VERTRAGSPARTNER
GTÜ
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workpaper

# ICOA conforming construction

# of

# strips and RESA

# inside the graded portion

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International rules and standards as ICAO International Civil Aviation Organization define structural requirements for operational surfaces to ensure that in case of accidental abnormal events only minimum or no damages to personnel and equipment may occur.

ICAO Annex 14 in 3.2.5 defines recommendations for acceptable consequences in case of aircraft running off paved surfaces of runways and taxiways and roll over hardened shoulders to non-hardened surfaces – strips.

(***Strength of runway strips*** / 3.4.16 **Recommendation.—** *That portion of a strip….should be so prepared or constructed as to minimize hazards arising from differences in load bearing capacity to aeroplanes which the runway is intended to serve in the event of an aeroplane running off the runway. Note.— Guidance on preparation of runway strips is given in the* Aerodrome Design Manual*, Part 1. 5.3.22 …., it should be graded in such a manner as to prevent the collapse of the nose landing gear of the aircraft. The surface should be prepared in such a manner as to provide drag to an aircraft and below the surface, it should have sufficient bearing strength to avoid damage to the aircraft…..*

Runway strips have to be kept in such a condition that an aircraft rolling over them will not suffer major structural damage, regardless of season or weather condition and independent from aircraft type.

Veering-off paved areas is infrequent, therefore possible necessary steps for surface treatment have to be regarded as occasionally – as an exception - and not as a norm.

**Fig. 1**

In an emergency situation on or beside runways with hardened surfaces, rescue vehicles like fire brigades can be forced to use the unhardened parts of the airfield.

***Strength of runway end safety areas*** / *3.4.11* ***Recommendation.—*** *A runway end safety area should be so prepared or constructed as to reduce the risk of damage to an aeroplane undershooting or overrunning the runway, enhance aeroplane deceleration and facilitate the movement of rescue and fire fighting vehicles as required in 9.2.26 to 9.2.28.). – etc..*
These surfaces have to be kept in such a condition that they can be passed over by rescue vehicles at all time regardless of season and weather conditions.

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**The hazard analyse - matching of actual situation and target state**

Bases of an ICAO conforming construction are informations about the actual condition of the graded portion that will be used by aircraft veering off the runway and by rescue vehicles.

For this the strips must be investigated in terms of two questions:

1. Strength of the unpaved soil
2. Situation of obstacles

Background informations and details of these investigations are described in our workpaper ***Investigation of strip and RESA – stability according to ICAO Annex 14***.

The strength of the unpaved soil is important for the sinking and the rolling resistance of aircraft wheels. If the sinking is too high, the resulting rolling resistance gets amounts which produce a collapse of landing gears. If the sinking is too low, not enough drag to an aircraft can be provided.

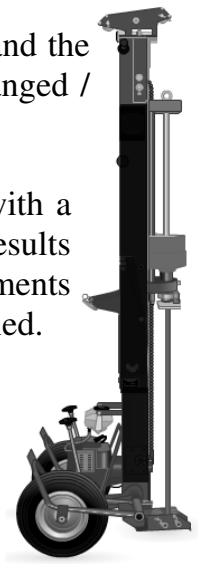
To analyse the overrun characteristics of the subsoil in the strips and the RESA we carry out the SCoRM test *Strip Control of Rolling Movements* with the real test RT procedures PIT or HWL- Test (sometimes both). In exceptional cases we use substitute procedures like CBR, cone penetrometer, static or dynamic plate-loading test etc. too.

<u>PIT Plate Impact Test</u>

With PIT, a modified CBR test, we determine the stability of the strips and the RESA in a grid pattern, fig. 2. The examined area remains nearly unchanged / not disturbed, visible deformations do not occur.

With this test the deformation energy of the ground will be measured with a defined impact load such as underneath a rolling wheel. Calibrated on results from extensive rollover procedures with high loaded nose gears statements along the strip quality according to the ICAO requirements will be compiled.

The PIT is specially designed for the study of small areas such as the RESA, selected strips or areas affected by a runway excursion.



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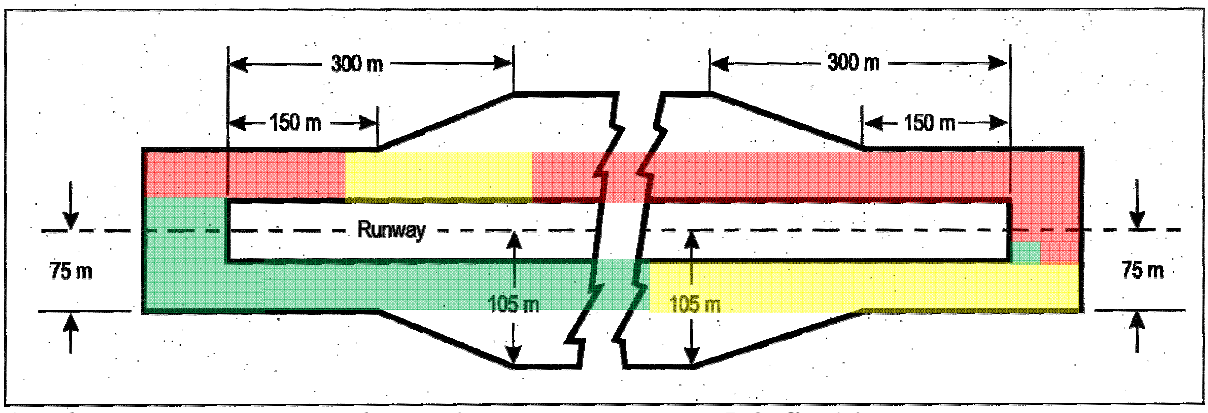
HWL – Test **H**eavy **W**heel **L**oad

With the HWL - test we measure the soil properties of large areas with respect to the representative capacity under the rolling aircraft wheel.

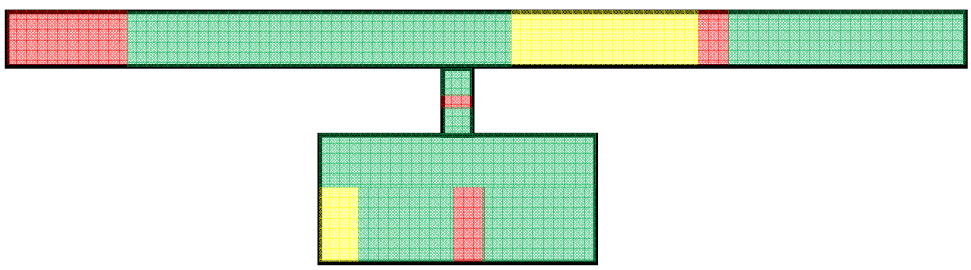
Heart of this method is an aircraft wheel which will be pushed continuous over the field under the real weight of a rolling aircraft. In the test the wheel - sinking will be recorded, fig. 3.


Based on the results of the SCoRM test (HWL or PTI) the risk of damages to aircrafts in case of a runway excursion can be illustrated by mapping, based on an estimated traffic light system TLS. The following figure 4 shows an example of presentation applying the TLS.




*Aeodrome Desing Manual Part 1 Runways, Figure 5-3*, fig 14.

The SCoRM test is also used in the assessment of unpaved surfaces such as airport runways, taxiways and aprons to assess the all – weather suitability of these areas. Figure 5 shows an example of results of these surface investigations.



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TLS legend:

The requirements of the soil strength are fulfilled for all-season, no measures of technical improvements are necessary.

The requirements of the soil strength are not fulfilled in case of high water content. In seasons with heavy rain the sinking and the rolling resistance are too high, collapses of aircraft wheels and a lack of mobility of rescue vehicle must be expected. Adapt measures of technical soil stabilization are necessary.

The requirements of the soil strength are not fulfilled (nearly) for all seasons. In case of a *runway excursion structural damages* must be expected. For rescue vehicles sufficient mobility doesn´t exist. Taxiing on runways, taxiways and aprons will result in structural damage to the aircraft. The strips have to be stabilized. Another test procedure, the so-called *"fast panel pressure tests"*, simulates mechanical impact of the wheel on the subsoil, confined on single measuring points.

In addition model test MT procedures like CBR, plate pressure EV/ME trial, airfield index as well as weight- or pressure- sounding, falling weight deflectometer or dynamic plate load test can be used.

The risk of damage to aircraft on non-hardened surfaces is influenced by obstacles too. When rolling on unhardened surfaces it is inevitable that wheels sink into the ground. Underground obstacles like pits or buried foundations, foundations for roads, lanes, runways and taxiways (crossings) can provoke a sudden blockage of aircraft movement and, besides the above-mentioned sinking and rolling resistance, form a further risk to persons and aircraft.

Also surface obstacles like buildings and parts of buildings near hardened surfaces can damage the aircraft too by direct contact with airplane components e.g., damages to aircraft structure – or indirectly e.g., by breaking off and hitting aircraft parts.

So a further component of the hazard analyse is the mapping of all obstacles in the strips inside the graded portion. Most of the described obstacles are already known and so it is only necessary to complete the existing maps or databases.

For the red and yellow fields – **fig 3** - of the investigated strips the results of the SCoRM test, the soil description and the databases of surface and subsoil obstacles have to be used to define kinds of technical construction and sequence of actions in the following phase of planning.

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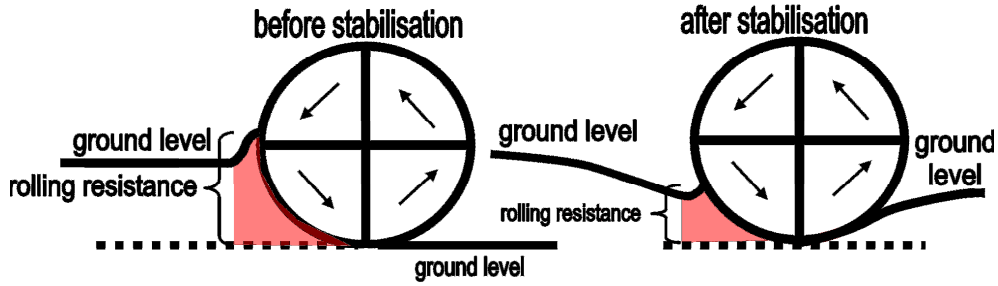
**The planning**

In the fields of the investigated strips which don´t fulfill the requirement *"..... the aeroplane without inducing structural damage....."* it is necessary to stabilize runway shoulders and RESA so that a controlled sinking allows the resulting rolling resistance to slow down the aircraft and so avoiding considerable damages to persons and aircraft.

To achieve this stability of the ground the unpaved soil has to be stabilized in such a way that first of all the wheel will sink in a controlled way.

The target of the controlled sinking is to limit the absolute sinking, optimize the rolling resistance in front of the wheel and to use the deformation of the surface as a “brake” for the moving aircraft – deceleration cavity -

In practical life it is essential to establish a surface stability, which effects a three-dimensional, crack free deformation in front of the wheel. Under this condition the rolling resistance is always lower than the required strength of the landing gear, **fig 6**.




To ensure that emergency vehicles can use the relevant areas during all seasons the surface has to be prepared in such a way that adequate traction can be achieved.

To reach these requirements, an EMAS Engineered Materials Arresting System has to be installed, which on the surface is equipped with a Foreign object Damage Protection Layer (FODPL).

The structural features of the EMAS have to be adapted to the quality of the ground and the characteristics of aircraft and vehicles.

On generally stable ground only minimum steps have to be taken for EMAS as additional compaction or -to optimize compaction – adding gravel to the ground by means of a vibrator plate or compactor (yellow fields).

On soft ground (loam, un-compacted sand, organic grounds etc.) special measures can be necessary for the EMAS like the installation of geogrid / geofleece systems with additional layers of gravel, compaction of soil layers, the drainage of the subsoil or combination of all of these measures (red fields).

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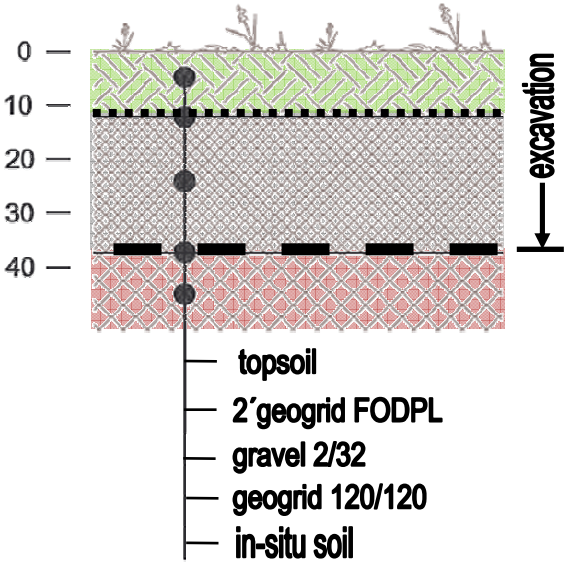
In practice, the following example of a soil stabilization has been constructed, **fig. 7**.




Especially the high water content in all-season and a loamy in-sito soil required this kind of construction.

With the right combination of the gravel layer - thickness and the strength of the geogrid each kind of the required stabilization can be achieved.

To reach an efficient, sustainable construction with a long-lasting stability of the AGP it is important to choose materials, which have no bad interacting chemical influence. For instance, by using recycled concrete as gravel, an adapted inert geogrid has been chosen.

The following **figure 8** shows the construction phase of an EMAS for an investigated strip.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The compiled planning describes exactly the necessary technical construction of the AGP, differentiated for each soil and strength condition in the investigated strips.

The last step of the planning contains, based on these descriptions, the compilation of the tender to get comparable submissions.

After the contract award process the construction in the strips can begin.

## Chaperoning and acceptance

To certificate the right implementation of the planning all phases of the work must be chaperoned. That means, that all used materials (geogrid, gravel a.s.o.), the mass of the excavated soil and the quality of the installation must be noticed and documented.

This document can be used for the cashing up and to evidence that the required qualities of the ICAO Annex 14 are fulfilled.

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**By the chamber of industry and commerce Bremerhaven / subsidiary in Hamburg / Germany publicly certified expert for soil examination and the investigation of contaminated sites expert of the GTÜ (German Society for Technical Supervision) http://bau.gtue.de / admitted expert of explosive ordnance investigation in Hamburg**

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