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A Study on the Linguistic Characteristics and Translation Techniques of English Scientific Papers in Geotechnical Engineering Mechanics

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Abstract

Reading scientific papers in geotechnical engineering mechanics is a fundamental approach to acquiring new methodologies and cutting-edge technologies in the international arena. This study conducts a systematic analysis of the distinctive linguistic features inherent in English scientific papers within this specialized field, focusing particularly on lexical and syntactic dimensions. Lexically, it investigates the prevalent use of acronyms, abstract nouns, derived terms formed through affixation, and highly specialized technical terminology. Syntactically, it examines the frequent occurrence of complex and elongated sentences, the extensive application of passive voice, and nominalization structures. Corresponding translation techniques and strategies are proposed and illustrated with concrete examples to effectively navigate these linguistic characteristics. The findings are anticipated to assist researchers, practitioners, and translators in overcoming comprehension barriers imposed by specialized language, thereby facilitating more efficient and accurate reading, understanding, and translation of geotechnical engineering literature. Ultimately, this research seeks to contribute to smoother and more effective international academic and technical communication within the geotechnical engineering community.

Keywords

Geotechnical Engineering Mechanics; Scientific Papers; Linguistic Features; Translation Techniques

1. Introduction

As geotechnical engineering practices align with international standards, staying abreast of global design trends has become essential for engineers. Reading English-language geotechnical engineering papers remains a vital channel for understanding the latest advancements in overseas design and construction practices. Engineers often encounter obstacles with specialized terminology and abbreviations, and even when familiar with a word, may struggle to grasp its precise meaning, leading to inefficient reading. Therefore, gaining a deep understanding of the linguistic characteristics of English papers in geotechnical mechanics, along with mastering their unique linguistic style and features, is crucial for enhancing the ability to read, comprehend, and translate English papers in soil mechanics.

2. Analysis of Lexical Characteristics in English Scientific Papers on Geotechnical Engineering Mechanics

The vocabulary in geotechnical engineering mechanics papers is characterized by precision, technicality, and a high

degree of standardization. This section analyzes these characteristics through the prevalent use of acronyms, abstract nouns, derived terms, and specialized terminology. Most English vocabulary in mechanics is relatively straightforward, involving many abstract concepts such as force(力), momentum(动量), acceleration(加速度), and friction(摩擦力), which carry strong academic and professional connotations. Within English scientific papers on mechanics, numerous physical quantities require precise linguistic expression. When describing physical phenomena and analyzing corresponding problems, emphasis is placed on functionality and practicality, necessitating clear articulation of logical relationships and causal connections while prioritizing scientific rigor and objectivity.

Mechanics-related scientific English extensively employs compound terms, particularly in geotechnical engineering where vocabulary often exhibits a one-word-one-meaning characteristic. Longer terms typically denote more specialized meanings. One of the significant characteristics of the language of scientific papers is the extensive use of technical terms within the papers (Sun, 1996). For example, the term “electro-chemo-mechanical” comprises three components representing processes of “电” (electro), “化学” (chemo), and “机械” (mechanical). This compound term specifically describes the interaction between electric fields, chemical reactions, and mechanical behavior. When translating such terms, particular attention must be paid to distinguishing their role as either the predicate or subject within a sentence to ensure accurate scientific communication. Additionally, subjects in sentences are often constructed using multiple adjective phrases, sometimes incorporating nouns as modifiers. The typical sequence is adverb, adjective, noun, noun, as seen in “a specially modified single edge V-notched beam method”.

2.1 Abbreviations and Acronyms

Scientific and technical literature in English frequently employs numerous abbreviations (Yashinta, Sri, & Patria, 2024), such as FEA (Finite Element Analysis), CFRP (Carbon Fiber Reinforced Polymer), BEM (Boundary Element Method), CFD (Computational Fluid Dynamics), and SLS (Selective Laser Sintering).

When a particular phrase requires frequent repetition in an article, scholars often combine the first letter of each word into an acronym. This practice aims to reduce text length and enhance readability (Chen & Fang, 2012). It is commonly used when referring to specific methods or technologies, such as: DEM (Discrete Element Method), SDEM (Smoothed Particle Hydrodynamics), GEO5 (GEO5 Software), PLAXIS (PLAXIS Software, a finite element software for civil engineering), CPT (Cone Penetration Test), etc. Table 1 summarizes some common abbreviations found in English scientific papers on mechanics.

Table 1. Common Abbreviations in English Scientific Papers on Mechanics (Partial List)

Term Phrase	Corresponding Abbreviation	Term Phrase	Corresponding Abbreviation
couple stress theory	CST	degree of freedom	DOF
electrical double layer	EDL	electroencephalography	EEG
electromagnetic energy harvester	EMEH	finite element analysis	FEA
functionally graded material	FGM	Galerkin truncation method	GTM
lattice Boltzmann	LB	lithium-ion battery	LIB
Monte Carlo method	MCM	micro-electro-mechanical system	MEMS
magnetohydrodynamics	MHD	ordinary differential equation	ODE
partial differential equation	PDE	piezoelectric quasicrystal	PQC
quasi-zero stiffness	QZS	four-sided simply-supported	SSSS
turbulent boundary layer	TBL	weighted essentially non-oscillatory	WENO

2.2 Abstract Nouns

In the field of geotechnical engineering mechanics, abstract nouns primarily refer to concepts, model theories, algorithms, or physical quantities used to describe the specific state or properties of an object or model, rather than concrete objects or physical entities. Examples include terms like resultant couple (a single equivalent couple

representing the combined effect of multiple couples). When translating terminology, the translator needs to ensure the accuracy of the translation to avoid ambiguity or misunderstanding (He et al., 2024). Some abstract nouns or phrases possess strong mathematical properties, requiring contextual understanding within a physical framework. These involve precise quantification and computation demanding high accuracy, necessitating mathematical operations and derivations. For example, a "tensor" (a mathematical object that generalizes scalars and vectors to describe multi-dimensional physical properties, such as stress and strain, in a coordinate-invariant manner). In geotechnical engineering English vocabulary, many abstract nouns are often linked to fundamental principles or laws, exhibiting strong logical coherence that necessitates logical reasoning and analytical induction (Dean, 2015). Examples include fixed-point motion (定点运动), translation (平移), and collision (碰撞).

2.3 Derived Terms

In mechanics-related scientific literature, new compound terms are formed by adding prefixes or suffixes. In mechanics English, prefixes are frequently used to modify words, often conveying specific practical meanings. Common prefixes include pre-, un-, over-, semi-, and micro-. For instance, in "pre-stress," the prefix pre- denotes prior modification; in "nonlinear," non- indicates negation; and in "overload," over- signifies exceeding limits.

Suffixes are used relatively frequently to diversify a word's part of speech and often convey specific conceptual characteristics. For instance: -acy, -ity, -it, -ship, -dom, -tion, -al: Noun suffixes denoting abstract concepts like qualities or states; Verb suffixes formed with endings like -ate, -en, -ent, -ify, -fy, -ise, and -ize typically denote the act of producing a certain result. New words ending in -ability generally denote a specific property, such as deformability, durability, strength, and measurability. In mechanical engineering literature, many adjectives and nouns are converted into verbs to express processes or actions. For example, "liquefy" is the verbalized form of the adjective "liquid," meaning to turn into a liquid state.

English vocabulary in geotechnical engineering mechanics extensively employs compound words—nouns combined with adjectives or the -ed form of verbs—to form new technical terms. Examples include "stress-induced" (应力引起的) and "strain-dependent" (应变相关的). Mastering a sufficient number of prefixes and suffixes offers significant advantages for familiarizing oneself with specialized terminology and enhancing the ability to read and translate technical literature.

2.4 Technical Terminology

Technical terminology is extensively used in geotechnical engineering papers, particularly in fields like soil mechanics and rock mechanics. Readers must be proficient in numerous concepts and definitions, as these disciplines demand high professional standardization and precision.

Generally, papers can be categorized based on the main branches of geotechnical engineering mechanics, such as soil mechanics, rock mechanics, and foundation engineering. Within more specialized subfields, researchers may focus on significantly different subjects and content. Nevertheless, many technical terms are widely applicable across the discipline, rooted in the fundamental theories of geotechnical engineering (Pedro et al., 2025). Table 2 lists some frequently encountered technical terms in English geotechnical engineering papers.

The English texts in geotechnical engineering are used in formal engineering documents or descriptions, requiring a strict and cautious expression (Duan & Zhao, 2019). In geotechnical engineering mechanics, mastering the usage of relevant measure words and physical quantities is crucial for ensuring accurate conceptual understanding. Concurrently, attention must be paid to the standardization of terminology and the precision of translations to avoid ambiguity or misinterpretation. Furthermore, cultural differences influencing related concepts should be considered to guarantee accurate comprehension of terminology. During translation, emphasis should be placed on conveying scientific concepts, balancing technical expertise with scientific rigor to ensure the final translation is clear and comprehensible.

Table 2. Commonly Used Technical Terms in Geotechnical Engineering Science Papers (Partial List)

Chinese Definition	Corresponding English Term	Chinese Definition	Corresponding English Term
本构关系	Constitutive relation	屈服压力	Yield pressure
应变曲线	Strain curve	应力/应变不变量	Stress/Strain invariant

Table 2 Continued

弹塑性	Elastic plasticity	应力比	Stress ratio
轴向应变	Axial strain	结构性突变	Structural mutation
关联流动法则	Associated flow rule	初始固结	Initial consolidation
孔隙比	Void ratio	塑性体变	Plastomeric deformation
峰值强度	Peak intensity	离散元	Discrete element
剪应变硬化	Shear strain hardening	体积模量	Bulk modulus
指数型关系	Exponential relationship	抗剪强度	Shear strength
海底滑坡	Submarine landslide	线性弹性	Linear elasticity
结构土	Structural soil	剪缩	Shear shrinkage

3. Analysis of Syntactic Characteristics in English Scientific Papers on Geotechnical Engineering Mechanics

In scientific literature, particularly within the field of mechanics, sentences are typically analyzed at the lexical level, while the entire article functions as the fundamental unit. Extensive scientific literature indicates that tense usage primarily centers on the past tense, present tense, present perfect tense, and present future tense, with the present tense exhibiting the highest frequency. The present tense is predominantly employed to express theorems, formulas, and phenomena—content that transcends temporal constraints, embodying universality and applicability.

When translating from English to Chinese, exact one-to-one correspondence is often unattainable due to significant differences in linguistic structure and sentence patterns. Translators frequently encounter challenges such as shifts in part of speech, variations in word order, discrepancies in grammatical structures, and cultural context influences. In such cases, specific treatment methods or the judicious use of loanwords are often necessary to ensure both accuracy and fluency in the translation.

E.g. 1. Word order transformation
As loading proceeds, p't begins to decrease from the initial value pt'0 with expanding yield surface and decreasing cementation after the Methane Hydrate Bearing Sediment reaches the initial yield surface. (能源土达到初始屈服面后，随着加载的进行，屈服面不断扩大，胶结作用逐渐减弱，p't 开始由初始值 pt'0 不断减小。)

E.g. 2. Rearrange sentence components and add a subject
However, with hydrate decomposition or shear loading, this cementation gradually disappears. Methane Hydrate Bearing Sediments exhibit strain softening with decreasing shear strength, while their cementation intensifies with rising hydrate saturation. Yet softening phenomena become more pronounced after cementation breakdown. (然而，随着水合物的分解或是剪切荷载的作用，这种胶结作用会逐渐消失，//剪切强度降低，表现出应变软化特性，水合物饱和度越大，能源土中的胶结作用也越强，胶结作用破坏后软化现象越明显。)

3.1 Complex Sentences

Mechanical science articles typically feature rigorous language, abundant specialized terminology, and strong logical structure. Logical connectors are extensively used throughout the text, such as: - Indicating cause: since, owing to, for; - Indicating continuation: therefore, thus, in addition to, moreover; - Indicating contrast: but, however, yet, still, otherwise; - Indicating assumption: if, providing, assuming, in case, supposing; restriction: only, besides, unless, except for; concession: though, although, in spite of, even if, etc.

English papers in mechanics frequently employ long sentences, often featuring a main clause with multiple subordinate clauses. These subordinate clauses may further contain embedded clauses and phrases, with phrases and clauses interlinked and mutually dependent, creating complex structures that can appear overwhelming. Sentence

structures must remain complete and rigorous. When writing or translating, it is essential to accurately distinguish different structural elements before integrating them effectively. For example: “By considering the features of architectures and the constraints of DNTs in magnetic tweezers experiments, a typical DNT is reduced as a pre-tension frame structure with two rigid ends, and its pre-tension state is determined by presenting a multi-scale model considering energy contributions both from the deformation of a DNA molecule in the statistical frame of the WLC model and the inter-chain interactions in the mesoscopic frame of the DNA liquid crystal model.” A more intuitive approach is to start with punctuation, dividing the entire sentence into its constituent structures—analyzing subordinate clauses, main clauses, etc. The first clause is an adverbial clause: “通过考虑磁镊实验中 DNT 的结构特点和约束条件” The subsequent main clause is connected by “and” The first main clause translates as: “典型的 DNT 结构可简化为具有两个刚性端的预张力框架结构”. The second main clause is a passive sentence with multiple adverbial structures. By dividing it at prepositions and rearranging, we obtain: “考虑 WLC 模型的统计框架中的 DNA 分子变形和 DNA 的液晶模型的介观框架中的链间相互作用的能量贡献，提出了一个多尺度模型来确定其预张力状态”.

When translating long sentences, first read the entire sentence thoroughly, clarifying its structure in context. Pay particular attention to the coordination and expansion relationships among words, phrases, and clauses. Begin by translating each segment literally, then adjust the word order and add or omit words as appropriate to ensure the original meaning is conveyed accurately in standardized, fluent, and concise Chinese.

3.2 Passive Sentences

Passive voice is extensively used in technical English because it emphasizes specific concepts or phenomena rather than human agents. It also more accurately conveys the author's ideas or perspectives, frequently appearing in descriptions of experimental procedures, test results, and data analysis. Abstracts in scientific journals often begin with phrases like “...is/are studied/discussed...in this paper.” (Zhang, 2024). For example, “A novel foundation reinforcement technique is developed for soil bearing capacity enhancement” directly states the research objective in the opening section: “为了提高土壤承载力，开发了一种新型地基加固技术”.

Employing the passive voice effectively avoids the use of personal pronouns and subjective judgments, thereby making sentences more rigorous and enhancing the professionalism of the article. However, when translating, passive voice must be converted to active voice in Chinese unless retaining the passive form emphasizes a specific action. When converting passive voice to active voice, the implied logical subject should be supplemented based on context—either through explanatory additions or by reverting to passive voice.

3.3 Nominalization

Scientific and technical English papers demand concise writing, objective expression, and accurate content, often stating existing facts. The extensive use of nominalized structures is one of the primary characteristics of scientific and technical English. When converting non-noun vocabulary into nouns, verbs or adjectives are typically replaced with nouns. Common structures include: the + adjective, the + past participle of a verb, the present participle of a verb, or nouns conveying action. For example, “make a decision” is a nominalized verb, while “the unexpected” denotes a category of unforeseen events, “the innovative” refers to novel concepts, and “running” serves as a nominalized verb functioning as a subject. These usages frequently appear in academic literature.

In geotechnical engineering research papers, authors often employ the “of + noun” structure to enhance clarity and emphasis. For instance, “The influence of pore water pressure on soil stability is analyzed” translates to “孔隙水压力对土壤稳定性的影响进行了分析”.

Furthermore, in the introduction sections of geotechnical engineering papers, the active voice is typically employed to describe researchers' findings. Within the main text, passive voice sentences are prevalent, and personal pronouns are minimized. When unavoidable, third-person pronouns like “one” or “the author” are generally used.

4. Conclusion

This paper systematically examines the lexical and syntactic characteristics of scientific papers in geotechnical engineering mechanics, presenting multiple translation examples and summarizing corresponding strategies. Both lexical application and translation require extensive vocabulary accumulation and mastery of prefixes and suffixes.

Regarding sentences, translators should primarily analyze sentence structures, combining literal and interpretive translation. They need not be overly fixated on the precision of every individual word, but rather focus on clearly conveying the research findings and key conclusions the author intends to present. The linguistic characteristics of scientific English and the techniques for translating them into Chinese warrant further research and refinement. It is hoped that this paper will contribute positively to advancing scientific communication.

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