

REVIEW ARTICLE

EXPERT INTELLIGENCE SYSTEM FOR INDONESIAN PRECAST AND PRESTRESSED CONCRETE TECHNOLOGY

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ABSTRACT

Precast and prestressed technology have been the main solution for Indonesia's infrastructure since 1962, with many innovations coming from the Indonesian experts. However, traditional learning methods are often ineffective due to limited access. The Expert System introduced in the same year is a systemic method for compiling and transmitting technical knowledge. Meanwhile, Artificial Intelligence (AI), which has developed since the 1950s, presents interactive learning tools. OpenAI applications like ChatGPT are too generic and not suitable for specific contexts such as Indonesian construction. The Expert Intelligence System is here as an effort to combine Expert Systems and AI, starting from Indonesian precast and prestressed technology. The goal is to develop an Expert Intelligent System based on Indonesian Development Standards and national innovations, with more accurate results in a local context than OpenAI applications. The research began with the preparation of an Expert System database that was validated through scientific publications. This data is integrated into the AI Retrieval-Augmented Generation (RAG) model to generate contextual answers. The model is tested through the learning process and compared to open AI in terms of precision and clarity. The result is an Expert Intelligence System web application for precast and prestressed technology in Indonesia. Evaluations demonstrate excellence in understanding the local context and can be continuously improved through the latest scientific publications. The system is focused on Indonesian data and Standard Nasional Indonesia (SNI) standards, and is prioritized for academics, stakeholders, and policymakers. This limitation actually strengthens the relevance and validity of the answers given.

KEYWORDS

Expert Systems, Artificial Intelligence, Learning Processes, Retrieval Augmented Generation, Prestressed Precast Technology 5

1. INTRODUCTION

Precast and Prestressed Concrete Technology is widely used for infrastructure development in Indonesia (Nurjaman, 2024). Especially lately as seen in figure 1 and figure 2. Indonesian construction stakeholders have made many unique innovations that provide quality, time, and cost efficiency (Nurjaman, 2018). Traditional learning methods are sometimes less effective for complex topics such as precast concrete. Physical books and learning classes are often expensive and difficult to access, especially in remote areas.

The Expert System, which was introduced in the 1960s, is a systematic method to form body of knowledge and pass it on to the next generation. Artificial Intelligence (AI) systems, mathematically modeled since the 1950s, are intelligent interactive learning tools. AI has undergone tremendous development with the invention of computers, digitalization and the internet. AI devices are accessible globally, anytime and anywhere,

making them more inclusive, accessible and constantly updated. OpenAI platforms such as ChatGPT, Poe and Jenni AI have been publicly accessible since November 2022, followed by CoPilot, Meta, Gemini and DeepSeek. The platform is just too general, so it's not suitable for specific contexts like Indonesian construction.

The Expert Intelligence System is an effort to combine the Expert System and the Artificial Intelligence System, which started from Indonesian precast and prestressed technology. In previous research (2008–2019), SNI has been prepared which discusses prestressed precast concrete, namely SNI 2847:2019 (Badan Standardisasi Nasional, 2019). Structural Concrete Requirements for Buildings. ChatGPT can be used as a reference for creating a prototype of the OpenAI platform with a context database based on SNI. The Expert Intelligence System will make the knowledge of precast and prestressed technology can be disseminate more widely and evenly, helping to improve the skills and competencies of engineers and construction workers in various stakeholders, policy makers in Indonesia.

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(a) Sarinah Building (1962)



(b) House of Representatives (1965)



(c) Cengkareng Public Housing (1995)



(d) IKN (2023-2024)

Figure 1: Building (Nurjaman, 2024)



(a) Semanggi Bridge (1962)



(b) Rajamandala Bridge (1979)



(c) High-speed trains (2014-2023)



(d) Sei Alala First Curve Cable Stayed Bridge (2021)

Figure 2: Infrastructure (Nurjaman, 2024)

2. LITERATURE REVIEW

This study explain that classical expert systems are often static and require manual updates (Russell et al., 2022). In contrast, modern systems tend to be adaptive and data-driven. This is especially relevant in the context of civil engineering and construction, which requires adjustments to environmental conditions, local materials, and technical adaptive policies (Russell, 2022). Russell and Norvig define Artificial Intelligence (AI) as the

study of intelligent agents that can sense their environment and take actions that maximize the chances of success in a particular task.

One of the classic approaches in AI is the development of an expert system, which is built to mimic the way an expert think and makes decisions in a particular field. According to them, expert systems work on knowledge bases and inference engines to draw conclusions. Although this method was initially symbolic and rules-based, technological advances have

allowed integration with statistical and machine learning approaches, resulting in so-called expert intelligence systems—intelligent systems that not only “think like experts” but also learn from experience and data.

According to this study, introduced the Retrieval-Augmented Generation (RAG) approach that combines retrieval-based models with generative language models to handle Natural Language Processing (NLP) tasks that require extensive knowledge (Lewis et al., 2020). In a RAG system, the model not only relies on internal knowledge, but is also able to dynamically access and retrieve external information from a large knowledge base, then integrate it into the resulting results or recommendations. Large language learning models have been shown to store factual body of knowledge within their parameters, and achieve sophistication when aligned in NLP task force flows. However, the model's ability to access and manipulate knowledge appropriately is still limited, so in use-times that require intensive knowledge, the model's performance lags behind specific architectures. In addition, providing resources for model decision-making and updating model knowledge is still open research. Learning models with variable access mechanisms to explicit nonparametric memory can address this problem, but so far, they have only been studied for extractive task force flows. This paper aims to explore a versatile alignment recipe for Retrieval Augmented Generation (RAG) models—which combine pre-trained parametric and non-parametric learning memory for language formation (Lewis et al., 2020). This study, introduce a RAG model where the parametric memory is a pre-trained seq2seq model and the non-parametric memory is the Wikipedia dense vector index, accessed with a pre-trained nerve retriever (Lewis et al., 2020). Lewis et al. compared two RAG formulations, one that conditions on the same parts taken across the entire sequence generated, and another that can use different parts per token. Lewis et al. refined and evaluated their model on a wide range of NLP tasks that required a lot of knowledge and established the most advanced ways on three open-domain QA clusters, outperforming the parametric seq2seq model and custom cluster capture and extraction architecture. For the language formation task, Lewis et al. found that the RAG model produces a more specific, diverse, and factual language than the seq2seq model based on the latest parametrics.

This concept is relevant in the development of expert intelligence systems in the field of civil engineering, especially precast and prestressed technology, because intelligent systems need to mimic how human experts work: looking for references, comparing cases, and concluding solutions based on available data and past experience. In the Indonesian context, where construction and design practice data are often scattered across a variety of technical documents, national standards, and field experience:

- i. Provide design recommendations and construction methods based on retrieval from SNI documents, project reports, and engineering publications.
- ii. Produce narrative outputs or technical recommendations with appropriate and accurate context.
- iii. Customize solutions based on local conditions without having to retrain the entire system.

3. RESEARCH METHOD

The program began with the preparation of a database in the form of precast and prestressed technology book based on SNI. The next step is the selection of OpenAI software which is then given the context of a book database in the form of RAG AI. This software is then tested through a learning process based on the RAG AI database. The final stage is the formation of an interactive menu for users.

The database is collected in 4 book titles, each of which consists of several chapters. Volume I title is Prestressed Precast Basic which consist of Introduction (Chapter 1), Basic Concept (Chapter 2). Design of Flexure Components (chapter 4), Loss of Prestressed Force (chapter 5), Shear design (chapter 6), Column Design (chapter 7), Composite Cross-Section Design (chapter 8), Design of Static Indeterminate Structures. Volume II title is Building Design which consist of Introduction (chapter 1), Pile design (chapter 2), Lateral Retaining Design of Geotechnical Structures (chapter 3), Slab Design (chapter 4), Frame Design (chapter 5), Wall Design (chapter 6), Earthquake Resistance Design (chapter 7), Tank Design (chapter 8), Shell Design (chapter 9). Volume III title is Infrastructure Building Design which consist of Introduction (chapter 1), Simple Girder Design (chapter 2), Continuous Girder Design (chapter 3), Pillar Design (chapter 4), Segmental Girder Design (chapter 5), Suspension Bridge Design (chapter 6), Cable Stayed Bridge Design (chapter 7), Extradosed Bridge Design (chapter 8), Arch Bridge Design (chapter 9), Concrete Pipe Design (chapter 10), Tunnel design (chapter 11). Volume IV title is Construction Methods which consist of Introduction (chapter 1), Prestressed Force Transfer Methods and Equipment (chapter 2), Stress Control Concept (chapter 3), Prestressed Reinforcement Corrosion Protection Design (chapter 4), Scaffolding Method Design (chapter 5), Crane Method Design (chapter 6), Designing Lifter Methods and Equipment (chapter 7), Design of Method and Equipment of Launcher Girder (chapter 8), Designing the Incremental launching Method (chapter 9), Designing the Form Traveller Method (chapter 10), Design of Method and Equipment for Long Span Bridge Construction (chapter 11). Summary of the e-book can be seen di table 1.

Table 1: Summary of Database from Four Book Titles

NO	BOOK TITLE
BOOK VOLUME I	PRESTRESSED PRECAST BASIC
CHAPTER 1	INTRODUCTION
CHAPTER 2	BASIC CONCEPTS
CHAPTER 3	DESIGN OF FLEXURE COMPONENTS
CHAPTER 4	LOSS OF PRESTRESSED FORCE
CHAPTER 5	SHEAR DESIGN
CHAPTER 6	COLUMN DESIGN
CHAPTER 7	COMPOSITE CROSS-SECTION DESIGN
CHAPTER 8	DESIGN OF STATIC INDETERMINATE STRUCTURES
BOOK VOLUME II	BUILDING DESIGN
CHAPTER 1	INTRODUCTION
CHAPTER 2	PILE DESIGN
CHAPTER 3	LATERAL RETAINING DESIGN OF GEOTECHNICAL STRUCTURES
CHAPTER 4	SLAB DESIGN
CHAPTER 5	FRAME DESIGN
CHAPTER 6	WALL DESIGN
CHAPTER 7	EARTHQUAKE RESISTANCE DESIGN
CHAPTER 8	TANK DESIGN
CHAPTER 9	SHELL DESIGN
BOOK VOLUME III	INFRASTRUCTURE BUILDING DESIGN
CHAPTER 1	INTRODUCTION

Table 1 (Cont.): Summary of Database from Four Book Titles	
CHAPTER 2	SIMPLE GIRDER DESIGN
CHAPTER 3	CONTINUOUS GIRDER DESIGN
CHAPTER 4	PILLAR DESIGN
CHAPTER 5	SEGMENTAL GIRDER DESIGN
CHAPTER 6	SUSPENSION BRIDGE DESIGN
CHAPTER 7	CABLE STAYED BRIDGE DESIGN
CHAPTER 8	EXTRADOSED BRIDGE DESIGN
CHAPTER 9	ARCH BRIDGE DESIGN
CHAPTER 10	CONCRETE PIPE DESIGN
CHAPTER 11	TUNNEL DESIGN
BOOK VOLUME IV	CONSTRUCTION METHODS
CHAPTER 1	INTRODUCTION
CHAPTER 2	PRESTRESSED FORCE TRANSFER METHODS AND EQUIPMENT
CHAPTER 3	STRESS CONTROL CONCEPT
CHAPTER 4	PRESTRESSED REINFORCEMENT CORROSION PROTECTION DESIGN
CHAPTER 5	SCAFFOLDING METHOD DESIGN
CHAPTER 6	CRANE METHOD DESIGN
CHAPTER 7	DESIGNING LIFTER METHODS AND EQUIPMENT
CHAPTER 8	DESIGN OF METHOD AND EQUIPMENT OF LAUNCHER GIRDER
CHAPTER 9	DESIGNING THE INCREMENTAL LAUNCHING METHOD
CHAPTER 10	DESIGNING THE FORM TRAVELLER METHOD
CHAPTER 11	DESIGN OF METHOD AND EQUIPMENT FOR LONG SPAN BRIDGE CONSTRUCTION

The books will be a source of data for building web-based applications with Artificial Intelligence, thus forming an Expert Intelligence System. The book data will be stored in a database that the RAG system can retrieve. The application will be trained and tested by the user until the answer from the system is appropriate according to the context of the database. A summary of the research method can be seen in the figure 3.

The Retrieval-Augmented Generation (RAG) system begins by preparing book data to answer user queries. The source material—typically in PDF format—is first loaded using PyPDF, although various libraries are available for reading PDF files. The system is designed to be flexible and can accommodate other data formats beyond PDF. Eventually, all of the book data will be stored in a database, from which the system will retrieve relevant information during query handling.

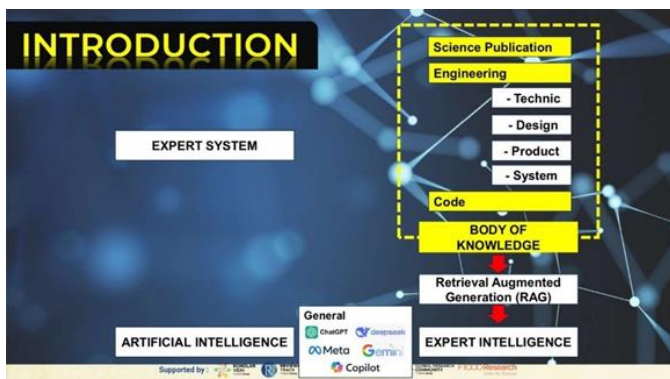


Figure 3: Research Method Scheme

The loaded book data is then segmented into smaller chunks to enable efficient processing, with the optimal chunk size determined empirically. Each chunk is subsequently embedded into a numerical vector representation and stored in memory, allowing the AI model to process the information effectively.

Upon receiving a query, the system retrieves the most relevant chunks rather than processing the entire book, thereby improving accuracy and reducing the LLM (Large Language Model) input size. Currently, the system retrieves the top $k = 4$ most relevant chunks, balancing the need for sufficient context while minimizing the input LLM tokens. While various retrieval algorithms exist, this work employs a word similarity scoring method, which can be adapted to improve performance if

necessary. Essentially, the chunks that contain the most words that appear in the query will be used.

The retrieved chunks are incorporated into a fixed prompt template alongside the user query, providing the necessary context for the LLM to generate precise and focused answers. The fixed prompt instructs the LLM to generate answers based solely on the provided chunk content and, importantly, to refrain from answering queries that are unrelated to the content. This approach aims to reduce the likelihood of incorrect or hallucinated responses.

Use the following pieces of context to answer the question at the end.

If you don't know the answer, just say that you don't know, don't try to make up an answer.

Keep the answer as concise as possible.

{context}

Question: {question}

Helpful Answer:

Fixed Prompt used: Context consists of the retrieved chunk content, and the question corresponds to the user query

The dynamic prompt is submitted to the LLM for inference, where the model processes the constructed query and generates a response. A standardized pipeline governs the entire process from query construction to model invocation. In this paper, OpenAI's GPT-4o-mini is utilized for its strong performance and popularity; however, the architecture allows for easy substitution with alternative LLMs. This paper also does not focus on determining the optimal LLM for this task, but further research can be conducted in that area.

The RAG system presented in this paper is built end-to-end using LangChain, a framework designed for developing applications powered by Large Language Models (LLMs) [18]. LangChain provides a comprehensive set of tools, including text splitters, vector embedders, data retrievers,

pipelines, and wrappers for various LLM models, enabling developers to efficiently construct complex AI workflows. It is particularly well-suited for RAG-based systems because it abstracts many of the low-level operations and offers seamless integration with databases and vector stores. The complete flowchart of the RAG program can be seen in figure 4.

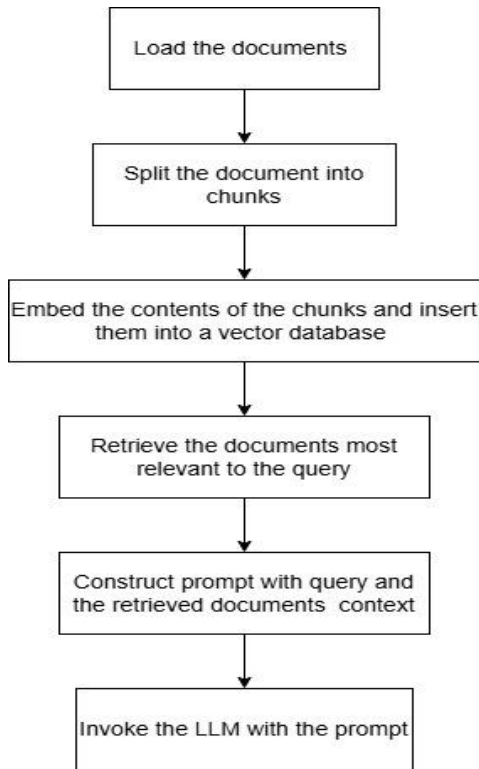


Figure 4: Expert Intelligence Flowchart Apps

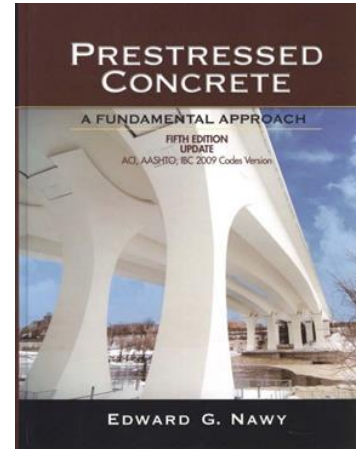
This Expert Intelligence model is developed using the Python programming language. Python offers a high-performance foundation for web development, cloud computing, data analytics, and machine learning. It is particularly well-suited for AI application development due to its extensive ecosystem of libraries, simple syntax, and strong community support. Python's readability and flexibility make it one of the easiest languages for building AI applications.

4. FINDINGS AND DISCUSSION

The Expert Intelligence System as a combination of Expert System and Artificial Intelligence for precast and prestressed technology developed in Indonesia already construed. Scientifically verified body of knowledge compiled from the first development in 1962 to the present and the Indonesian National Standard SNI 2847:2019 can be made in the form of a RAG which is a context of the The Expert Intelligence System Platform, so that it can be applied in Indonesian construction environment.

Body of knowledge consists of:

- i. Science publication consists of Textbooks, articles in Conference Proceedings and articles in scientific journals. The examples are:
 - Text Book: Prestressed Concrete, A Fundamental Approach, by Edward G. Nawy (2009) (Nawy, 2009)
 - Article in Conference Proceedings: Use of Vertical Unbonded Post Tensioned on Precast Concrete Wall to Counteract Vertical Earthquake in 17th World Conference of Earthquake Engineering, 17 WCEE, Sendai, Japan – September 13th to 18th 2020, by Hari Nugraha Nurjaman (Nurjaman, 2020)
 - Article in Scientific Journal: Development of Numerical Model of a High Performance Precast Concrete System Equipped with Base Isolation, Evergreen Joint Journal of Novel Carbon Resirced Sciences & Green Asia Strategy, Vol. 09, Issue 02, pp547-555, June 2022 by Hari Nugraha Nurjaman (Nurjaman et al., 2022)



(a) Text Book



(b) Article in Conference Proceeding



(c) Article in Scientific Journal

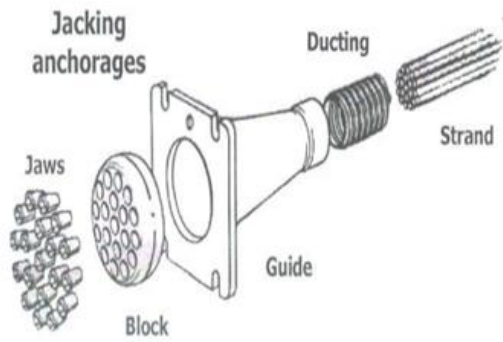
Figure 5: Science Publication

(a) Engineering: consist of technic, design, product, and system. The examples are:

- **Technique:** There are 2 techniques for providing prestressing force: Pre-tension technique dan post-tension technique (Nurjaman, 2024). In the pre-tensioning technique, the cable is tensioned first before the concrete is cast. This technique is generally used for piles, girders, rail sleepers, floor slabs, and is often manufactured in factories. In the post-tensioning technique, the concrete is cast first before the cable is tensioned. This system requires more special components and equipment, which are sometimes foreign patents.



(a) Pre-tension Technique



(b) Post-tension Technique

Figure 6: Prestressing Technique

- **Design:** Modular design of a prototype multistory low-cost housing type Jentera 24 Ministry of Public Housing and Settlements with a Modular System (Nurjaman, 2025)

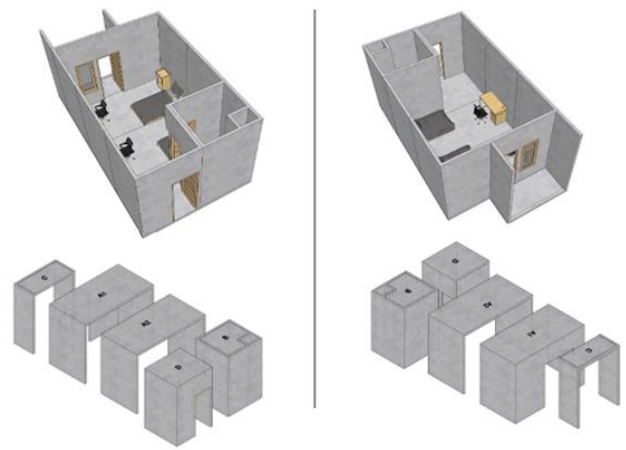
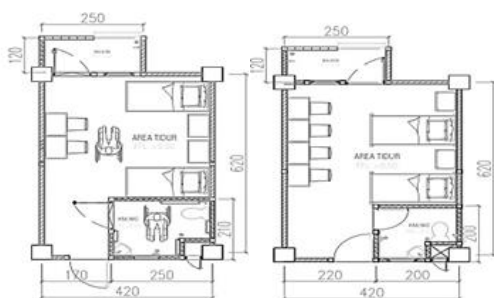


Figure 6: Modular Design of Low-Cost Housing Prototype

- **Product:** Indonesian precast and prestressed industry product can be seen in the Precast and Prestressed Concrete Industry Product Catalog published by the Ministry of Public Works and Housing (Rakyat KPUDP., 2014). Some examples: piles, sheet pile, girder, pavement, building, tunnel lining, and pipe can be seen in figure 7.

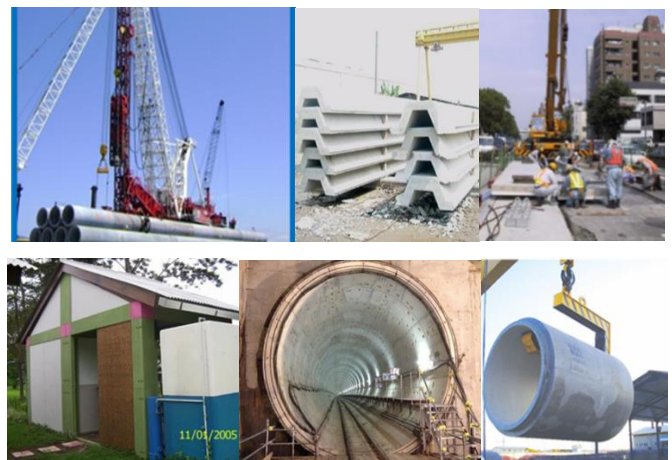


Figure 7: Precast Product

- **System:** The system is a combination of several components to form an integrated system. For example, precast system for a building consisting of beam, column, and plate components combined with an earthquake-resistant connection system (Badan Standardisasi Nasional., 2021; Badan Standardisasi Nasional., 2023). High-performance earthquake-resistant precast systems use an unbonded posttension connection system (Badan Standardisasi Nasional., 2017). Modular systems combine components into a complete unit, then install them unit by unit.



(a) Precast earthquake-resistant system



(b) Precast high-performance earthquake-resistant system



(c) Modular system

Figure 8: Precast System

(b) **Code:** Building codes in Indonesia are mostly adopted from the United States. The first precast code was SNI 7833:2012 Tata Cara Perancangan Beton Pracetak dan Beton Prategang untuk Bangunan Gedung which was adopted from ACI 318-08 Building Code Requirements for Structural Concrete (ACI 318-08) and Commentary, in the precast and prestressing sections. This code was then updated in 2019 Persyaratan Beton Struktural untuk Bangunan Gedung dan Penjelasan SNI 2847:2019, as an integral part of the complete concrete code. The code was adopted from ACI 318-14 Building Code Requirement for Structural Concrete and Commentary (Nurjaman, 2024). In 2025, ACI/PCI issued a special code for precast, (American Concrete Institute et al., 2025) which will soon be adopted as the Indonesian precast code



Figure 9: Indonesian Precast/Prestressed Building Code

Several program trials were conducted with the following questions:

- Tolong jelaskan apa itu beton prategang? (Please explain what prestressed concrete is?) in figure 10.
- Jelaskan keunggulan-keunggulan beton prategang (Explain the advantages of prestressed concrete) in figure 11.



Beton prategang (Prestressed concrete)

— Beton bertulang dimana tegangan dalam diberikan untuk mereduksi tegangan tarik potensial dalam beton yang dihasilkan dari beban, dan untuk pelat dua arah menggunakan dengan sekurang-kurangnya tulangan minimum prategang.

Figure 10: Tolong jelaskan apa itu beton prategang (Please explain what prestressed concrete is)

Answer: Beton prategang (Prestressed concrete) didefinisikan sebagai beton bertulang di mana tegangan dalam diberikan untuk mereduksi tegangan tarik potensial dalam beton yang dihasilkan dari beban

In English: Reinforced concrete in which internal stresses have been introduced by prestressed reinforcement to reduce potential tensile stresses in concrete resulting from loads.

This answer is exactly the same as the definition of prestressed concrete in SNI 2847:2019, showing that the system is able to retrieve the exact definition for the relevant question (Badan Standardisasi Nasional, 2019). It is worth noting that the LLM is able to understand the Indonesian language prompt.

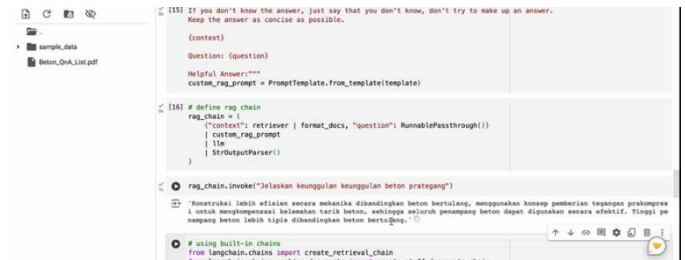


Figure 11: Jelaskan keunggulan beton prategang (Explain the advantages of prestressed concrete)

Answer: Konstruksi lebih efisien secara mekanika dibandingkan beton bertulang, menggunakan konsep pemberian tegangan prakompresi untuk mengkompensasi kelemahan tarik beton, sehingga seluruh penampang beton dapat digunakan secara efektif. Tinggi penampang beton lebih tipis dibandingkan beton bertulang.

In English: The construction is more mechanically efficient than reinforced concrete, using the concept of precompression stress to compensate for the tensile weakness of concrete, so that the entire concrete cross-section can be used effectively. The height of the concrete cross-section is thinner than reinforced concrete.

The Expert Intelligence System Comparison with Public OpenAI

The performance of this The Expert Intelligence System platform can be seen in the answers to 3 questions regarding Chapter 1 of the Book Volume I, when compared to the answers of the OpenAI ChatGPT 4.0 platform.

- Jelaskan apa itu beton pracetak (Explain what precast concrete is?) In figure 12
- Tolong ceritakan sejarah beton prategang di Indonesia (Explain the history of prestressed concrete in Indonesia) in figure 13.
- Jelaskan konsep dari stress control (Explain stress control concept) in figure 14.



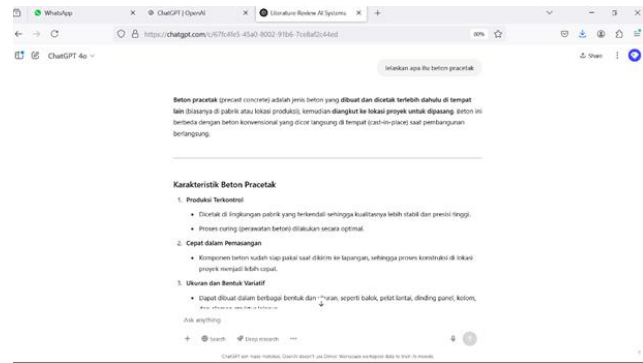
Beton pracetak (Precast concrete) — Elemen beton struktur yang dicetak di tempat lain dari posisi akhirnya dalam struktur.

(a) Expert Intelligence

Answer: Beton pracetak didefinisikan sebagai elemen beton struktur yang dicetak di tempat lain dari posisi akhirnya dalam struktur.

In English: Structural concrete element cast elsewhere that its final position in the structure.

This answer matches exactly the definition of prestressed concrete in SNI 2847:2019, even when the question is slightly modified (Badan Standardisasi Nasional, 2019). The LLM successfully captures and understands the core intent of the query, and intelligently refers to the context we've provided to base its answers from. It also shows that the chunks that are fed into as context are the correct relevant chunks.

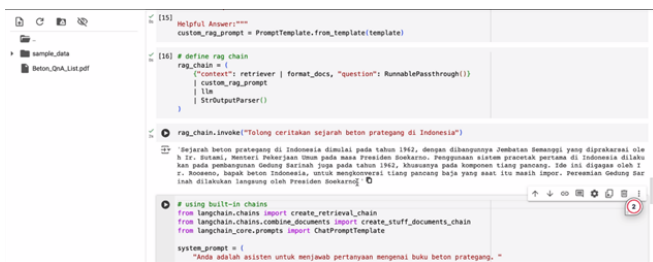


(b) ChatGPT 4.0

Figure 12: Question: Jelaskan apa itu beton pracetak (Explain what precast concrete is)?

In English: Precast system is a construction method where the structural elements of a building, such as beams, columns, floor slabs, walls, and other components, are first manufactured off-site (usually in a factory or special production facility) under controlled conditions, then transported to the construction site to be assembled and erected.

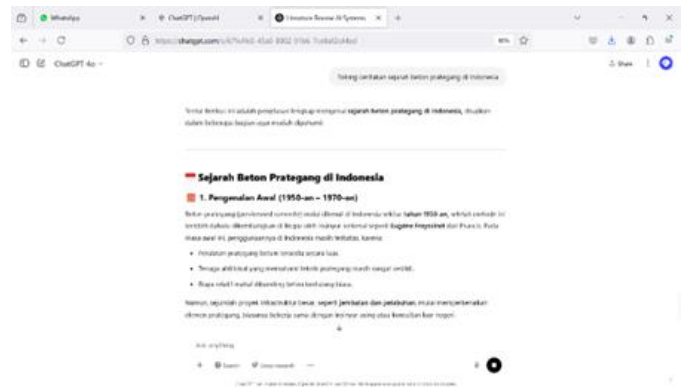
The answer to ChatGPT 4.0's question regarding the Definition of a Precast System is not in accordance with SNI 2847:2019. This is because the model doesn't have the context of the Indonesian National Standard. Most likely, it is not trained with the book data. The LLM will try to answer the question using a more general definition of a precast system. Since these LLM's are trained on a big variety of data, it's accuracy on questions specific to a field is limited.



(a) Expert Intelligence

Answer: Sejarah beton prategang di Indonesia dimulai pada tahun 1962, dengan dibangunnya Jembatan Semanggi yang diprakarsai oleh Ir. Sutami, Menteri Pekerjaan Umum pada masa Presiden Soekarno. Penggunaan sistem pracetak pertama di Indonesia dilakukan pada pembangunan Gedung Sarinah juga pada tahun 1962, khususnya pada komponen tiang panjang. Ide ini digagas oleh Ir. Rooseno, bapak beton Indonesia, untuk mengkonversi tiang pancang baja yang saat itu masih impor. Peresmian Gedung Sarinah dilakukan langsung oleh Presiden Soekarno.

In English: The history of prestressed concrete in Indonesia began in 1962, with the construction of the Semanggi Bridge initiated by H. Ir. Sutami, the Minister of Public Works during the time of President Soekarno. The use of the first poracetak system in Indonesia was carried out in the construction of the Sarinah Building also in 1962, especially on the pile components. This idea was initiated by Ir. Rooseno, the father of Indonesian concrete, to convert steel piles that were still imported at that time. The inauguration of the Sarinah Building was carried out directly by President Soekarno.



(b) ChatGPT 4.0

Figure 13: Question: Tolong ceritakan sejarah beton prategang di Indonesia (Explain the history of prestressed concrete in Indonesia)

In English: Prestressed concrete began to be known in Indonesia around the 1950s, after this method was first developed in Europe by famous engineers such as Eugène Freyssinet from France. In this early period, its use in Indonesia was still limited, because: Prestressed equipment was not widely available. There are still very few local experts who understand pretension techniques. The cost is relatively expensive compared to ordinary reinforced concrete. However, a number of major infrastructure projects, such as bridges and ports, began to introduce pre-existing elements, usually in collaboration with foreign engineers or foreign consultants.

The answer to the ChatGPT 4.0 question is not accurate and also does not point to the significant main event milestones

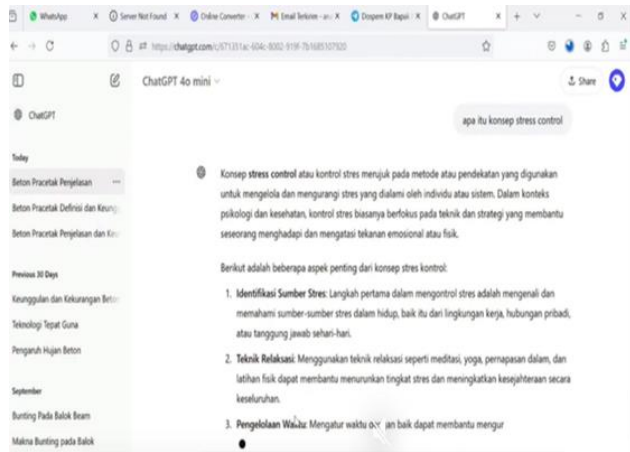


(a) Expert Intelligence

Answer: Konsep stress control pada beton prategang mengacu pada cara mengontrol tegangan yang ada dalam beton selama proses prategang. Teknik ini menggunakan kabel bertegangan tinggi yang ditarik sebelum beton dituangkan, sehingga menciptakan tegangan prakompresi yang optimal untuk menahan beban lentur. Penampang beton umumnya tetap utuh (tidak retak) pada beban layan. Metodi ini memerlukan perhatian khusus terhadap pengaruh jangka Panjang beton dan baja, serta control tegangan, dan biasanya lebih kompleks serta lebih mahal dibandingkan dengan struktur beton bertulang.

In English: The concept of stress control in prestressed concrete refers to how to control the tension present in the concrete during the prestressing

process. This technique uses high tensile tendon that are drawn before the concrete is poured, thus creating an optimal pre-compressed stress to withstand bending loads. The cross-section of concrete generally remains intact (not cracked) under load. This method requires special attention to the long-term effects of concrete and steel, in stress control procedure, and is usually more complex and more expensive than reinforced concrete structures.



(b) ChatGPT 4.0

Figure 14: Jelaskan konsep dari stress control (Explain stress control concept)

In English: The concept of stress control refers to methods or approaches used to manage and reduce stress experienced by individuals or systems. In the context of psychology and health, stress control usually focuses on techniques and strategies that help a person cope with and overcome physical emotional stress.

ChatGPT 4.0's answer is even out of the context of Civil Engineering science

5. CONCLUSION

The Expert Intelligence System has been proven to be developed by combining scientifically tested body of knowledge compiled with the concept of Expert System with Artificial Intelligence System. The combination is carried out by creating a body of knowledge context in the form of Retrieval-Augmented Generation (RAG) embedded in the AI Platform. The body of knowledge compiled is a collection of precast and prestressed technology knowledge developed in Indonesia since 1962 which is compiled in 4 book titles and the Indonesian National Standard SNI 2847:2019. The platform has been tested in the preliminary stage by comparing the answers with the general OpenAI model, which shows consistency with the context created in some of the chapters in the title of the first book. The platform is currently being developed with the creation of RAGs for all book titles.

The RAG system shows that it is able to retrieve relevant parts of the SNI book to accurately answer specific questions about precast and prestressed technology. It succeeds where the general LLM fail because it has the necessary specialized context. No model retraining is needed to put the context in the AI, which saves significant time and cost. This concept will make a significant contribution to improving the conditions of education and practice in the field of civil engineering, especially in precast and prestressed technology applications. This concept will also be applicable to other fields of science, as all that needs to be done is to change the data source of the system to the relevant field. The current available LLM's are already smart enough to link the question with the context in Indonesian language, making this solution viable in the Indonesian context.

LIMITATION & FURTHER RESEARCH

The platform is designed to adopt data updates whenever there is new data. This activity requires excellent infrastructure, by combining good software, cloud services and security so that application development with expert intelligent system can be carried out efficiently. The development of this platform is expected to receive support from the Kedaireka matching fund program from the Ministry of Higher Education, Science

and Technology. This platform can also obtain commercial value in the form of rental fees charged from consumers who use this platform.

As mentioned in the research methodology section, there are several areas that can be further researched to improve the quality of the answers, such as the algorithm for choosing the most relevant chunks and the selection of the LLM model. A comparison of different algorithms and models could be done to assess which combinations produce a combination of results.

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