

Pre-stressed/ Post-tensioned Concept In Asian Ball-jointed Dolls

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Introduction

Asian Ball-jointed Dolls are resin made dolls in parts assembled by loops of elastic strings. The dolls could be put into different poses and could stand rigidly by only relying on the internal tension of the elastic strings inside the resin parts. The assembling of these dolls also demonstrates a similar concept used in pre-stressed concrete.

Concept

These dolls are actually in many small separate parts. To assemble a doll, two or three elastic strings are often used, and in this case as shown in figure 1 required three elastic strings.

One elastic string in the doll hooks at the two wrists to form the arms, and the other two are hooked at the neck part to each foot through the torsos and legs. Figure 2 shows the hooks at different parts to hold the elastic strings in place.

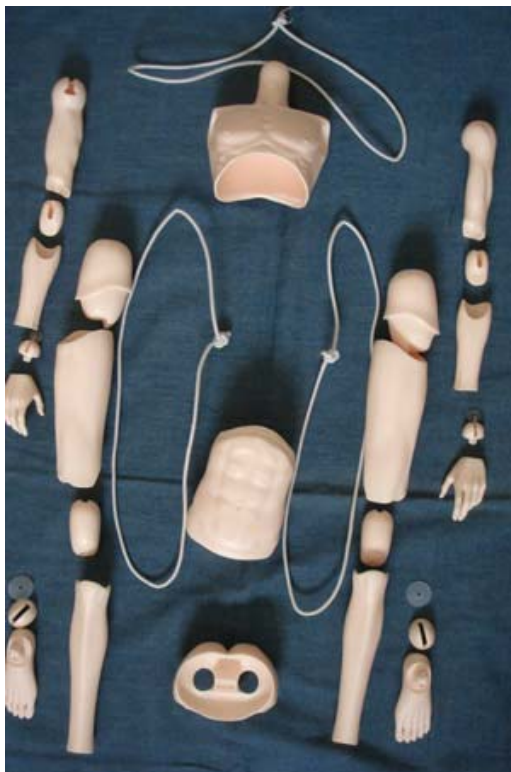


Figure 1: Disassembled parts of doll



Figure 2:
Hooks parts at
hand, feet and
neck parts



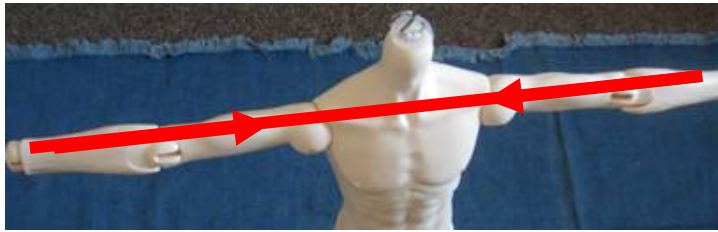


Figure 3: Elastic strings pre-stressing resin parts

As the elastic strings pull within the body parts of the doll, for example as shown in figure 3, forces in the tensioned elastic string pulls the arm parts together and compressed the loose parts to hold in place. The compressive forces could keep the arms in horizontal position and overcomes the self-weight of the resin despite only an elastic string exists in the hollow parts.

Since resin used for these dolls is a brittle material, stress cracks could appear due to unevenly distributed stress, the ball joint at the wrist are therefore designed to transfer the stresses evenly through the hollowed arm parts and onto the main torso of the doll. The same concept applies also to both legs, where an elastic string is placed in each leg through the main torso to the neck hook.

However, as the elastic string itself could be easily bent into all directions, this also allows the joints of the doll to be bent into all sorts of flexible poses. Figure 4 shows the layout of the three elastic strings, where the blue lines represent the two strings compressing the leg parts and the red represent the string compressing the arm parts.



Figure 4: Elastic strings in doll

Application to Pre-stressed/ Post-tensioned Concrete

Pre-stressed or post-tensioned concrete is using the similar concept as the doll, where the elastic strings of the dolls are steel bars or tendons instead. The hooks of the doll at the wrists, foot and neck are similar to anchorages or jacking tools which holds the steel bars or tendons in place in the concrete. Force in the tendon or steel compresses the concrete before it is actually used to withstand any loadings, just as the elastic strings compressing body parts of the doll.

However, as concrete and steel are much difficult to be bent comparing to the brittle resin parts and elastic strings. Post-tensioned or pre-stressed concrete obviously would be more difficult to deform under perpendicular loading to the pre-stressed or post-tensioned direction.

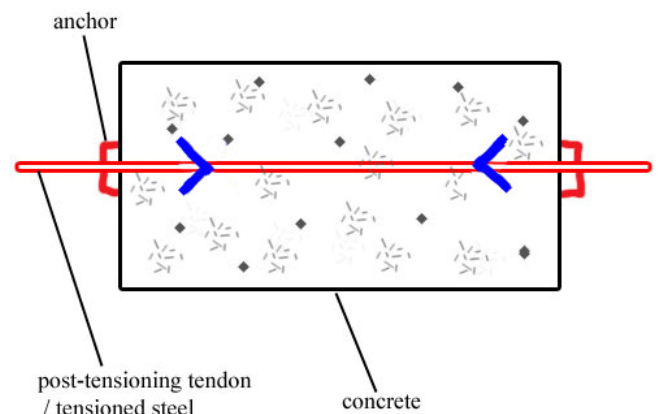


Figure 5: Illustration to concept of pre-stressed/ post-tensioned concrete

Source: All photos and graphics are produced by See Wing Tang