Case Studies of Synthetic Sports Pitches in Ireland

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ABSTRACT:

This paper presents a comprehensive design methodology for synthetic third generation (3G) sports pitches, covering site selection, topographical survey, ground investigation, foundation design, and commissioning. Two case studies, Holy Trinity College, Cookstown Co. Tyrone, and Ballyfin National School, County Laois, demonstrate the geotechnical assessment of near-surface soils, subsoil drainage conditions, and subgrade bearing capacity required to support multi-layer synthetic turf systems. The approach follows Eurocode 7 principles and the GAA Guidelines for Synthetic Turf Surfaces (2022) and SAPCA (2020).

Ground investigations included dynamic probing, shear vane testing, and lightweight deflectometer (LWD) testing to derive indicative CBR values. Depending on the subgrade strength, reinforcement design was undertaken using either the Giroud and Han (2004) method or multilayer approaches such as Rimoldi and Simons (2013). The case studies confirm that geogrid reinforcement enhances bearing capacity and reduces granular thickness. LWD testing was also used to verify in-situ stiffness (Ev) and confirm compliance with performance targets.

Keywords: dynamic probing, CBR, LWD Lightweight Deflectometer, Ev, Evd, Eurocode 7.

1 INTRODUCTION

Irish schools and community clubs increasingly depend on reliable, all-weather playing surfaces as winter rainfall and low evaporation frequently render natural grass pitches unusable. Saturated ground conditions lead to closures and reduced access to outdoor activity, a challenge intensified by trends toward wetter winters and heavier rainfall (Met Eireann, 2024) [1].

In rural and semi-rural areas, development of synthetic pitches has been supported by targeted capital funding, through the CLÁR (Department of Rural and Commumity Development and the Gaeltacht, 2025)[2] programme, which assists local authorities in delivering community and school sports infrastructure.

2 PURPOSE AND APPLICATION

A structured design procedure is essential to ensure efficient and technically robust sports pitch procurement. This paper provides guidance on the early-stage development of synthetic sports pitches. The process begins with the appointment of a suitably qualified consulting engineer and the preparation of a clearly defined design brief outlining performance, regulatory, and budgetary requirements.

Early-stage topographical surveying and a comprehensive desk study inform the development of a Conceptual Ground Model (CGM), which characterises the geological, geotechnical, hydrological, and environmental conditions influencing earthworks, drainage, and platform design. National datasets, including those from GSI (Geological Survey Ireland , 2025) , [3] supported by soil and groundwater mapping, are used to identify anticipated ground conditions, environmental sensitivities, and site constraints. This baseline assessment enables preparation of a constraints plan and supports early evaluation of layout feasibility, drainage strategy, and subgrade performance requirements.

The preliminary CGM informs a targeted ground investigation programme, including trial pits, probing, in-situ testing, and groundwater monitoring. This risk-informed approach reduces geotechnical uncertainty and facilitates proportionate, evidence-based design decisions.

3 CONSTRAINTS IDENTIFICATION USING SURVEYS, RECORDS AND HISTORIC MAPPING

Early identification of buried services and overhead electrical infrastructure is critical at the feasibility and design stages, as such assets impose physical, statutory, and safety constraints that may influence pitch layout, drainage design, earthworks, and construction planning.

School and community sites frequently contain drainage networks, utilities, and legacy services with incomplete or inaccurate records, creating uncertainty regarding their location, depth, and condition. From a geotechnical perspective, service trenches may comprise poorly compacted or variable backfill, resulting in reduced bearing support and an increased risk of differential settlement.

A comprehensive constraints assessment, therefore, combines utility record reviews, statutory searches, site verification through walkover inspections, topographical surveys, and geophysical detection techniques. Overhead power lines require compliance with statutory clearance distances and may restrict structural elements, plant access, and the developable footprint. Historic mapping can further assist in identifying legacy features and areas of made ground.

All identified constraints are incorporated into the Conceptual Ground Model to inform targeted ground investigation, risk mitigation, and development of a safe, compliant, and buildable pitch layout.

4 TOPOGRAPHICAL SURVEY

Accurate topographical surveying is a key early-stage requirement in synthetic sports pitch development, providing the geometric framework for layout, drainage and earthworks design. Using high-precision GNSS (Global Navigation Satellite System) and, where appropriate, drone-based photogrammetry, surveys define site levels, constraints and surface features.

The resulting terrain models enable optimisation of pitch orientation, alignment and formation levels, minimising cut-and-fill, supporting gravity-led drainage design and outfall assessment. Survey data also informs early earthworks quantification and targeted ground investigation planning.

5 DETERMINATION OF SUBGRADE SOIL PARAMETERS

Determination of representative subgrade parameters is fundamental to the design of synthetic sports pitch foundations, directly influencing both constructability and long-term performance. Parameters are established in accordance with Eurocode 7 (Geotechnical Design), Part 2, which include ground investigation, soil classification, in-situ testing, and laboratory assessment to derive characteristic values appropriate for lightly loaded infrastructure. Soils are classified according to IS EN ISO 14688, with undrained shear strength (cu) in cohesive soils determined primarily from handheld shear vane testing, supported by probing and excavation records. Bearing capacity is assessed using CBR values derived from a TRL Dynamic Cone Penetrometer (DCP) with 8kg weight dropping 575mm onto a 20mm diameter rod with a 60^{o} cone.

A lower-bound CBR of 2% (or cu $\geq$ 60 kPa) is adopted as the minimum acceptance criterion, consistent with TII Series 600 and SR21 guidance.

6 SPORTS PITCH BASE DESIGN AND REINFORCEMENT DESIGN APPROACHES

The sports pitch foundation is designed as a pavement-type system to provide a stable, durable, and well-drained platform capable of supporting both the synthetic turf system and construction loading while limiting long-term deformation. Performance is governed by subgrade strength, granular layer characteristics, and geosynthetic reinforcement.

6.1 *Single Layer design method*

Where subgrade strength is moderate, single-layer geogrid reinforcement is provided at the subgrade–granular interface in accordance with the (J.P.Giroud; J.Han., 2004)[4] method. The aggregate thickness is determined based on subgrade CBR, deformation criteria induced by the number of vehicle passes, and geogrid tensile properties.

The geogrid enhances performance by providing lateral confinement of the aggregate, improving load distribution and reducing shear stress transmitted to the subgrade, thereby enabling a more efficient and stable platform design. (C Reilly, K Nell, 2018) [5].

6.2 *Multi-layer design method*

For weak or variable subgrades, multilayer geogrid reinforcement is designed using the (P Rimoldi, 2013)[6] method.

This approach considers the combined contribution of reinforcement layers within the granular base, accounting for lateral restraint, membrane tension at the subgrade interface, and progressive stiffness mobilisation with depth. Geogrids improve performance through three primary mechanisms:

- Lateral confinement of the base course under self-weight and wheel loading,
- Reduction of horizontal stresses within the granular layers,
- Development of a tension membrane effect at the deck–subgrade interface.

These mechanisms generate tensile forces within the reinforcement layers, increasing effective bearing capacity and limiting deformation, (K Nell, C Reilly, 2024)[7]

Design is based on a layered pavement model comprising asphalt (where present), base course, subbase and subgrade. By enhancing load distribution and confinement within this system, multilayer geogrid solutions can reduce the required aggregate thickness, improving constructability and cost efficiency on soft soils.

Therefore, a 4-layer model has been developed for geogrid design. The general scheme of the model and the symbols that will be used for the calculations are indicated in, Figure 1.

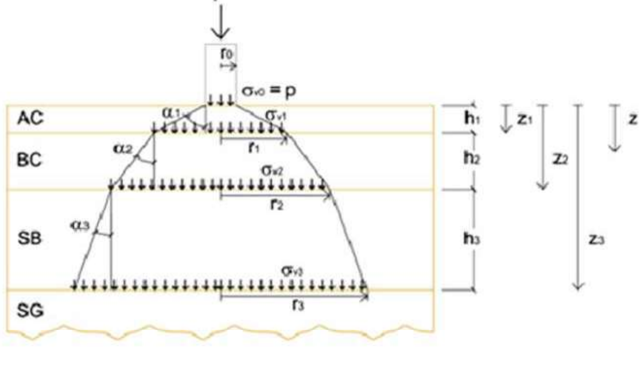


Figure 1: Multilayer System

The model assumes that the wheel load is applied as a uniform vertical pressure σv0 = p (tyre inflation pressure) on a circular area with an equivalent radius r0, Figure 2.

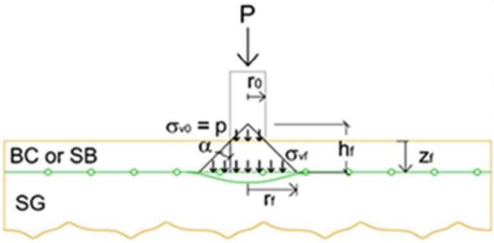


Figure 2: Loaded area.

The load is spread in 3 layers of the road structure (AC, BC and SB) according to their load spread angles α1,α2 & α3.

The pavement structure comprises a geogrid-reinforced base course, while the asphalt layer, if present, is unreinforced. The subbase may be either reinforced or unreinforced depending on design requirements.

The lowest geogrid layer, located at the subgrade interface, is subjected to the greatest vertical deformation due to settlement of the soft subgrade during placement and compaction of the initial fill. This layer is therefore assumed to mobilise a tension membrane (catenary) mechanism. In contrast, upper geogrid layers experience smaller vertical displacements and their membrane contribution is generally considered negligible. Each geogrid layer must be designed to resist the total horizontal forces acting within its plane arising from soil and loading effects.

Total Horizontal Force = Tzi + TPi + Tm (1)
Where:

- Tzi = Force due to horizonatal soil thrust in the i-th geogrid layer.
- TPi = Force due to horizontal stresses generated by wheel loading in the i-th geogrid layer.
- Tm = Force due to the tension membrane mechanism at the interface with the subgrade.
- The i-th geogrid layer shall be able to provide a tensile force equal to or greater than Ttot-i at a maximum of 5% strain.

6.3 *Granular Backfill*

Granular materials used in synthetic sports pitch foundations must provide sufficient strength, stiffness, and drainage to support construction and operational loading without excessive deformation. Aggregates are specified in accordance with I.S. EN 13242, TII Series 600 (September 2024), and SR 21, with grading selected to ensure effective load distribution and permeability. Materials are placed in controlled lifts and compacted to achieve uniform density, with subgrade protection and moisture control measures implemented to maintain formation integrity. Quality assurance includes material certification, inspection, and Lightweight Deflectometer (LWD) testing to verify achieved stiffness. All records are maintained in accordance with BCAR requirements to ensure compliance and traceability.

6.4 *Construction, Compaction and Quality Control*

Construction of the synthetic sports pitch base follows a controlled sequence to protect the subgrade and achieve consistent platform performance. After removal of unsuitable material, the formation is trimmed, inspected, and protected from trafficking. A non-woven geotextile separator and a geogrid reinforcement are installed, followed by placement of compliant granular fill in controlled lifts.

Quality assurance measures include inspection hold points, material certification, and Lightweight Deflectometer (LWD) testing to verify achieved stiffness and performance.

6.5 *Drainage Design and Integration*

Effective drainage is critical to maintaining subgrade strength and ensuring the long-term performance of synthetic sports pitches, particularly in Ireland's high-rainfall climate. Drainage systems are designed to remove infiltrating water rapidly, preventing saturation and loss of formation stability.

Design rainfall is derived from (Met Eireann, 2024) [1] data. Subsurface systems typically comprise perforated lateral drains connected to carrier drains, with spacing based on soil permeability, groundwater conditions, and site gradients. Pipes are installed within free-draining granular surround to maintain positive flow.

Where discharge to watercourses is required, outfall design accounts for flood risk and tailwater effects, informed by mapping from the Office of Public Works (OPW), and incorporates appropriate environmental protection measures.

7 CASE STUDY: HOLY TRINITY SCHOOL, COOKSTOWN, CO, TYRONE

This full size (150m*80m) GAA Synthetic sports pitch was part of the Holy Trinity School extension.

7.1 *Geological Mapping & Testing*

Published geological mapping indicates the superficial deposits underlying the site comprise glacial till of variable lithology, usually sandy silty clay with occasional gravel and sand-rich lenses. These deposits are underlain by sandstone and limestone of the Armagh Group. (GSNI, 2026)[8]

Construction Testing Services Ltd carried out a series of plate bearing tests using a 450mm dia. plate in accordance with BS 1377-9. The locations and results of the plate tests are indicated in Table 1 and Figure 3.

Table 1: Plate Bearing Test Results – Sub Grade

Test No.	CBR	Report No.	Sub-Grade
1	1.6%	PLT14123	Clay
2	0.4%	PLT14122	Clay
4	0.4%	PLT14124	Clay
5	1.0%	PLT14125	Clay
8	1.0%	PLT14126	Clay

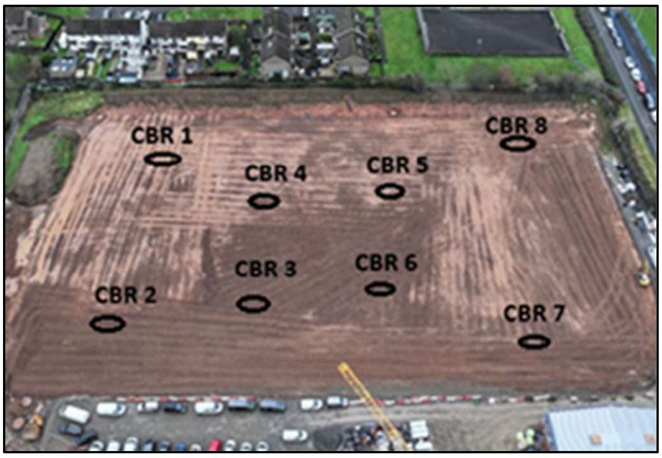
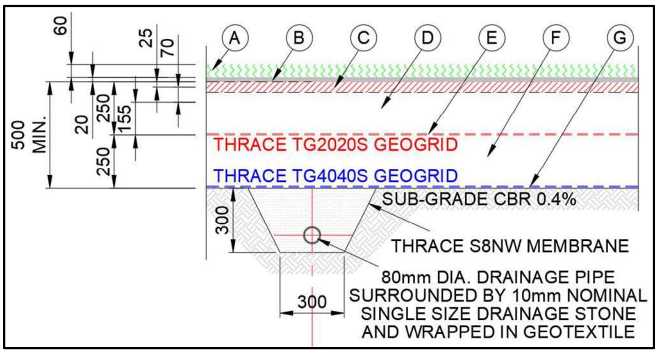


Figure 3: CBR - Plate Bearing Test Locations

7.2 *Base design*

The design sequence of the multilayer reinforcing stone column comprises defining the applied load, which is normally construction traffic wheel contact area, assessing subgrade CBR values, selecting a trial granular mattress thickness, calculating stresses and tensile demand at each reinforcement level, including any membrane action, selecting suitable geosynthetics at 5% strain, and checking bearing capacity, rutting and serviceability.

Based on this assessment, a total reinforced base thickness of 500 mm was adopted in accordance with the multilayer methodology, as illustrated in Figure 4.



Legend:
A = 60mm long carpet to GAA performance specifications
B = 20mm prefabricated shock pad
C = 50mm layer of 10-20mm clean stone (blinding)
D = 200mm layer of Class N6 granular fill
E = One layer of Thrace TG2020S geogrid
F = 200mm layer of Class N6 granular fill
G = One layer of Thrace TG4040S geogrid

Figure 4: HTC pitch design

7.3 *Drainage*

The drainage system comprised lateral drains discharging to a central carrier pipe. Monitoring demonstrated significant attenuation and storage within the pitch structure supporting the role of artificial pitches in sustainable drainage, Figure 5. Once the drainage system was installed, the entire area was covered with a Thrace S8NW separation membrane which ensured that the sub-grade did not contaminate the granular N6 base layer.

Figure 5: Drainage Installation

The first layer of Thrace TG4040S geogrid was placed on the separator membrane. The N6 fill was compacted in accordance with TII Series 600 Earthworks specifications.

A second layer of Thrace TG2020S geogrid was installed on the compacted 6N fill. The N6 fill was compacted in accordance with TII Series 600 Earthworks specifications, Figure 6.

Figure 6: Placement of granular backfill and geogrids

7.4 *Testing*

The sports pitch formation performance is typically verified using Lightweight Deflectometer (LWD) or Plate Bearing Testing to confirm that the required stiffness has been achieved prior to installation of the synthetic turf system.

The minimum stiffness value suggested currently for a sports pitch sub-base is 40 MPa, (P.Flemming, 2016) [9] A modulus of sub-grade reaction EV (40MPa) equates to 12.1% CBR using the equation. (M.Carter, 2016)[10]

$$Ev=3.6CBR-0.088CBR1.73+3 \quad (2)$$

The measured CBRs of the constructed base were consistently greater than 12.10% CBR. Only once the sport pitch foundation was confirmed, would the construction of the blinding, shock pad and carpet proceed.

8 CASE STUDY: BALLYFIN NATIONAL SCHOOL, CO. LAOIS

Ballyfin NS appointed TerraTech Consulting Ltd to provide engineering services for the construction of the new sport pitch. A site survey and geotechnical investigation was carried out.

8.1 *Site Investigation and Topographical Survey*

A desk top study was carried out using the Geological Survey of Ireland online tools. It was determined that Teagasc soils for the site are derived from Devonian Sandstone Tills, Figure 7.

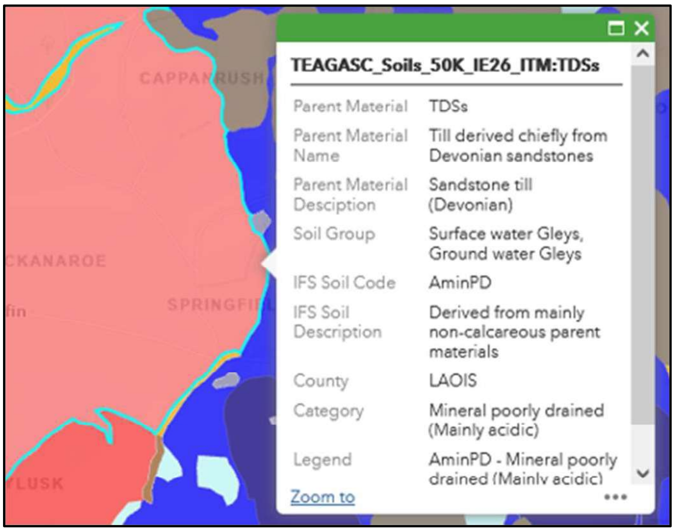


Figure 7: TEAGASC soils Devonian Sandstone

A detailed topographical survey was then undertaken to define the available site area, identify services and hazards, and set out the locations of dynamic test probes (Figure 8). Based on the survey, the pitch dimensions were established at 45 m in length and 29 m in width.

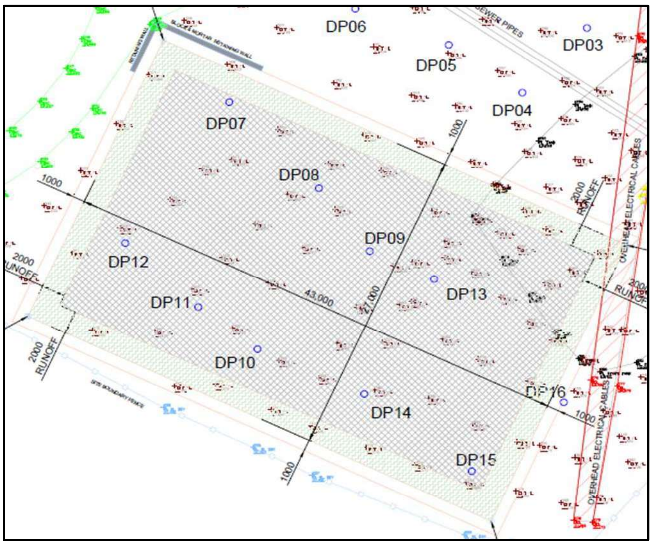


Figure 8: Topographical Site Survey

The results of the 9 Dynamic Cone Penetrometer tests are indicated in Table 2.

Table 2: Dynamic Probing Test Results – Sub Grade

Test No.	CBR	Sub-Grade
DP7	8.3%	Sandstone Till
DP8	19.4%	Sandstone Till
DP9	21.9%	Sandstone Till
DP10	13.9%	Sandstone Till
DP11	12.7%	Sandstone Till
DP12	16.6%	Sandstone Till
DP13	29.2%	Sandstone Till
DP14	8.1%	Sandstone Till
DP15	7.1%	Sandstone Till

The CBR of the sub-grade was > 5%, hence reinforcing geotextile would not provide any additional structural support. The sub-grades were robust enough to support a sports pitch.

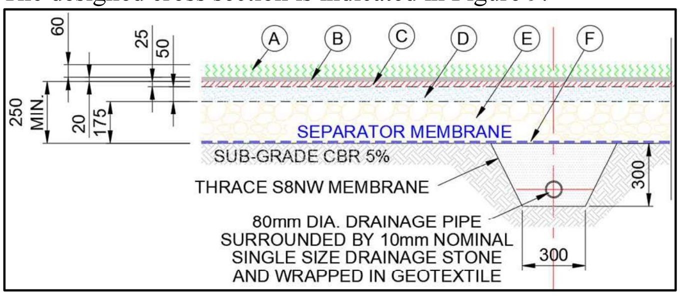
8.2 *Sports Pitch Foundation Design*

The design of the sports pitch foundation was determined using the (J.P.Giroud; J.Han., 2004) [4] design method. The design input data is indicated in Table 3.

Table 3: Input Data

Description	Data Input
Standard Axle	80kN
Wheel Load	40kN
Tyre Pressure	500kPa
Allowable rut depth	30mm Construction Traffic
CBR of Sub-Grade	5%
CBR Final Base Course	15%
Number vehicle axle passes	200
Granular Design Depth	225mm (Use 250mm)

The designed cross section is indicated in Figure 9.



Legend:
A = 60mm long carpet to GAA performance specifications
B = 20mm prefabricated shock pad
C = 25mm layer sand (blinding layer)
D = 50mm layer 10-20mm clean stone
E = 175mm layer of SR21 type 3 granular fill
F = One layer of Thrace S8NW separator membrane

Figure 9: Cross section through granular base

The Lightweight Deflectometer was used to determine the granular base stiffness, (Table 4).

Table 4:Lightweight Deflectometer results 11.12.2025

EVd MPa	Ev2 MPa	CBR
42	84	32.69%
20	40	12.10%
32	64	22.13%
25	50	16.02%

EVd is the quick dynamic site test value measured with Lightweight Falling Deflectometer (FWD), while EV2 is the comparable static plate-load value. A common indicative relationship is: $EV2 \approx 2 \times EVd$ (3)

Code of Practice (SAPCA, 2020) [11] for bases to outdoor synthetic sport areas gives specific LWD stiffness targets as indicated in Table 5.

Table 5: SAPAS base targets

Description	**Minimum Target Values**
Very weak formation SAPAC	< 2.5% geosynthetics reinforcing to be used
Construction formation SAPAC	≥ 5% CBR
Surface Modulus SAPAC	≥40MPa

Following the achievement of the target CBR value, the construction of the blinding layer, installation of shock pad and placement of the carpet could commence, Figure 10.

Figure 10: Installation of blinding, shock pad and carpet

9 DISCUSSION

The two case studies demonstrate contrasting geotechnical conditions and proportionate foundation solutions for synthetic sports pitch construction. At Holy Trinity School, Cookstown, very low subgrade CBR values (0.4%–1.6%) confirmed the presence of soft glacial till deposits requiring engineered improvement. A multilayer geogrid-reinforced pavement solution, based on Rimoldi and Simons (2013), was therefore adopted. The resulting 500 mm reinforced foundation was designed in accordance with Eurocode 7 principles to improve load distribution, mobilise membrane action, and control deformation over the design life.

The design addresses both ULS and SLS requirements, with particular emphasis on limiting settlement, rutting, and progressive strain accumulation. Integrated drainage measures further enhance platform stability and provide measurable attenuation within the pitch structure.

By contrast, the Ballyfin National School site was underlain by competent Devonian Sandstone Till, with verified CBR values consistently exceeding 5%. Ground conditions permitted a simplified pavement design using the Giroud and Han (2004) method without structural geogrid reinforcement. A 250 mm granular foundation proved sufficient to meet performance requirements.

In both projects, performance-based verification using Lightweight Deflectometer (LWD) testing confirmed achieved stiffness values exceeding the target equivalent CBR of 12.1% ($E_v \geq 40$ MPa), validating the adopted design methodologies and construction controls.

10 CONCLUSIONS

These case studies demonstrate the importance of targeted ground investigation and Eurocode 7 aligned risk-informed design in delivering synthetic sports pitch foundations. Very weak subgrades can be successfully engineered through multilayer geogrid reinforcement and controlled granular construction, while competent tills allow efficient, unreinforced solutions. In both cases, integration of desk study data, in-situ testing, proportionate design methods, compliant construction practices, and stiffness verification ensured robust, durable, and performance-compliant pitch platforms.

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