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# FRAME JACKETING

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## ABSTRACT

The experience suffered in Mexico City during the earthquake event of September 1985, left an indelible trace for the society in general, and specially for the engineers, the start of a concept revision stage, the adecuation and actualization of codes and norms, as well as a revision of the traditional constructive techniques. In a very particular way, the interaction between the seismic and structural engineering with the real estate owners and the authority incremented, to understand and accept the high-risk seismic position in a great part of our country, which will be undoubtedly manifested in a higher cost of edifications.

The experiences in national and international research centers, are rapidly interchanged and become technical support in the personal art of constructors and designers, and only after a while, are integrated in the codes and norms. The column and beam jacketing. as a repair technique of isolated pieces or, to increase the frame rigidity to which they belong, represents special difficulty in those elements of colindance with other edifications, for which any theorical consideration is canceled due to the inefficacy in the execution. Some of the solutions applied in these cases, specially in columns, are here presented.

## KEYWORDS

Beam Jacketing; Column Jacketing; Jacketing; Repair; Rehabilitation.

## GENERAL CRITERIA

The important seismic events, like the one suffered in Mexico City in the year 1985, show the vulnerability of structures designed with inadequate criteria (Aguilar, J., et al. 1989). Unfortunately new techniques and criteria are not well timed scheduled in norms or regulations.
The relative-slow incorporations into norms process, as well as the even slower adaptation of the constructive process and the edifications' cost in the economy of the construction industry, makes the number of high-risk constructions increase.

Flexible columns, with reinforcement details, incompatibles with the ductility needed in members and joints, and the "strong beam-sick column" criterium, are the technical ingredients of many of the existent structures, from which the owners expect a long useful life. Additionally, the regulations criteria, concerning parking places in new edifications, lead the owners of the existent edifications to conserve them, although the important cost of rehabilitation.

The advance progress concerning the rehabilitation of damaged edifications in Mexico City, has been slow but continuos, and concerning the undamaged ones, it is not economically feasible for the owners, to deal with this risk-reduction labor. Parallel, the authorities have seen themselves in difficulties to make a new law retroactive, even for the "class A" edifications, like schools, hospitals, etc.

The column and beam jacketing, and the combination of this process with the incorporation of new rigidity elements, as share walls and bracing, represents a rehabilitation alternative, compatible with our constructive process as well as with our supervision practice (Jara,M. et al 1989) (Hirosawa,M. 1990-91). The column and beam jacketing practice includes the new reinforced concrete, sorrounding the existent concrete, or, the new metallic elements, as longitudinals and transverse sorrounding the existent concrete, in order to increase the element's resistance and ductility.

Jacketing columns only,Fig (1,2,3) or column and beam jacketing, has been use, always passing the new reinforcement through the joint body, to enhance the characteristics of resistance, rigidity and energy dissipation. The constructive difficulties, specially in the extreme frames, due to the proximity with neighbor structures, put frequently in doubt the jacketing process effectivity.

The commercial negotiations between neighbors, in order to have space enough between themselves, is not frequent up to date, and enables the "metallic-piece" jacketing, which unfortunately has not enough investigation. In my opinion, a good column and beam jacketing solution, is given with a good combination of new concrete and new steel visible pieces, which guarantee the concrete's confinement both in the members and joint, making easier the integration and connection with other elements as bracing, walls and horizontal diaphragm reinforcement.

Recent investigations (Alcocer, S.M., et al, 1993), expose the satisfactory results, when applying current regulations of new edifications, as suitable criteria applicable to the jacketing reinforcement, in the rehabilitation process, specially concerning the joints submitted to reversible actions. Other investigations, have showed very good results in behavior of elements with partial or total metallic jacketings.

## COLUMN JACKETING

The removal of fractured elements, to heal a hard-damaged column, will assure that the reinforcement hasn't suffered any bending, and it will permit the new concrete to fill in the spaces with a strength at least the same as the old concrete. Cracks up to 3 mm. do not represent the need of partial demolition to heal a damaged zone, and according to researches and field experience, a moderate roughness with chipping or sand blast action is good enough to adequate the contact surface.(Alcocer, S.M., et al 1993) (Rodriguez, M., et al 1994)

The old concrete humidification, as well as a careful and adequate cast and curing the new concrete, will guarantee a good result.

The steel cage sorrounding the joint (Fig.1), can be proportioned in order to provide an equivalent confinement to that recommended in the ACI Comity 352 report (A.C.I.-ASCE. 1976).

The use of distributed bars is convenient although bundled bars have showed good behavior under certain conditions. The use of exterior angles in the corners, with transversal plates welded to them, constitutes a metallic jacketing which besides confining the existent concrete, gives a new lingitudinal reinforcement, assuring that a refill grouting takes place between the metallic elements and the old concrete (Valluvan,R., et al-1993), and that the first and last transversal plate series are adjusted against the upper and lower horizontal surfaces of the corespondent beams. In this way, besides the continuous contact and adherence between steel and concrete, there will be a mechanic action which obstructs the longitudinal sliding of the corner angles, treated as an additional longitudinal reinforcement.

The placement of additional clamps in the metallic jacketing (P1) or (P2) (Fig. 1,2,3), inside the concrete, define undoubtedly an integrity between steel and concrete, but it requires a grater investigation support. It has been used in our circle, as a local reparation technique and with no support concerning the new-steel participation, in the repaired- element inertia.

The limitations which the A.C.I. imposes to a reinforced concrete element, vs. the limitations which A.I.S.C. imposes in the design of a steel element with concrete contribution, leave a supportless field for frequent solutions which the structural engineers require in their professional practice. The frequent situations of ignorance concerning existent reinforcement as well as the absence of the original project in old structures, lead us to ignore it and to consider the resistance only with the participation of new steel, which may lead us to practice the column jacketing only falling in the "strong column-weak beam" concept.

## BEAM JACKETING

Jacketing with concrete(Fig. 5), becomes a complicated and high-cost technique. Specially when the existent steel is unknown, we incur in the possible beam reinforcement, over the correspondent to a column. Figure 4 shows the possibility of stirrup use, in order to integrate the concrete jacketing to the slab in its diaphragm action.

A steel jacketing results a high-cost and doubtful efficient collocation when pretended as a reinforcement to flexion, due to the small deformities' incompatibility.

A partial steel jacketing, basically destined to give shear strength, can be done with rounded bars or vertical plates, which joined to the transversal plates, form a cage to which slab reinforcement can be connected to encrease its diaphragm action, and also in the beam extremities can be easily connected to bracing or walls of the frame rigidity system.

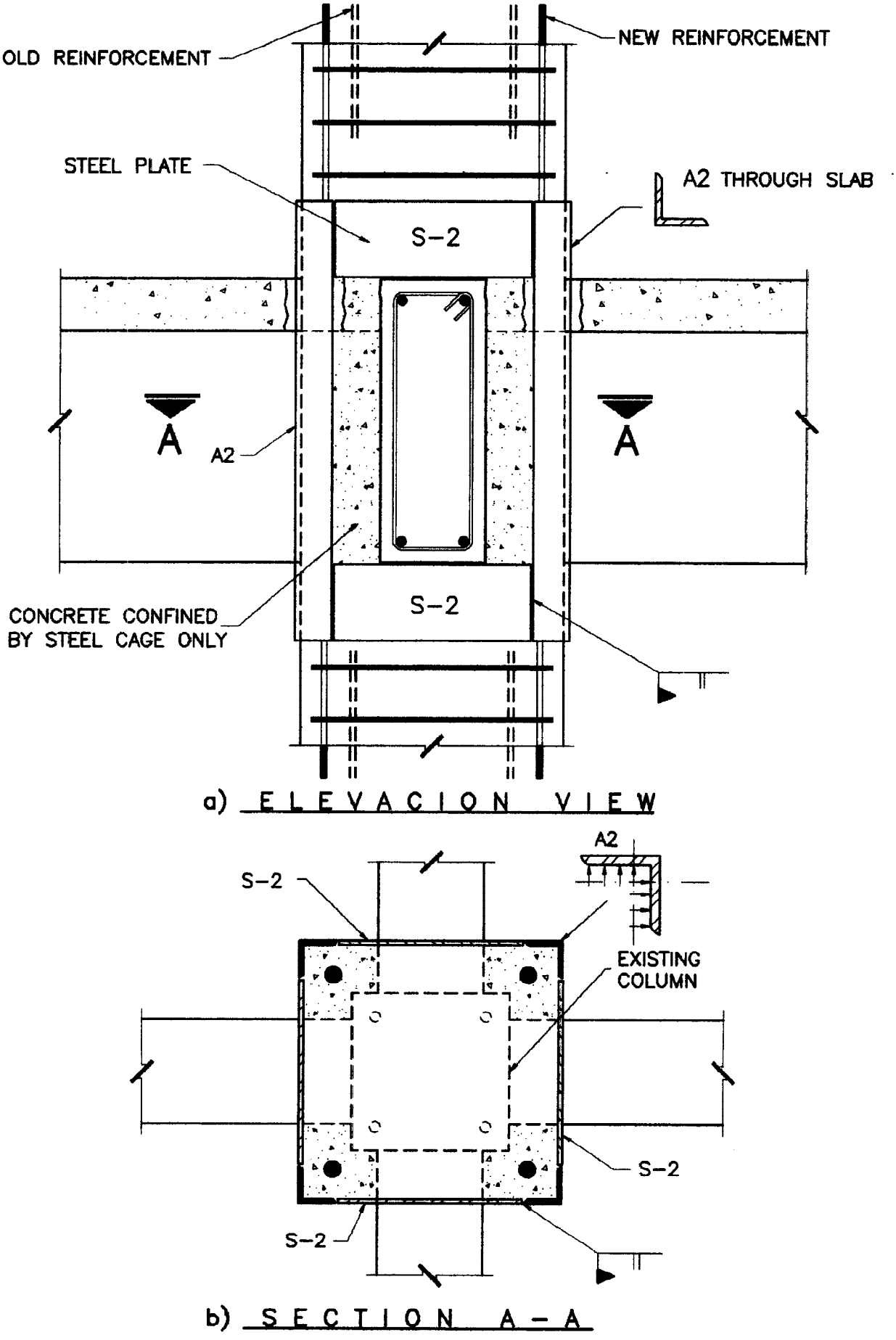
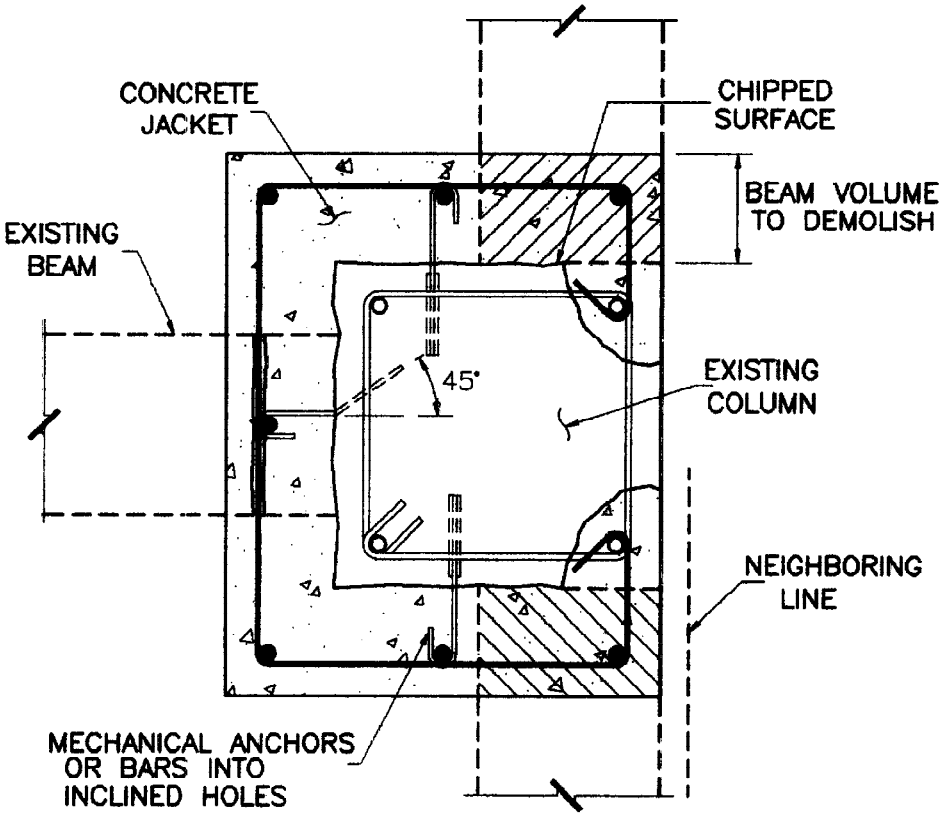
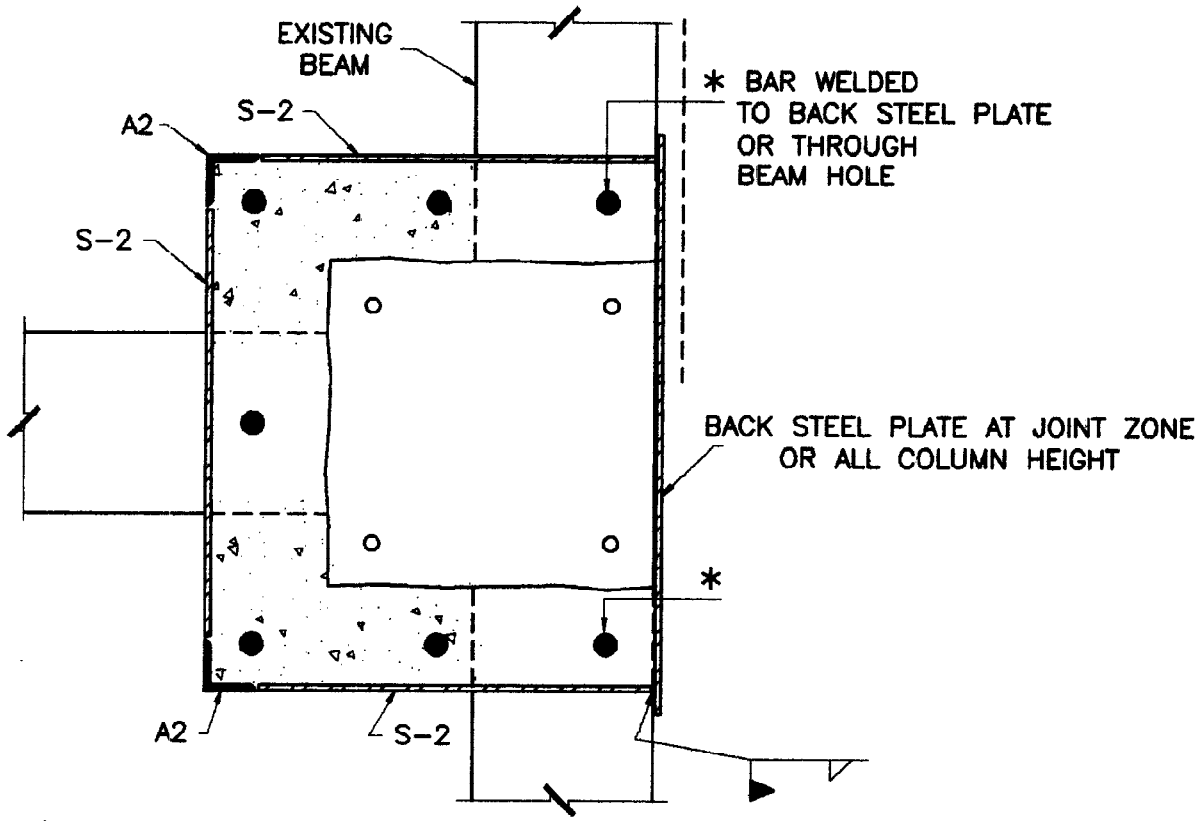



Fig. 1 Concrete Column Jacketing with joint confinement steel cage

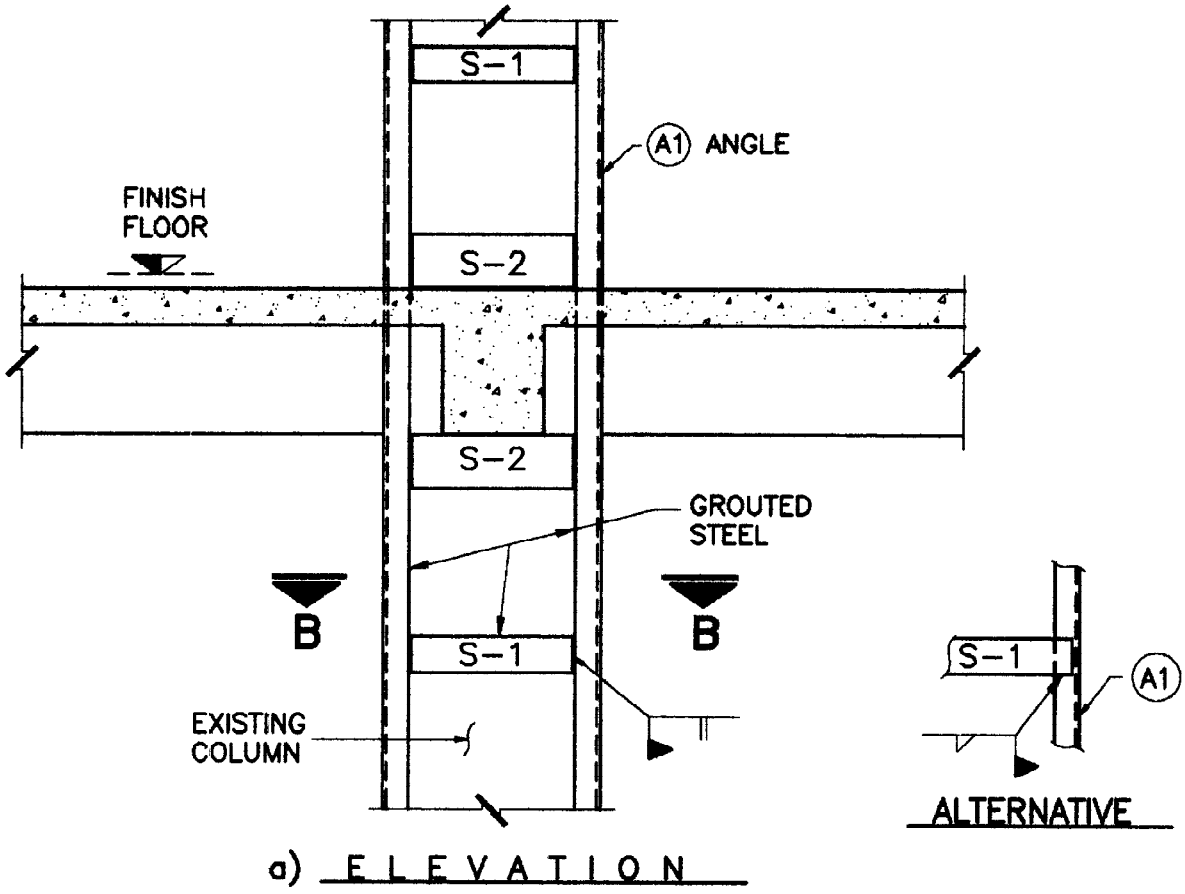



a) SECTION A–A WITH JOINT CONFINEMENT STIRRUPS

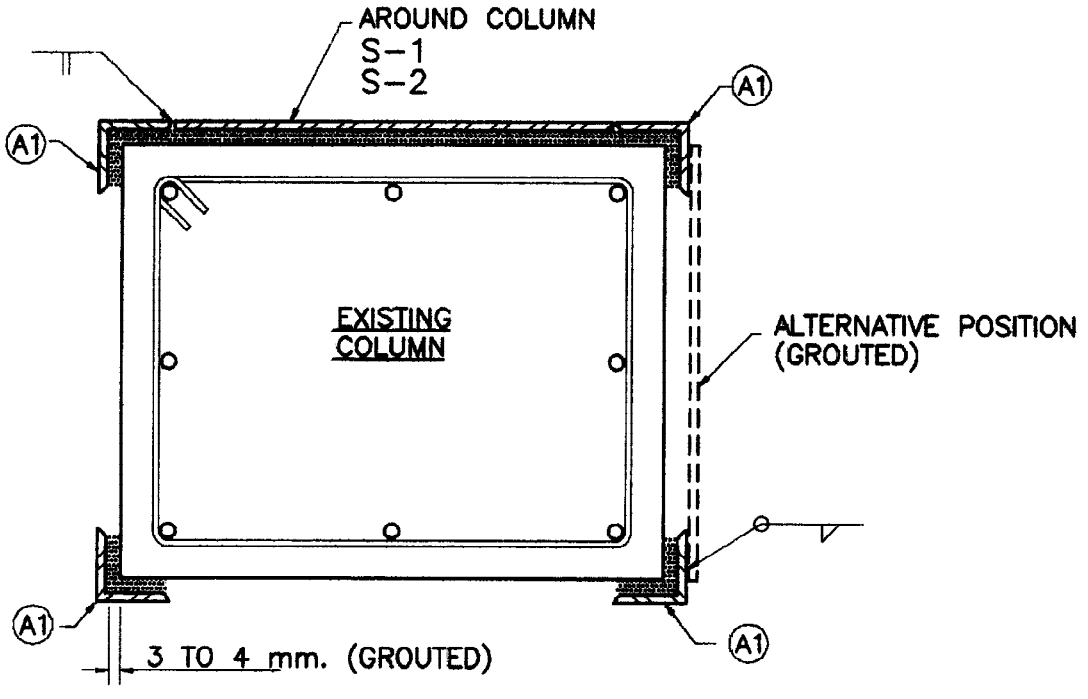



b) SECTION A–A WITH JOINT CONFINEMENT CAGE

Fig. 2 Concrete Column Jacketing in neighboring position

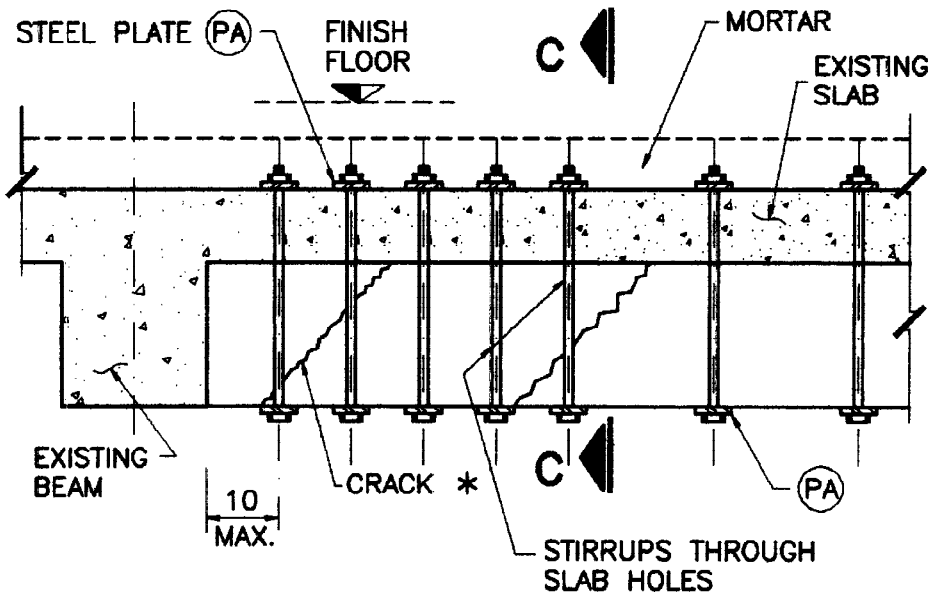



a) ELEVATION



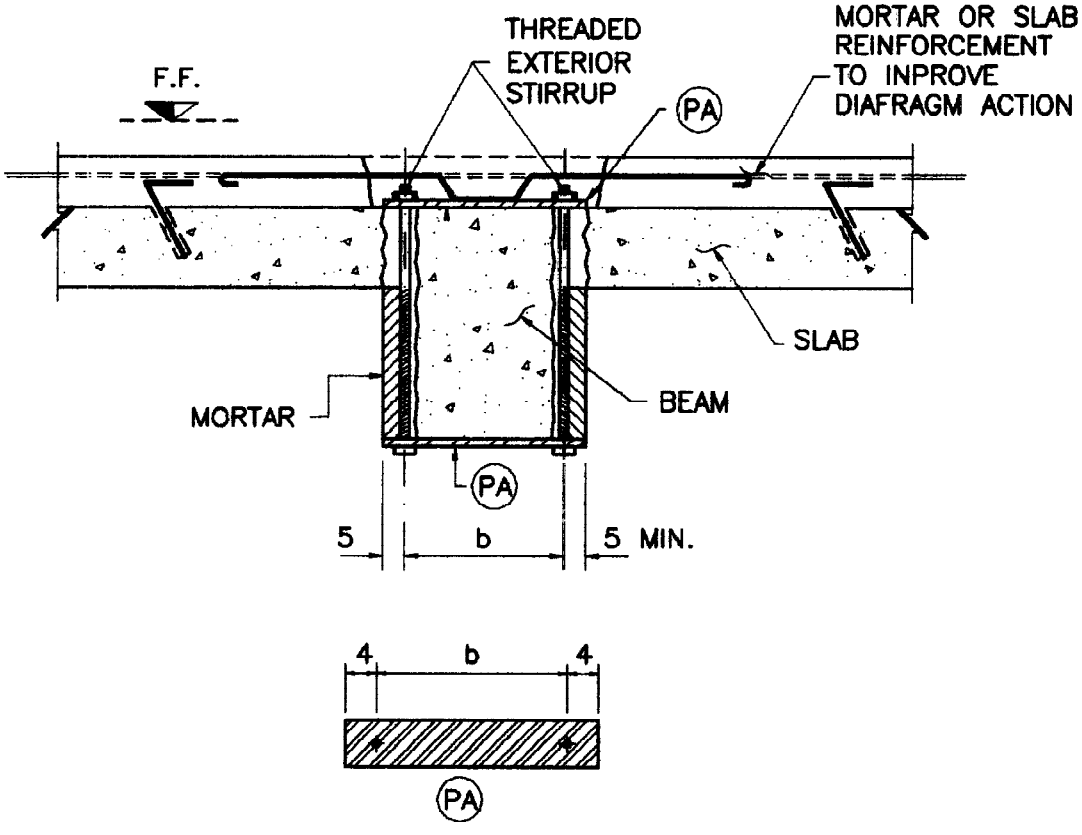

b) SECTION B - B

Fig. 3 Steel Column Jacketing




* 0.5 mm. CRACKS OR BIGER, FILLED WITH EPOXI RESIN

a) E L E V A T I O N




b) S E C T I O N C – C

Fig. 4 Beam external transverse reinforcement

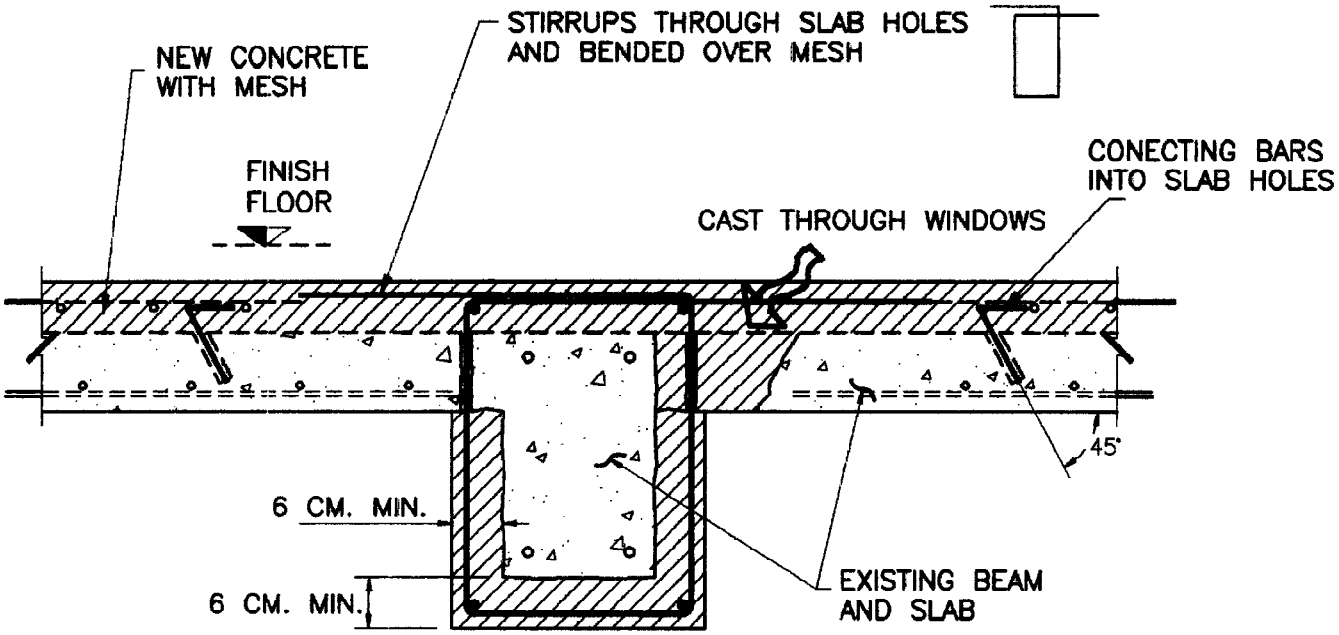



Fig. 5 Concrete Beam Jacketing

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