## PREFABRICATED CAGE SYSTEM FOR REINFORCING CONCRETE MEMBERS

What the innovation is: A new reinforcement system functioning as both the longitudinal and transverse steel in reinforced concrete (RC) structural members. The Prefabricated Cage System (PCS) is fabricated by perforating (using laser equipment) hollow steel tube elements. The resulting PCS acts as transverse and longitudinal reinforcing steel working compositely with the surrounding concrete to resist applied loads (Fig. 1).

Why it is innovative: The new PCS system: 1) eliminates the labor cost for fabrication of reinforcing steel bar cage including cutting, bending, and tying bars in RC construction. PCS is produced by cutting out openings on steel plates or tubes by laser. Laser cutting is relatively cheap and very precise; 2) improves the structural performance (Fig. 4). Through improved mechanical interaction between reinforcement and concrete, PCS is capable of developing certain transfer mechanisms that conventional RC cannot develop or only develops at low levels of loading; 3) allows inspection of concrete after the member is subjected extreme loads. Although promising, concrete-filled tubular systems (Fig. 1b) are met with resistance in the bridge engineering community due to the inability to inspect the quality of the concrete infill and potential adverse effects of long-term deterioration of bond between the tube and concrete; 4) eliminates some of the possible weaknesses and detailing problems inherent in traditional RC construction. For example, PCS relieves steel congestion seen in many conventionally reinforced structural members, such as near the beam-column joint regions or in the boundary elements of shear walls. The amount of transverse or longitudinal steel in PCS can easily be increased by increasing the plate thickness or by changing the opening dimensions without creating additional detailing problems; 5) is easy to install at the construction site. The use of PCS enhances work zone safety, because there is no need to tie a reinforcing cage on site; 6) reduces the construction time and associated costs, e.g., the economic loss resulting from traffic disruptions due to bridge construction can be reduced significantly; 7) can be used to retrofit existing structural members with insufficient and/or corroded reinforcement (Fig. 2); 8) has corrosion and fire resistances better than or similar to those of RC members. Steel structures and concrete-filled steel tubes are generally vulnerable to fire and corrosion since the steel is exposed; 9) permits a high degree of quality control through perfectly uniform transverse steel spacing which matches specified design values.

What it changed and replaced: As an integral transverse and longitudinal reinforcement, PCS replaces the traditional reinforcing steel cage. PCS and RC specimens shown in Fig. 3 have the same amount of longitudinal and transverse steel (e.g., PCS-9, PCS-10, and PCS-11 have ¼, 3/16, and 1/8 in.-thick steel plates, respectively). Test results have shown that the axial load carrying capacity of PCS specimens is similar to or better than RC specimens (Fig. 4).

Where and when it originated, has been used, and is expected to be used in the future: It originated during research discussions between Dr. H. Sezen and his PhD student, M. Shamsai in April 2003. This innovation is patent pending. The Office for Technology Licensing at the Ohio State University has filed two patent applications (serial numbers: 10/932,560 and 60/616,174). The experimental research (Fig. 3) was funded by the U.S. National Science Foundation (CMS- 0355321). PCS has many potential applications other than in building columns; e.g., bridge piers, abutments, pier caps, shear walls with PCS steel plates or with PCS boundary elements, beams, piles, foundations etc.

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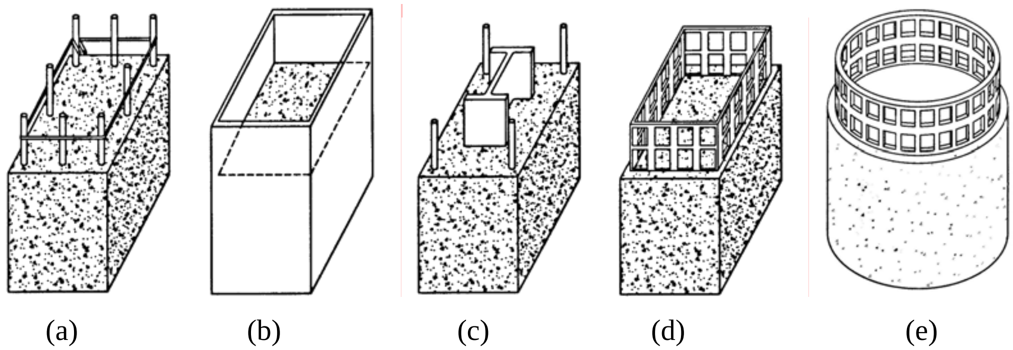


Fig. 1 a) traditional rebar reinforced (RC) system; b) concrete-filled steel tube; c) steel-concrete composite system; d and e) PCS reinforcement

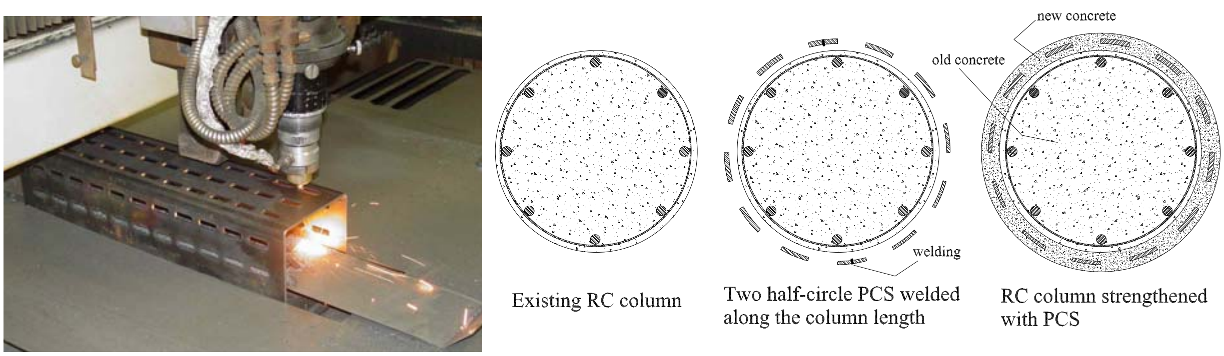


Fig. 2 PCS fabrication; and example of retrofitting deteriorated RC circular column/bridge pier using PCS

Fig. 3 PCS-7 PCS-8 RC-18 PCS-9 PCS-10 PCS-11 RC-19

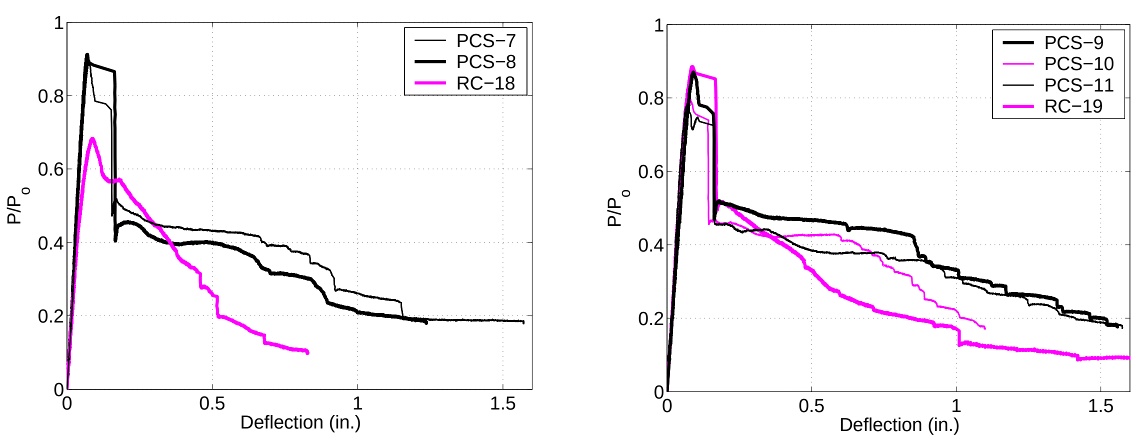


Fig. 4 Comparison of experimental normalized axial strength versus deflection relations for equivalent PCS and RC specimens shown in Fig. 3. $P_o = A_s f_y + f_c'(A_g - A_s)$

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