VERSO UN MODELLO INTEGRATO DI DIGITALIZZAZIONE
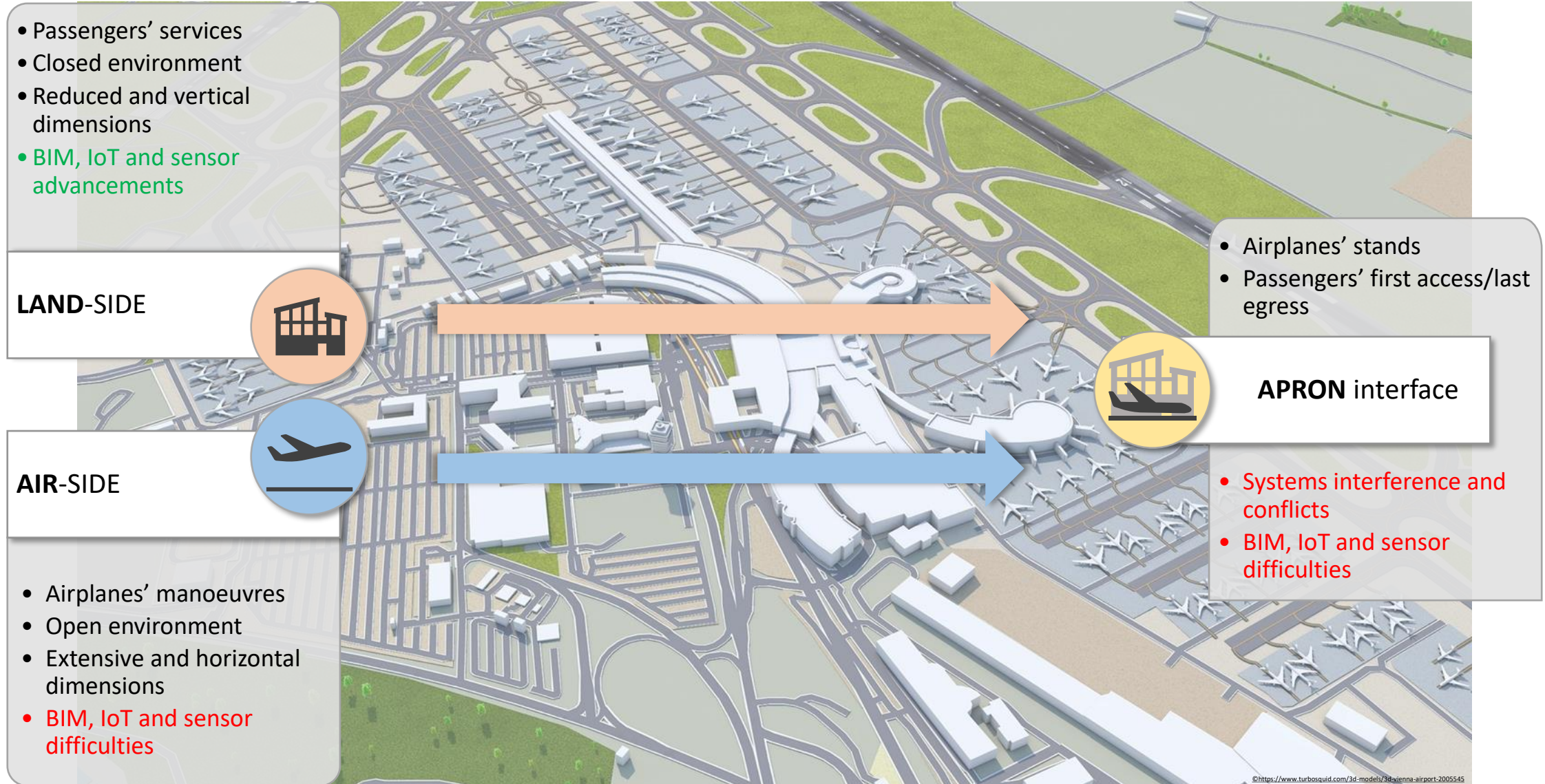# PER IL PAVEMENT MANAGEMENT DEGLI APRON

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iNGEGNERIA CIVILE, INFORMATICA E DELLE TECNOLOGIE AERONAUTICHE

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Piacenza, 19 aprile 2024

FRAMEWORK

- Passengers' services
- Closed environment
- Reduced and vertical dimensions
- BIM, IoT and sensor advancements

LAND-SIDE

AIR-SIDE

- Airplanes' manoeuvres
- Open environment
- Extensive and horizontal dimensions
- BIM, IoT and sensor difficulties

- Airplanes' stands
- Passengers' first access/last egress

APRON interface

- Systems interference and conflicts
- BIM, IoT and sensor difficulties

©https://www.turbosquid.com/3d-models/3d-vienna-airport-2005545

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FRAMEWORK

Ground Penetrating Radar (GPR)

- Thickness of pavement's layers
- 3Dimensional superstructure configuration

Heavy Weight Deflectometer (HWD)

- Elastic modulus of pavement's layers
- Global pavement elastic response

- Pavement priority analysis
- M&R optimum prediction
- Cost-effective strategies
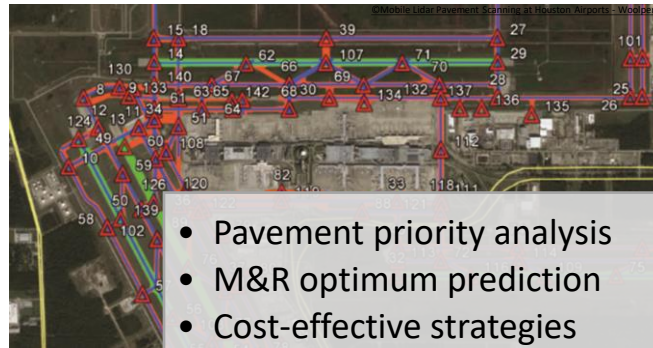
Airport Pavement Management System (APMS)

- Pavement focused
- No BIM implementation
- No landside comparison
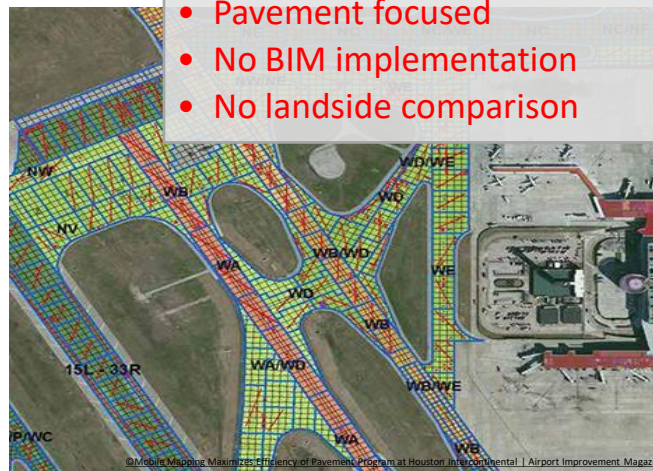
Informative data

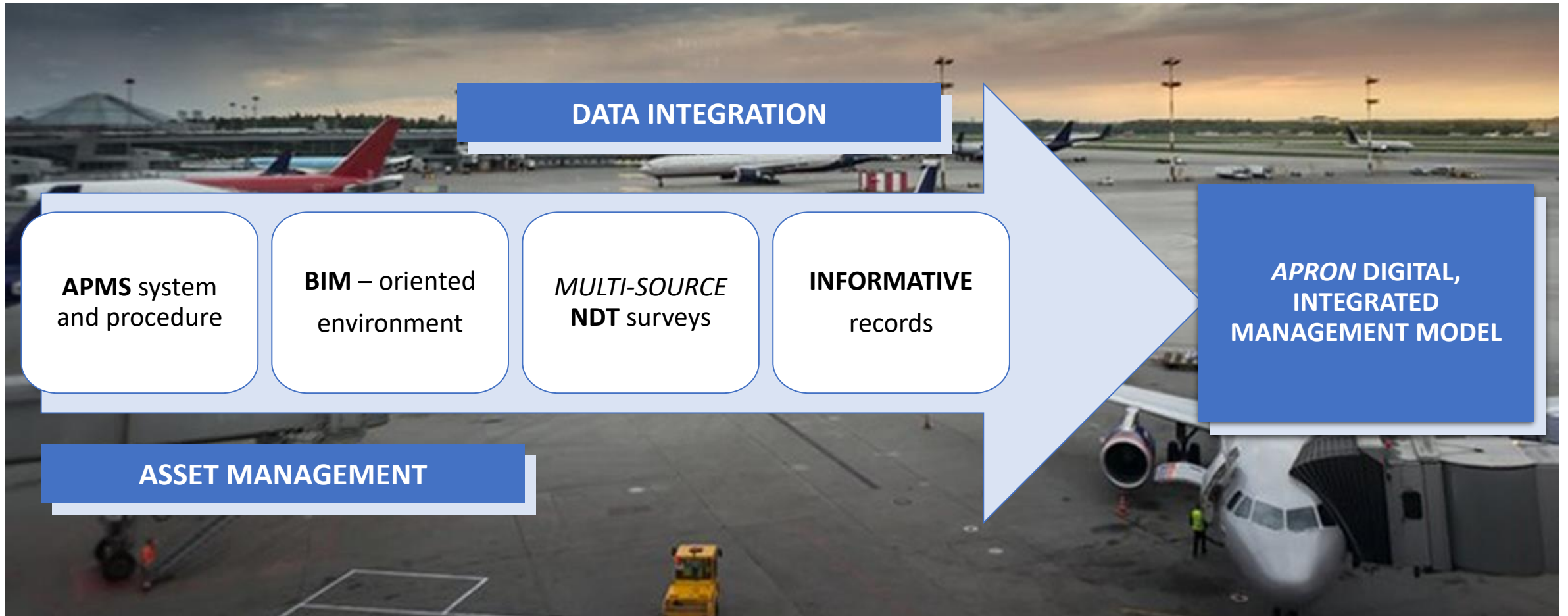- Record of past inspections
- Track of annual traffic
- Topographic surveys

Pavement Condition Index (PCI)

- Visual report of a sample unit's condition
- Detection of superficial pavement distresses

Therefore, the need to promote a ***digitalization and sustainable transition of the airside – landside interface (apron)*** of the airport infrastructure.

DATA INTEGRATION

| **APMS** system and procedure | **BIM** – oriented environment | *MULTI-SOURCE* **NDT** surveys | **INFORMATIVE** records |

APRON **DIGITAL, INTEGRATED MANAGEMENT MODEL**

ASSET MANAGEMENT

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Development of a **_unique database_**, structured to _integrate datasets of qualitative inspections and quantitative surveys_ by:

> ➢ **_Spatial clustering_**, _hierarchical subdivision_ of the monitored asset;
>
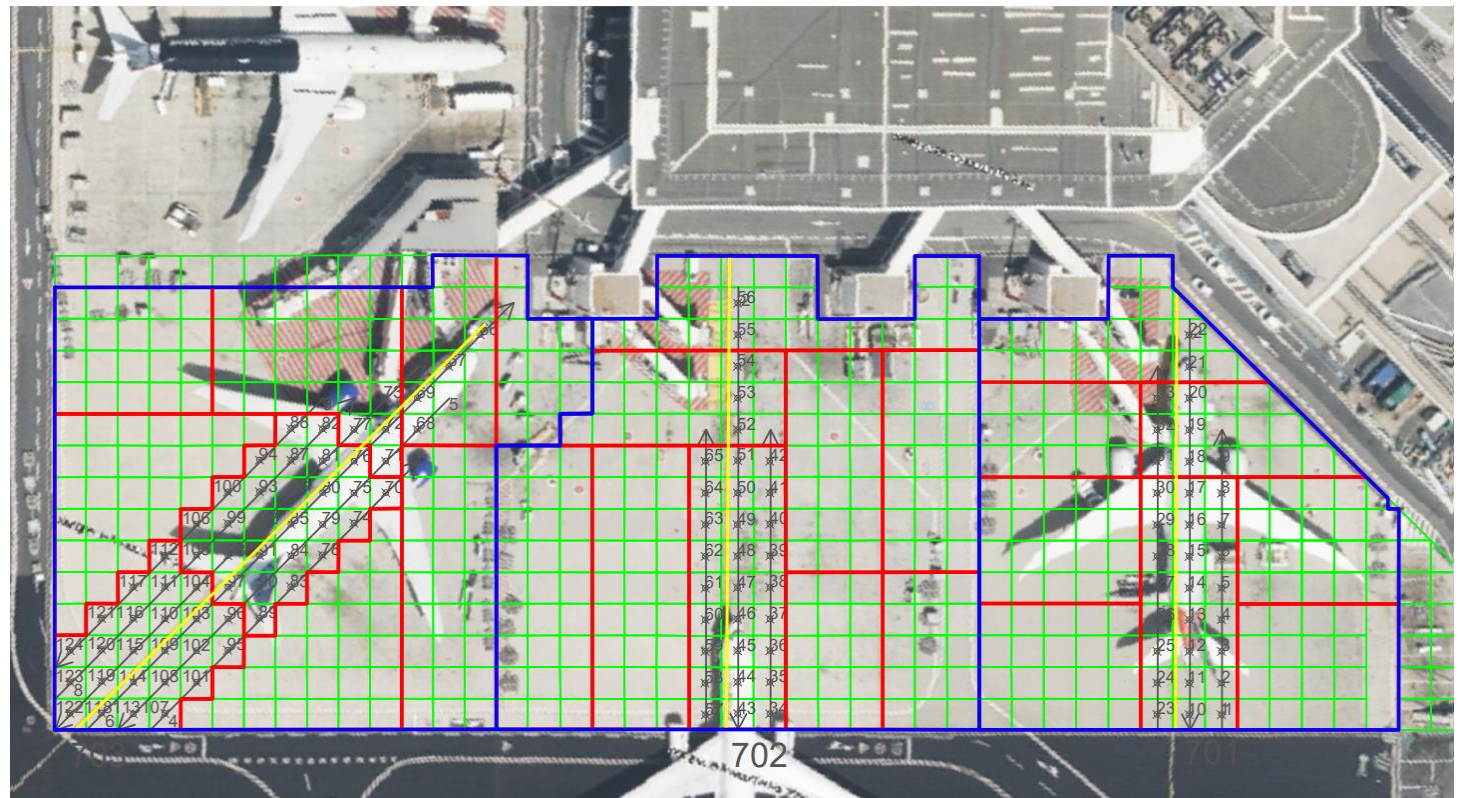> ➢ **_Chronological clustering_**, subdivision per survey date and tipology.

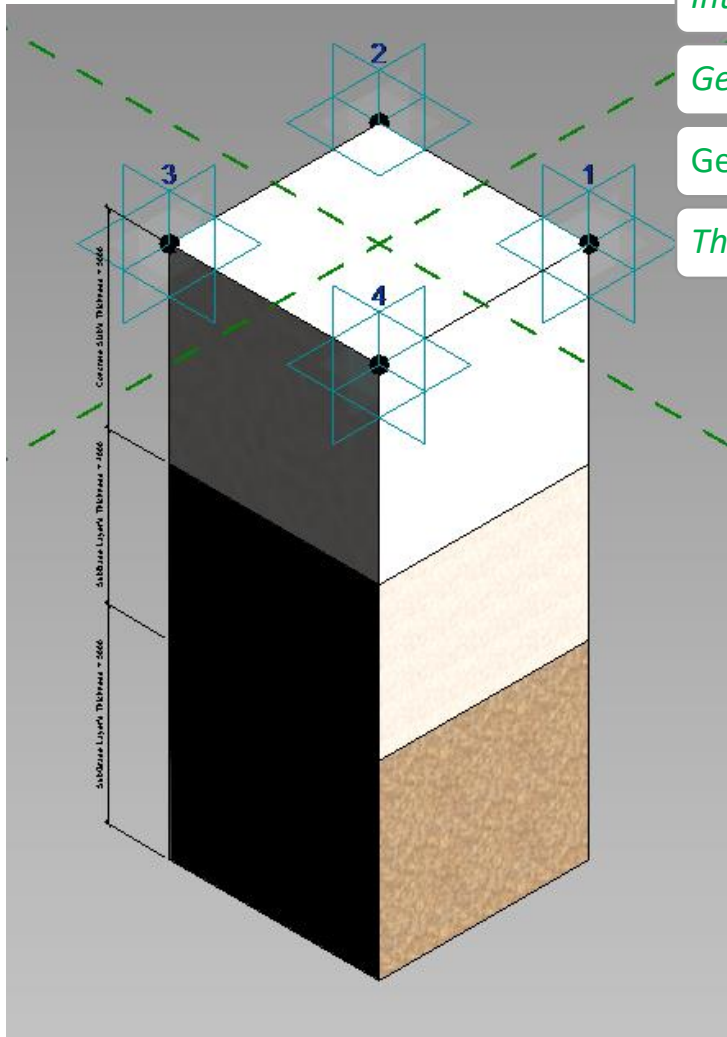**Network** _(Airport)_

Branch _(Apron, Runway, Taxiway, …)_

Section _(Stand701, Stand702, Stand703 …)_

Sample Unit _(701_01, 701_02, 701_03 …)_

Elementary Unit _(701_01_01, 701_01_02, …)_

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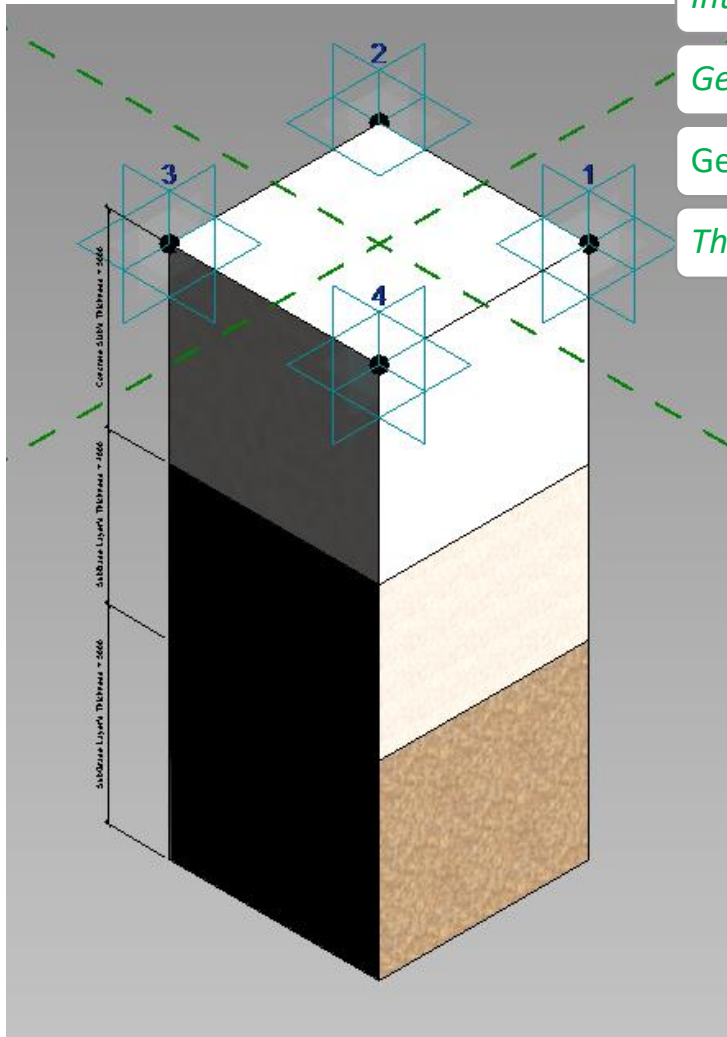
Interoperable digital architecture;

Geolocalization implemented;

Generic *parametric and adaptive* model of the geometrical – informative properties;

Threedimensional parametric *constraints.*

Interoperable digital architecture;
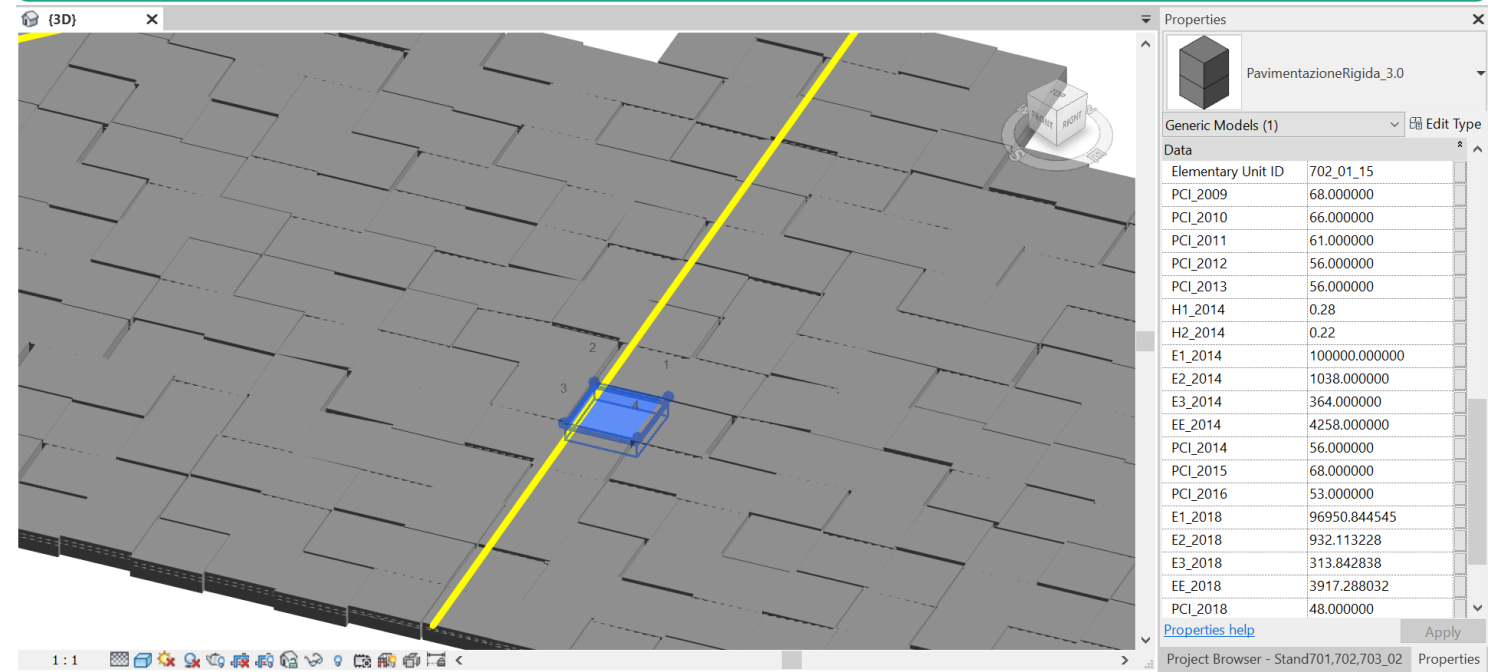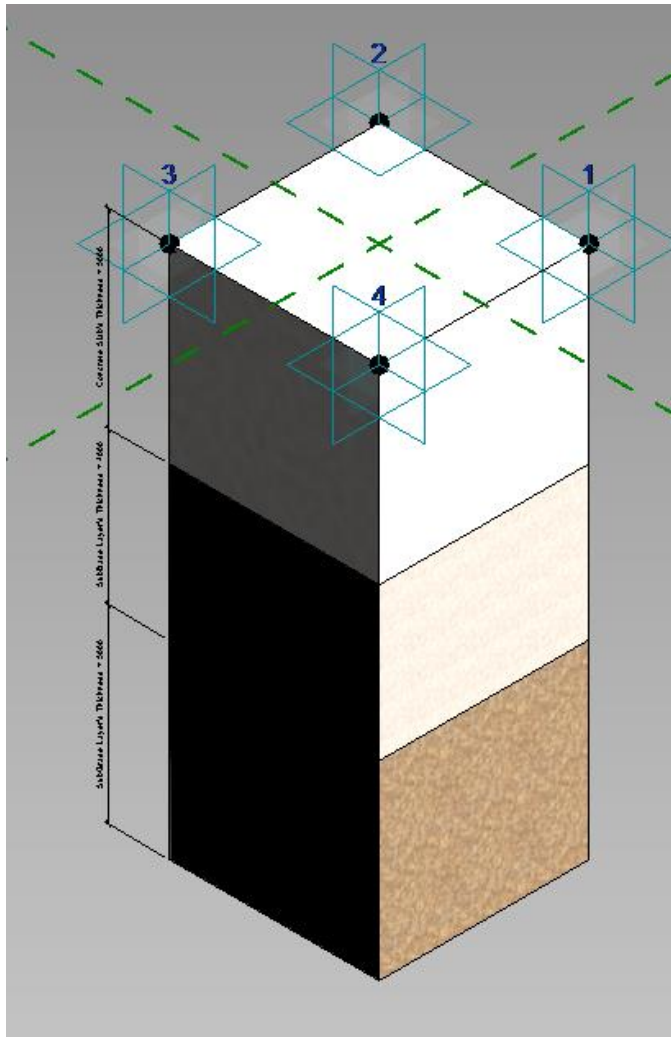
Geolocalization implemented;

Generic *parametric and adaptive* model of the geometrical – informative properties;

Threedimensional parametric *constraints*;

Automated creation and assignment of every elementary unit

Properties

PavimentazioneRigida_3.0

Generic Models (1) ⌄ Edit Type

Data

Elementary Unit ID	702_01_15
PCI_2009	68.000000
PCI_2010	66.000000
PCI_2011	61.000000
PCI_2012	56.000000
PCI_2013	56.000000
H1_2014	0.28
H2_2014	0.22
E1_2014	100000.000000
E2_2014	1038.000000
E3_2014	364.000000
EE_2014	4258.000000
PCI_2014	56.000000
PCI_2015	68.000000
PCI_2016	53.000000
E1_2018	96950.844545
E2_2018	932.113228
E3_2018	313.842838
EE_2018	3917.288032
PCI_2018	48.000000

Properties help   Apply

Project Browser - Stand701,702,703_02   Properties

Interoperable digital architecture;

Geolocalization implemented;

Generic *parametric and adaptive* model of the geometrical – informative properties;

Threedimensional parametric *constraints*;

Automated creation and assignment of every elementary unit

Conjunct Analysis of integrated mechanical and geometrical properties

The digitalization and BIM management of apron rigid pavement procedure is based on the case study of *apron 700, in particular stands 701, 702 e 703 Leonardo Da Vinci Airport, Fiumicino, Rome, Italy*.
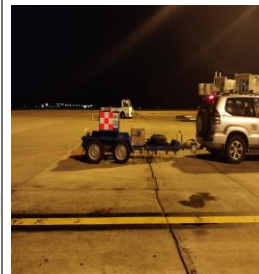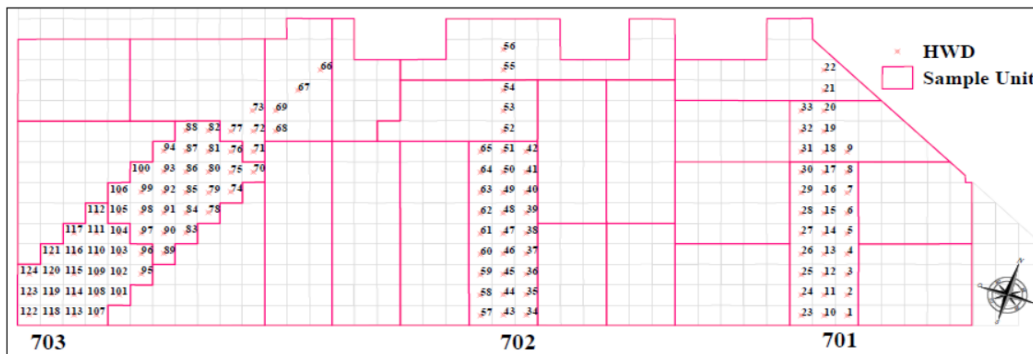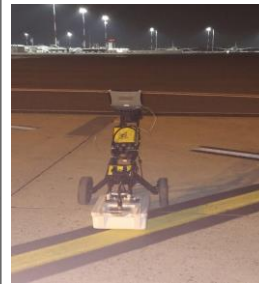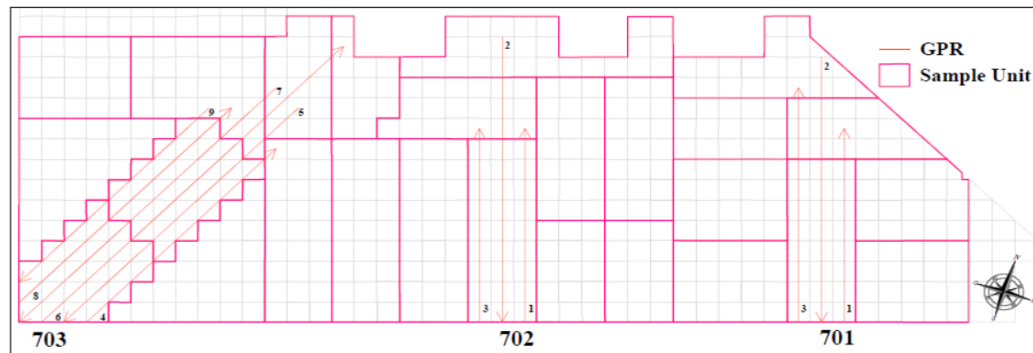
FCO Airport
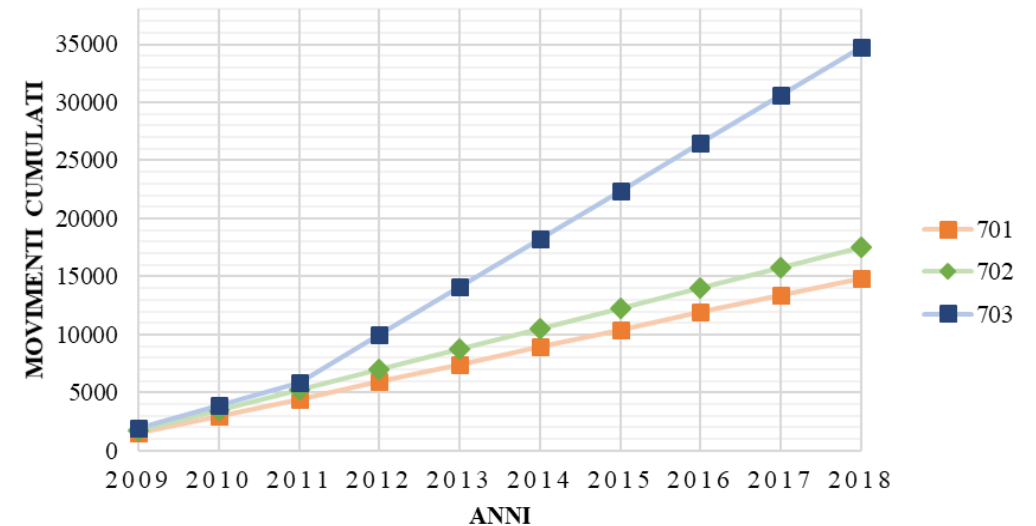
Apron 700 – Stand 701-703
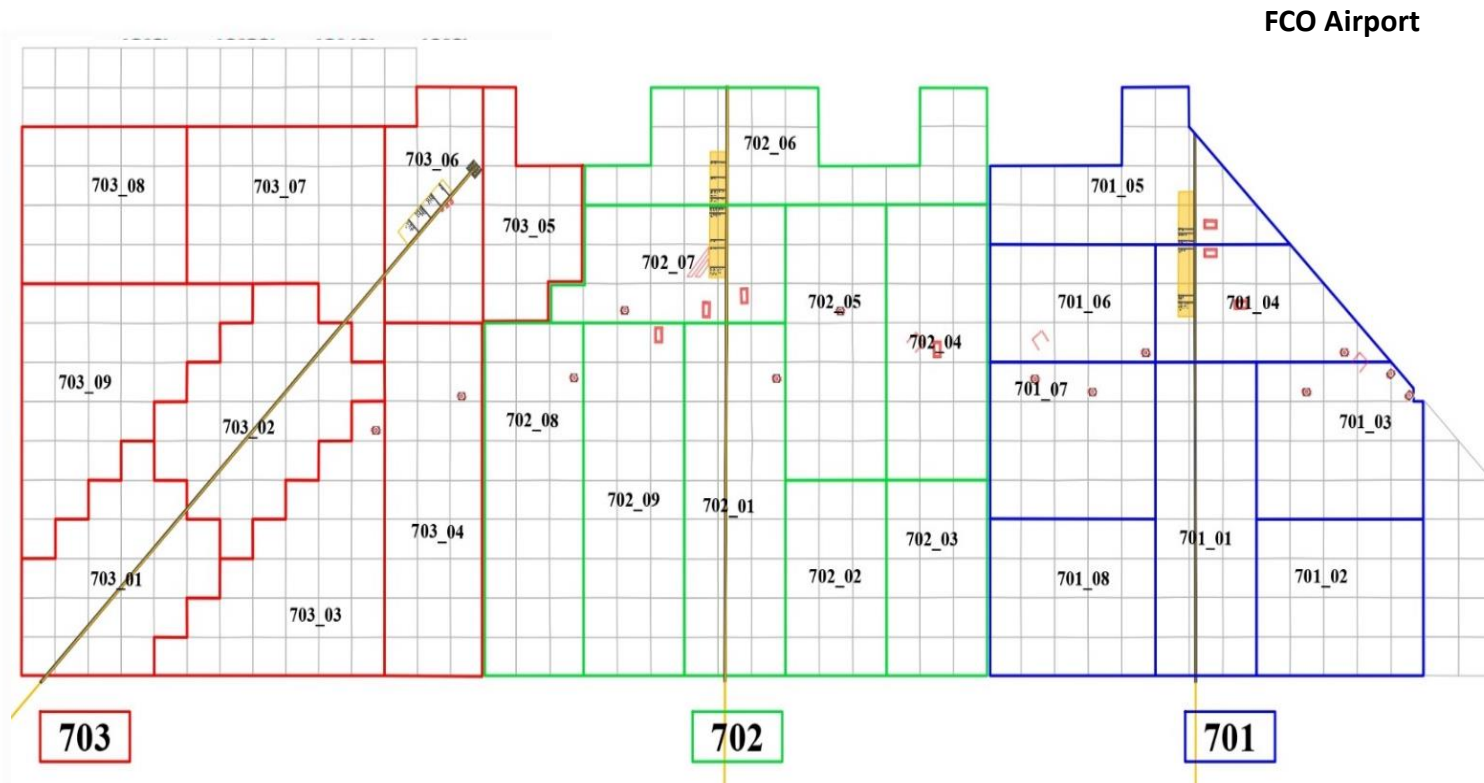
Tutti e tre gli stalli di sosta si prestano come *caso pilota per il test* di gestione digitale, avendo condiviso dal 2009 al 2019:

➢ assenza di interventi di manutenzione straordinaria;

➢ assenza di modifiche della geometria dei piazzali e della segnaletica;

➢ spazio omogeneo e comune data la prossimità fisica dei tre stand;

➢ dati da ispezioni visive e indagini strutturali condotte su *analoghi percorsi di ingresso/uscita aeromobili*.

Tuttavia, le funzioni e le prestazioni erogate da questi stalli *differiscono nel tempo per condizioni di esercizio*, ovvero traffico di aeromobili e quindi classi di carico consentite nel tempo.
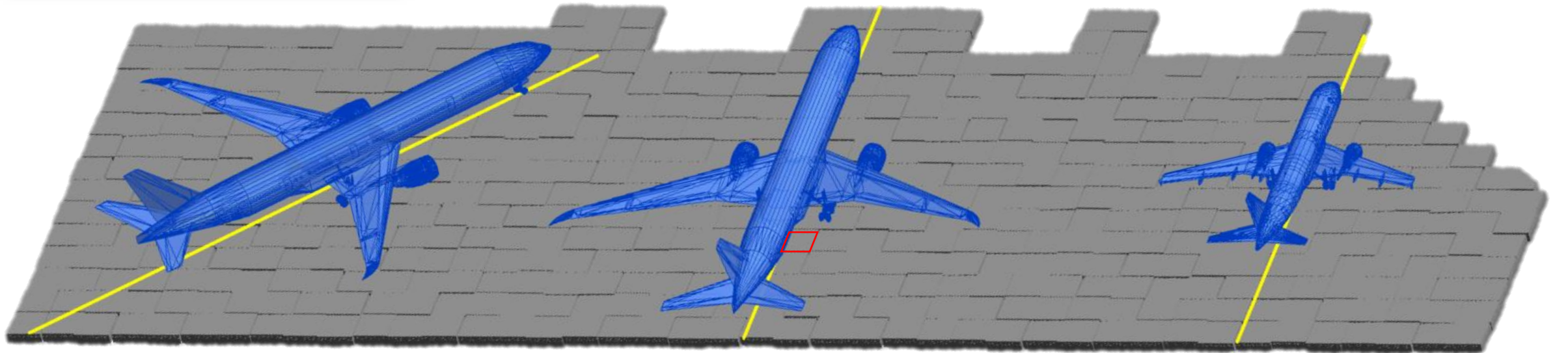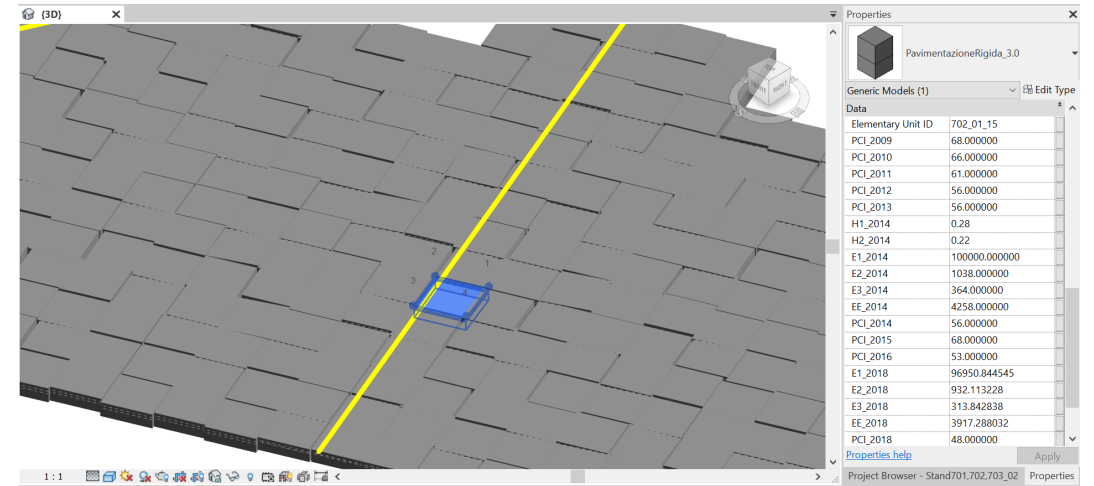
DIGITALIZATION OF APRON 700

Surface condition (PCI) vs Mechanical properties (E)

20.000 — Frame — 50.000   Slab's stiffness (E1 [MPa])

0 — Fill — 100   Pavement Condition Index (PCI)
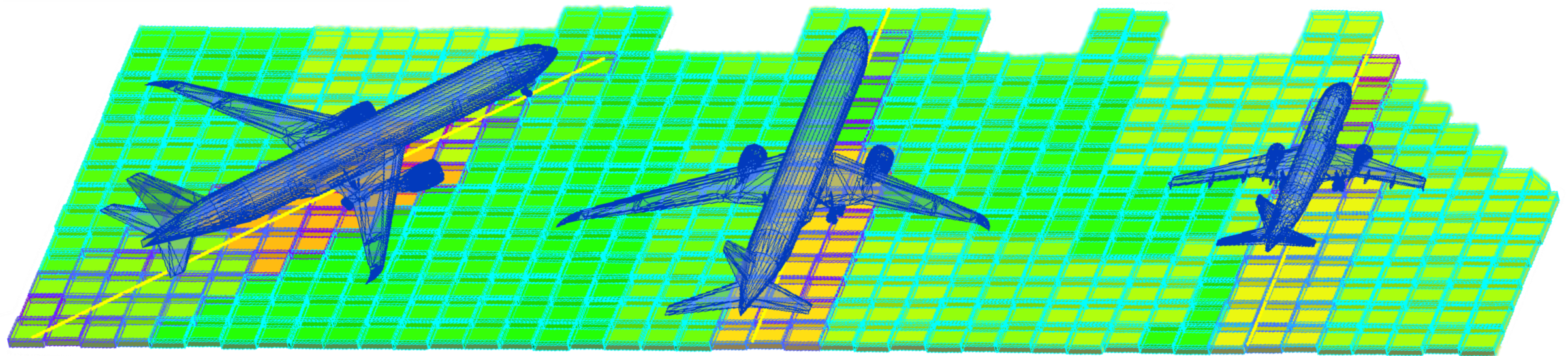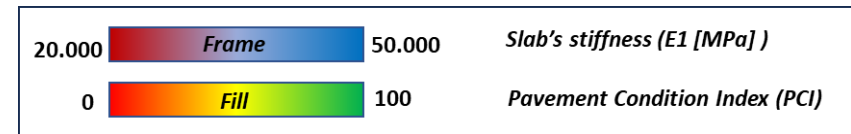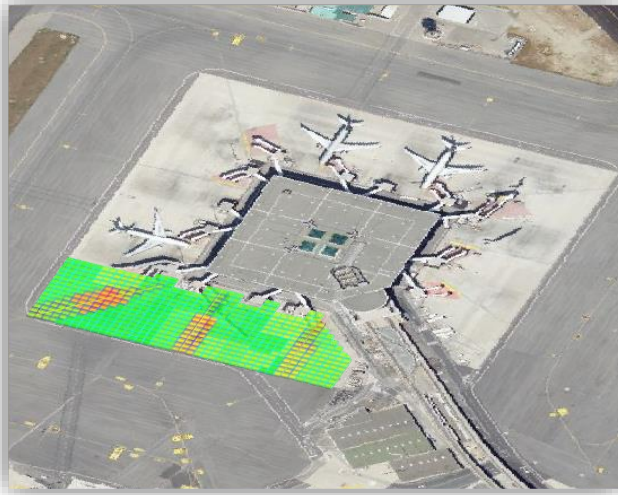
FROM THEORETICAL STRAIN-STRESS ASSESSMENT TO THE HEALTH CONDITION ANALYSIS

$$N_{cop.\,rott.,i} = 10^{\left\{\frac{R_m}{\sigma_i * \alpha_i * \beta_i * \gamma_i} - \left[\frac{(1-SCI/100)(ad-bc)+F'_s bc}{(1-SCI/100)(d-b)+F'_s b}\right]\right\} / \left[\frac{F'_s bd}{(1-SCI/100)(d-b)+F'_s b}\right]} \implies D_{e,i} = 1/N_{cop.\,rott.,i}$$

$$CDF_i(x) = \frac{N_{pass.\,appl.,i} * 20\,anni}{P/C_i} * \int_{-\infty}^{+\infty} \frac{dD_{e,i}(x)}{dx}\,dx \implies maxCDF_i = \frac{N_{pass.\,appl.,i} * 20\,anni}{P/C_i} * D_{e,i}$$

Riempimento — *Danno Cumulato Totale (CDF)*
200   20 1   0.1

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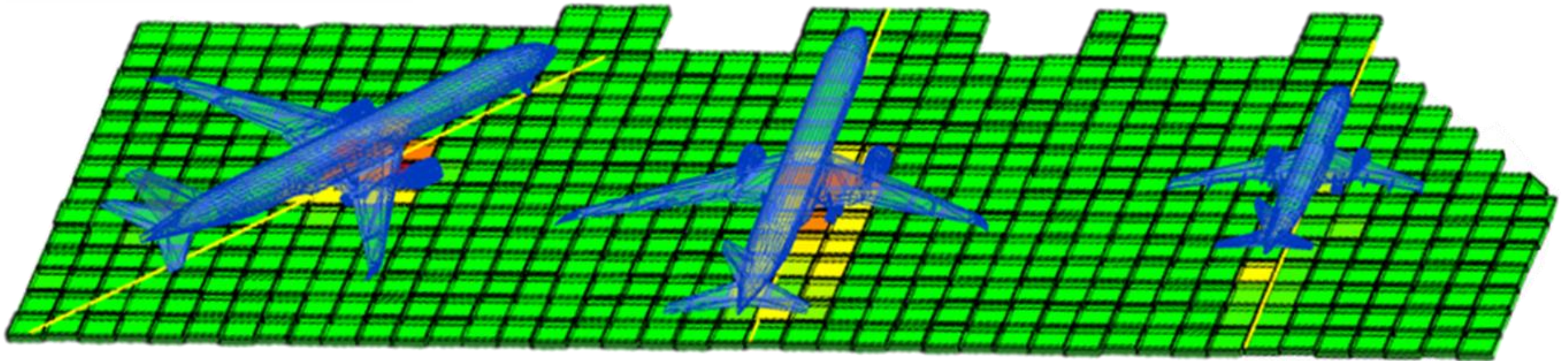UNIVERSITÀ DEGLI STUDI

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Optical fiber

Transmitted light

Reflected light

Grating

Analisi agli Elementi Finiti (F.E.M.)

HWD: E_1, E_2, E_3

GPR: H_1, H_2

P-501 PCC Surface | T=356 mm | R=4.48 M
P-401/P-403 HMA Stabil | T=127 mm |
P-209 Crushed Aggregate | T=152 mm | E=517.11
Subgrade | k=46.8 MN/ | E=103.42

$\sigma_{XX,appl,i}$
$\sigma_{YY,appl,i}$

$maxCDF_i$

$maxCDF_{tot}$

Teoria delle lastre sottili

PCC Slab

ACR - PCR

Aircraft Fleet & Traffic

Pavement Type

Subgrade Strength

Tire Pressure

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GRAZIE