeps the carriage S in contact with the guide rail FS. In the two exemplary embodiments of a device for determining the rectilinearity of guide rails in accordance with Figs. 1 and 2 two upper rollers R1, R2 run in a first plane on a face SF of the guide rail FS, whilst lefthand lateral rollers R3, R4 and righthand lateral rollers R5 run in a second plane on lateral guide surfaces FF of the guide rail FS. The lateral rollers R3, R4, R5 are advantageously pressed against the guide surfaces FF of the guide rail FS by means of spring force in order to ensure a play-free running of the roller guide or the carriage S in this plane.

With advantage, a length position of the detected change D in the spacing between the guide rail FS and the reference axis AA' is detected. Each detected warpage is positioned in absolute manner as a spacing from a zero point on the guide rail FS. For this purpose the carriage S advantageously has a travel pick-up WA, wherein the travel pick-up WA measures the spacing, per unit of length and unit of time, of the carriage S in relation to, for example, a zero point, for example the light source LQ at the first end of the guide rail FS or on the second end of the guide rail FS, as travel data WD.

The travel pick-up is, for example, an encoder. The travel pick-up WA is optional. The detection of the length position of the detected change D in the spacing between the guide rail FS and the reference axis AA' is also possible, for example, by a ruler. The spacing from a zero point of the guide rail can be read off at the ruler and detected as travel data. The position of the measuring slide can also be calculated through the size of the light point on the diffusing disc BS. Equally, the position can be ascertained by interference of the light source.

The carriage S advantageously comprises an angle member WK, wherein the angle member WK is articulated to the roller guide to be pivotable about at least one axis. In the two exemplary embodiments of a device for determining the rectilinearity of guide rails in accordance with Figs. 1 and 2 the light detector LD is mounted in stationary location on this angle member WK. By way of the angle member WK the angular position of the light detector LD with respect to the direction of the light beam emitted by the light source LQ is

adjustable by adjusting means WKJ. Any adjusting means, such as cage suspensions, frames, screws, etc., are usable. An optical filter is optionally fixable to the slide between the light source LQ and the light detector LD.

Advantageously, the light source LQ and the light detector LD are arranged in alignment along the reference axis AA' of the direction of the light beam emitted by the light source LQ. In the exemplary embodiment of a device for determining the rectilinearity of guide rails in accordance with Fig. 1 the light beam emitted by the light source LQ is incident in advantageous manner at an angle of less than 90° on the photo apparatus PA or the photo camera in order to avoid reflective effects onto the optical system of the photo apparatus PA or the photo camera. The angle of incidence of the light beam, which is emitted by the light source LQ, on the photo apparatus PA or the photo camera is advantageously settable by way of the pivotable angle member WK.

The manner of recordal of the image data BD or travel data WD takes place continuously or discontinuously.

- In the case of continuous detection of image data BD or travel data WD the carriage S is in advantageous manner guided along the guide rail FS at a constant speed, for example by means of a drive, whilst image data BD from the light detector LD or travel data WD from the travel pick-up WA are detected per freely selectable unit of length and unit of time. It is obviously also possible to stop the carriage S for the data detection and then to guide it to a further position on the guide rail FS. The data detection takes place at, for example, uniform or non-uniform length sections or time intervals. For example, image data BD are detected every 10 cm, preferably every 2 cm, for preference every 5 mm.
- In the case of a discontinuous detection of image data BD or travel data WD the carriage S is in advantageous manner guided to specific freely selectable positions of the guide rail FS in order to detect image data BD from the light detector LD. A travel pick-up is usable, but not necessary, for such a discontinuous operation. For example, instead of a travel pick-up it is possible to place a ruler against the guide rail FS and to detect, in accordance with this ruler, image data BD from the light detector LD at spacings of, for example, 50 cm, preferably 5 cm, for preference 5 mm. The warping of the guide rail FS can thus be detected in incremental steps

and digitalised as absolute positions over the length of the guide rail FS. Non-rectilinearities of the guide rail FS can thus be localised very precisely as length positions. Many possibilities of variation in the form of recordal of the image data BD or travel data WD are freely available to the expert with knowledge of the present invention.

Fig. 4 shows a schematic diagram of the detection, transmission and evaluation of image data BD or travel data WD. Image data BD ascertained by the light detector LD are passed on to an evaluating unit AE and travel data WD ascertained by the travel pick-up are passed on to the evaluating unit AE. This transmission can be carried out in numerous modes and manners, for example by signal cable, or cordlessly, or by transport of image data BD or travel data WD stored on a storage medium, etc. The evaluating unit AE is advantageously a commercially available computer with a central computing unit, at least one memory and communication interfaces, etc.

The change D in the spacing between guide rail FS and reference axis AA' is computed in locally resolved manner in the evaluating unit AE starting from these image data BD or travel data WD. Standard software can be used for that purpose. The result E of this calculation can be further processed as result data ED, for example stored, or graphically represented. Fig. 3 shows a resulting exemplary diagram of the change D in the spacing between the guide rail FS and the reference axis AA' in local resolution over the length L of a guide rail FS. For example, the change D for a length L of 5 m amounts to around 0.5 mm. In addition, the permissible deviation in rectilinearity is filed in the evaluating unit AE, which enables an automatic selection of guide rails with respect to rectilinearity.

It is provided in that case to preset a maximum permissible warping or a freely settable permissible warping. The change D in the spacing between the reference axis AA' and the guide rail FS can be computed as permissible (YES) or impermissible (NO) for each point of the guide rail FS on the basis of such a permissible warping. The obtained relative deviations are made available to the engineer who thereby gains information about local non-rectilinearities of the guide rail FS and in which direction and by which amount the guide rail FS has to be straightened so that the guide rail FS corresponds with the selected permissible warping. With advantage the guide rail FS is straightened only when the result E exceeds the permissible warping. It is thus achieved that on the one hand the guide rail FS only has to be reprocessed as accurately as necessary and costly reprocessing time is

saved and on the other hand no vibrations, which impair travel comfort, are transmitted from the guide rail FS to the lift cage.

Local non-rectilinearities of the guide rail FS are straightened by the engineer, for example in accordance with a correction protocol in a reprocessing unit NB on the basis of the result E with result data ED. The result data allow accurate diagrams as well as concrete straightening proposals, so that the engineer can reprocess the guide rail FS precisely and quickly. This reprocessing can in turn be checked by the device for determining the rectilinearity. It is also possible to indicate the correction or the result of the correction "on line", i.e. in real time, for example on a monitor M. In the embodiment according to Fig. 4 the monitor M is part of a portable computer, for example a hand-held computer, which obtains result data ED, for example, by way of signal cable, or, for example, cordlessly by radio. In principle it is possible to realise the evaluating unit AE and the monitor M in a portable computer, for example in a hand-held computer. Overall, the quality of the straightening operation is significantly increased.

Reference symbol list

AA'	reference axis
AE	evaluating unit
A1, A2	supports
BS	diffusing disc
D	change in spacing between reference axis and guide rail
d _{LD}	spacing between light detector and guide rail
d _{LQ}	spacing between light source and guide rail
E	result
ED	result data
FF	guide surface
FS	guide rail
G	gravitational force
L	length
LD	light detector
LQ	light source
NB	reprocessing unit
PA	photo apparatus
PY	photoarray
R	slide
R1, R2, R3, R4, R5	rollers
R10, R11	screws
S	carriage
SF	face
SZ	measurement opening
WA	travel pick-up
WD	travel data
WK	angle member
WKJ	adjusting means

Patent Claims

1. Method of determining the rectilinearity of the guide rails (FS) of a lift for persons or goods, in which a guide rail (FS) is oriented substantially parallelly to a reference axis (AA'), at least one light beam is emitted along the reference axis (AA') by a light source (LQ), the light beam is detected by a light detector (LD), wherein the light source (LQ) or the light detector (LD) is displaced on the guide rail, and warping of the guide rail (FS) is detected as a change (D) in the spacing between the guide rail (FS) and the reference axis (AA').
2. Method according to claim 1, characterised in that the light beam is emitted by the light source (LQ) at a constant spacing (d_{LQ}) from the guide rail (FS) and in the case of non-warpage of the guide rail (FS) is detected at constant spacing (d_{LD}) from the guide rail (FS) by the light detector (LD).
3. Method according to claim 1 or 2, characterised in that the change (D) in the spacing between the guide rail (FS) and the reference axis (AA') is detected by the light detector (LD) as image data (BD) per unit of length and unit of time and/or that a length position of the change (D), which is detected on the guide rail (FS), in the spacing between the guide rail (FS) and the reference axis (AA') is recorded as travel data (WD).
4. Method according to one of claims 1 to 3, characterised in that image data (BD), which are detected by the light detector (LD), and travel data (WD) are passed on to an evaluating unit (AE).
5. Method according to claim 4, characterised in that in the evaluating unit (AE) the change (D), which is based on the image data (BD) and travel data (WD), in the spacing between the guide rail (FS) and the reference axis (AA') is calculated as a result (E) with result data (ED) and is identified as a local non-rectilinearity of the guide rail (FS).
6. Method according to claim 5, characterised in that the local non-rectilinearity of the guide rail (FS) is straightened in a reprocessing unit (NB) on the basis of the result (E) with the result data (ED).
7. Device for determining the rectilinearity of guide rails (FS) of a lift for persons or goods, comprising at least one support (A1, A2) for placing the guide rail (FS) substantially

parallel to a reference axis (AA'), a light source (LQ) which emits at least one light beam along the reference axis (AA') and a light detector (LD) which detects this light beam and detects a warping of the guide rail (FS) as a change (D) in the spacing between the guide rail (FS) and the reference axis (AA'), characterised in that the light source (LQ) and/or the light detector (LD) is or are arranged on the guide rail (FS).

8. Device according to claim 7, characterised in that the light source (LQ) is rigidly mounted on the guide rail (FS) and that the light detector (LD) is movably arranged on the guide rail (FS).

9. Device according to one of claims 7 and 8, characterised in that the light detector (LD) is a diffusing disc (BS) and a downstream photo apparatus (PA) or that the light detector (LD) is a photoarray (PY).

10. Device according to one of claims 7 to 9, characterised in that a travel pick-up (WA) records the length position of the change (D), which is detected on the guide rail (FS), in the spacing between the guide rail (FS) and the reference axis (AA') as travel data (WD).