



THE STRENGTHENING OF TUBULAR CENTRIFUGED CONCRETE POSTS USING MBRACE SYSTEM – A NATIONAL PROBLEM

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November, 3rd, 2005

1

Introduction

- These posts were installed in Brazil by mobile telephone companies since 1996;
- The great majority of these posts, approximately two thousand units, were manufactured by a single company, using a centrifugal process;
- The heights of these concrete poles varied from 20m [60 ft], 30m [98 ft], 40m [120 ft], 50m [164 ft] and 60m [197 ft];
- The posts are composed of several modules (allowing for transportation and field assembly) which were connected by a metallic flange;
- The average wall thickness of the posts is of 10cm [3.9 in] and the external diameters range between 60 [23.6] and 100cm [39.4 in].

2

Colapse

- Some of the posts collapsed after a few years of use with four of these cases being confirmed in the states of Sao Paulo, Espirito Santo, Rio de Janeiro and Rio Grande do Sul;
- In each of the known collapses, the failure occurred within the development length between the first module (fixed to the ground) and the second module.



3

Diagnosis

- The most significant problem encountered in such structure, was its inadequate percentage of reinforcement at the joint area, between 8.5% and 18.2%;
- These rates exceed considerably the maximum reasonable limit, which among other reasons guarantees adequate conditions for stress transfer.



4

Diagnosis

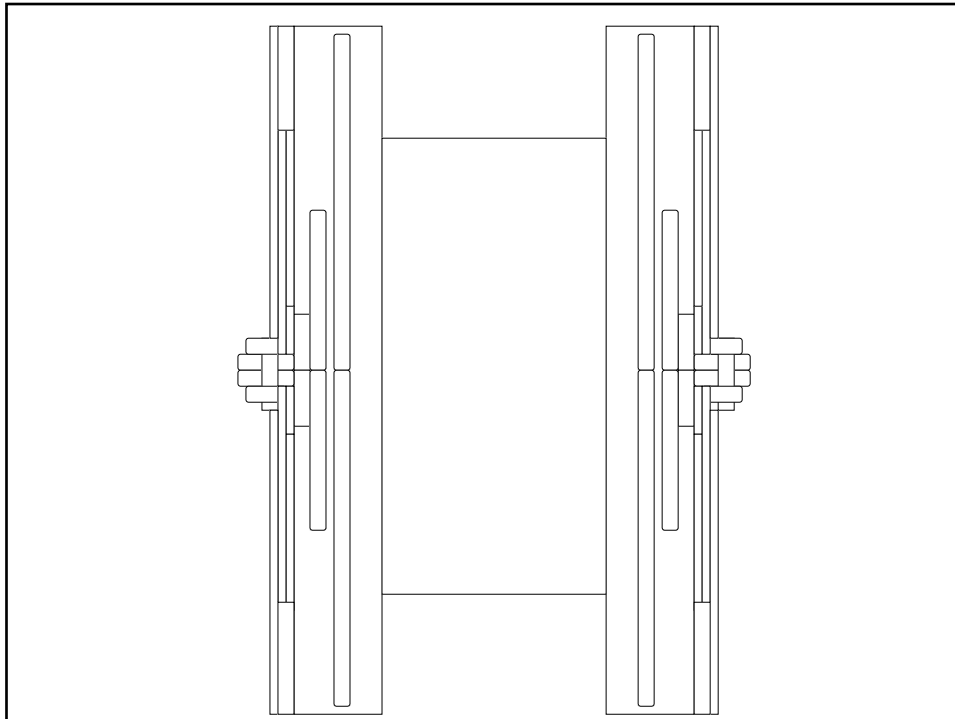
- An insufficient development length for an adequate stress transfer;
- An excessive diameter of the rebars related to the concrete wall thickness.

5

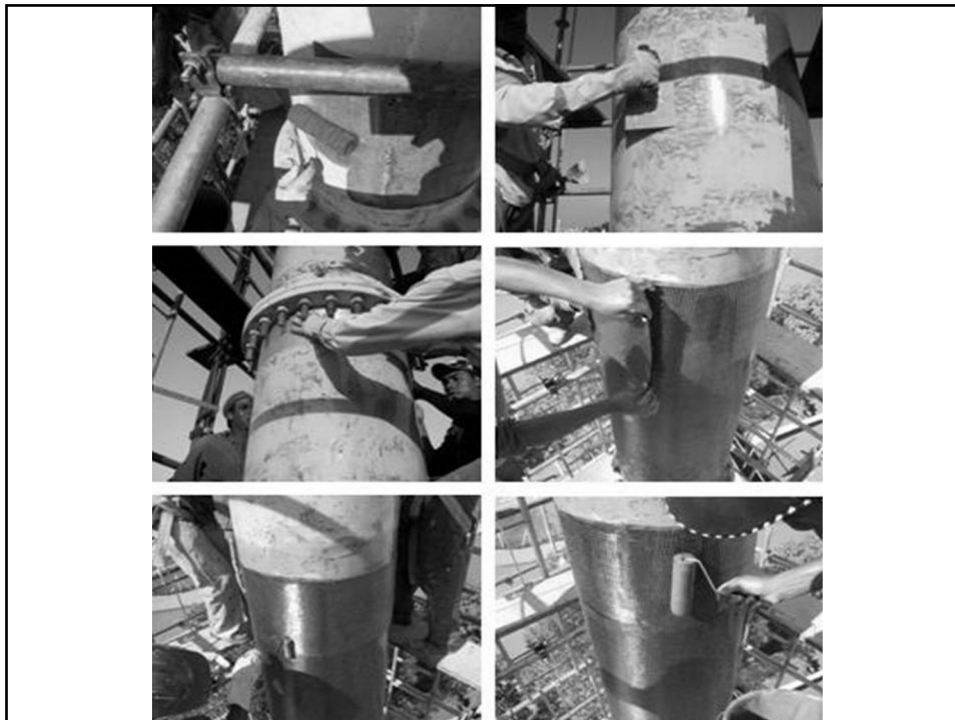
Description of the project

- A high mechanical Strength Grout MASTERFLOW 320 ($f_{c28days} = 50\text{MPa}$) is used in order to increase the concrete area, thus reducing the reinforcement percentage on the new gross concrete area;
- A passive confinement with a layer of carbon fiber CF-130 (MBrace System) is applied in that same area, to prevent a possible displacement of the joint bars.

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Laboratory tests

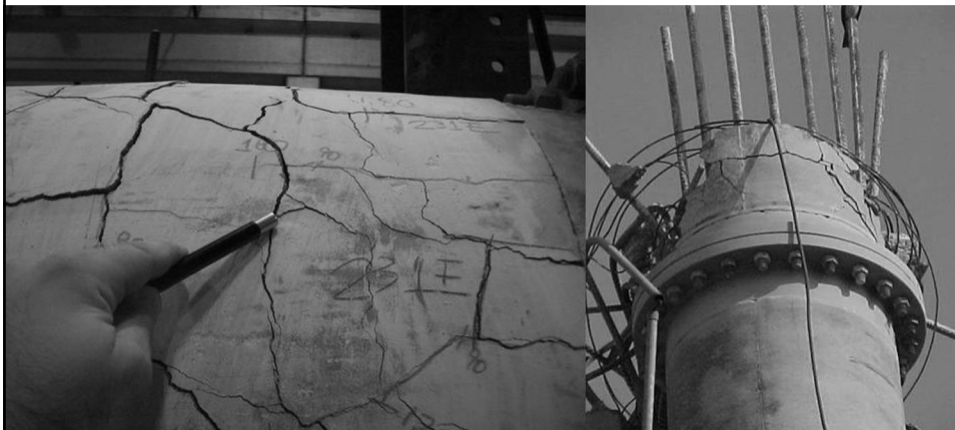
- The proposed solution was tested with actual pole specimens and confirmed efficiency of the repair procedure.



9

Laboratory tests

- All of the tests carried out with non-reinforced posts presented a failure mechanism very close to those found in the posts that collapsed.



10

Laboratory tests

- The failures that occurred in the newly reinforced poles in the joint region developed due to flexure in the Section III domain without any deterioration of the joint area, proving the efficiency of the proposed reinforcement;



11

Conclusions

- 150 posts already finished required, on average, 30m^2 [330 sq ft] of carbon fiber used to rehabilitate a post;
- Extrapolating this amount to round numbers for about 2,000 posts already manufactured results in a total carbon fiber consumption of about $60,000\text{m}^2$ [770,000 sq ft];

12

Conclusions

- The rehabilitation cost is, on average, about a third of the value of the removal and replacement of the post by a metallic tower – a practice that was being carried out by a large proportion of Brazilian mobile telephone companies.
- This provides an attractive option for the companies in this business both in time and repair cost. It also provides a solution to the design of any additional new concrete poles to be installed in the future – rather than losing this market to metal poles.

13



14