

BOND STRESS IN PRECAST CONCRETE  
SPIRAL CONNECTORS

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## **ABSTRACT**

Connections are defined as the system used to tie a precast member to the supporting structure or adjacent so they can be described as the most important part in a precast structure. The bond between the infill material and the steel bar is the key factor that governs the capacity and the performance of the connection. This study was intended to evaluate the parameters that affect the bond-slip relations in the connection. The variables in this study were the pitch distance of the spiral and reinforcement bar diameter. Altogether, 21 specimens were prepared that 3 of them were the control specimens. These splices utilized a spiral surrounding the main bars and 4 Y 10 steel bars which were welded to the inner surface of the spiral. All these grout filled splices were tested under incremental loading. The experiments examined the bond stress as well as the failure mode of the splices. The results indicate that using the spiral without the vertical bars cannot increase the bond capacity of the splices significantly. The results also show that reducing the bar diameter and the pitch distance of the spiral lead to a higher ultimate bond strength. Thus, the highest bond stress was observed in the specimen with the lowest pitch distance and smaller bar diameter.

## **ABSTRAK**

Penyambungan didefinisikan sebagai sistem yang digunakan untuk mengikat komponen struktur penyangkang atau berdekatan supaya mereka boleh digambarkan sebagai bahagian yang paling penting dalam struktur pra-tuang. Pengikat antara bahan pengisi dan bar keluli adalah faktor kekunci yang menyumbangkan kapasiti penyambung. Kajian ini bertujuan untuk menilai parameter yang mempengaruhi hubungan pengikat-gelincir dalam penyambungan. Kepelbagaian dalam kajian ini adalah jarak sudut gegelung dan diameter keluli bar bertetulang. Sebanyak, 21 spesimen disediakan di mana 3 daripadanya spesimen kawalan. Penyambatan ini memanfaatkan keliling gegelung bar utama dan bar keluli 4Y10 yang dikimpalkan pada permukaan dalam gegelung. Kajian tersebut mengenalpasti tegasan pengikat serta mod kegagalan penyambat. Keputusan tersebut menyatakan bahawa penggunaan gegelung tanpa bar menegak tidak meningkatkan kapasiti pengikat penyambat secara signifikan. Ia juga menunjukkan bahawa pengurangan garispusat bar dan jarak antara gegelung memberikan kekuatan muktamad yang lebih tinggi. Walau demikian, tegasan pengikat paling tinggi diperhatikan dalam eksperimen dengan jarak antara gelung paling kecil dan bar diameter yang lebih kecil.

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Introduction**

The clearest definition for precast concrete is the concrete which has been cast and cured in a location which is not its final destination. This destination can be only a few meters or kilometers.

The very existence of precast concrete and using this technique itself proves that it is practical and economical. The market share of precast structures from place to place depends on some factors like climate, material, labor and transportation cost.

The main difference between precast concrete and cast in-situ concrete is the way that reflects to the internal and external effects. A precast concrete element has a finite size, so in order to make a complete structure it has to be joined to other elements. If these elements are connected together suitably, they will be able to resist any kind of gravity or lateral load.

Using any kind of precast structure (plain or mixed) will always offer a solution which is buildable, cost effective and fast to erect. Connections are defined as the system to tie a precast member to its support or the adjacent members. Precast structures are consisted of elements namely beams and columns etc, which for making a complete precast structure they need to be connected together in a way that the overall stability and robustness of the structure is satisfied. Connections can be called the most important part of each structure since they introduce the way a definite structure distributes the applied loads (including internal and external loads) and transfers them to the foundation.

In order to satisfy both serviceability and ultimate limit states, the manufacture of the elements and the technique of the construction must be considered in practical and economical connection design. Connections must be able to tolerate the applied forces during their life time. It is not needed to build a connection which is resistant to all types of forces, maybe that connection will never be subjected to those kinds of loads and it is undesirable.

Maximum economy of precast concrete construction is achieved when connection details are kept as simple as possible, having efficient performance and ease of erection at the same time. In addition complex connections have seen to be hard to perform, slowing the erection process and less satisfactory.

## **1.2 Statement of Problem**

Grout filled splices have been used for the past two decades in North America, Europe, And Japan to connect precast concrete members. Many types of pipes including steel, FRP and PVC pipes have been used but still there is inadequate

information on the effect of different parameters which exist in these kinds of connections. It's very important for the producers to make splices which are able to give higher bond strength between the steel rebar and the infill material. Many experiments have been done before in order to reach to higher bond strength, but still there are many unknowns to the experts. Development of precast structure exposes using new methods in performing the connections leading into newer unknowns and newer parameters that can be investigated.

The industrial grout filled splices that are being built are proprietary and expensive since they are made outside Malaysia and this can be an economical problem to the clients. Therefore, investigating the factors that affect the performance and increase the bond strength in the splice seems essential. This study intends to investigate the effect of pitch distance of the spiral, compressive strength of the grout and the bar diameter on the bond stress-slip relation so that these information can be used in the design of new types of grout filled splices in the future.

### **1.3 Objectives of Study**

The objectives of the study are as follow:

1. To identify the effect of pitch distance on the bond stress-strain relation.
2. To investigate the effect of bar diameter on the bond stress-strain relation.
3. To obtain parameters that are being increased or decreased simultaneously, that will lead to the optimized performance of the connection.

## **1.4 Scope of Study**

The scope of this study was focused on the behavior of the 21 grout filled splices. These splices were consisted of a spiral with 4 Y10 additional lap bar inside the spiral. The spiral and the additional surrounded the main bar which was located at the middle and the whole parts were located at the center of a PVC pipe which was used as the mold. Therefore, a total number of 21 pull out tests was done to understand the effect different parameters that could affect the bond stress-slip relation in these specimens.

## **1.5 Significance of Study**

The importance of connections in precast structures as a link for connecting the members is obvious and known. Therefore, improving the performance of the connections will lead to the better performance of the precast structures. This study intends to understand the effect of different parameters on the bond stress-slip relations in connections which can lead to understanding ways for optimizing these kinds of connections.

Building optimized connections can be a good step to developing industrial building systems (IBS) as an alternative to the cast in-situ method which is not effective these days because of rapid increasing of population and the demand for new construction. The application of grout filled splices can accelerate the speed of erection, copes with the problem of rebar congestion at the splices and guarantees higher quality assurance.