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PROGETTAZIONE DI EDIFICIO COMMERCIALE CON STRUTTURA COMPOSTA CON MURI IN C.A. A TAGLIO E ACCOPPIATI CON SISTEMI DISSIPATIVI

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1. Introduzione

I paragrafi seguenti spiegano il contributo principale offerto da Ferriere Nord SpA (FeNO) al progetto *Precasteel,* nel quale viene presentato un sistema di controventamento alternativo per edifici commerciali di altezza ridotta situati in zone sismiche, ovvero un sistema a pareti con doppia soletta in c.a. prefabbricata. In particolare, attraverso una metodologia (innovativa) semplificata di predimensionamento, si forniranno informazioni utili alla definizione dei livelli di carico e alla distribuzione delle pareti.

Un particolare contributo da FeNO riguarda il confronto operato tra la soluzione strutturale con pareti in c.a. e gli alternativi sistemi a controventi in acciaio concentrici ed eccentrici, sottolineando le differenze in termini di capacità dissipativa e costo di costruzione.

2. Obiettivi di progetto

Il suddetto metodo semplificato di progettazione permette di accelerare e facilitare la fase decisionale del progetto, dalla valutazione di fattibilità alla stima economica degli investimenti.

Sulla base di una preliminare analisi statistica dei dati, sono state definite varie configurazioni strutturali, aventi differenti geometrie (luce delle campate, numero di piani, configurazione planimetrica o pendenza delle coperture), tali da risultare compatibili con le diverse destinazioni d'uso (industriali o commerciali) e competitive con il mercato del calcestruzzo armato. Le soluzioni strutturali selezionate per gli edifici commerciali hanno avuto un percorso di progetto iterativo, in cui i parametri geometrici e gli schemi statici resistenti sono stati fatti variare al fine di definire le soluzioni ottimali; tale ricerca dell'ottimo è stata ripetuta sia per le strutture composte acciaio-calcestruzzo (con pareti in c.a.) che per quelle in acciaio.

La suddetta progettazione iterativa, effettuata per molteplici edifici e integrata mediante un'analisi dei costi, ha dato vita ad una vera e propria analisi delle prestazioni, in cui le prestazioni strutturali (valutate in accordo alle prescrizioni tecniche contenute negli *Eurocodici*) vengono armonizzate con i costi di realizzazione. Le informazioni usate nella definizione del modello di costo provengono da tre diverse aree comunitarie (Italia – Sud Europa; Germania – Europa Centrale; Romania – Est Europa), in modo tale da consentire la standardizzazione dei valori adottati e, al contempo, individuare i mercati nazionali in cui determinate soluzioni possono rivelarsi competitive.

Per quanto riguarda gli edifici commerciali, le soluzioni derivanti dalle analisi effettuate (statistiche e di costo) sono tutte riconducibili a una configurazione strutturale modulare che prevede l'accoppiamento di due sistemi resistenti con diverse funzioni:

- una porzione strutturale adibita al sostegno dei carichi verticali (struttura a gravità);
- una porzione controventante per fronteggiare l'azione sismica (sistema di controvento).

Le simulazioni numeriche e gli studi per l'ottimizzazione delle prestazioni sismiche strutturali condotti in questa sede hanno interessato edifici commerciali aventi differenti sistemi di controvento laterale.

In particolare, sono state analizzate le seguenti configurazioni strutturali:

- edifici commerciali con telai in acciaio a controventi concentrici (UniCAM);
- edifici commerciali con telai in acciaio a controventi eccentrici (UniCAM);
- edifici commerciali controventati con pareti prefabbricate in calcestruzzo armato (FeNO);
- edifici commerciali provvisti di cuscinetti in gomma altamente dissipativi, interposti tra la struttura a gravità e le pareti prefabbricate in c.a..

La parte finale della ricerca è stata orientata alla definizione di un metodo di progettazione (procedura progettuale) utilizzabile da professionisti e ingegneri interessati alle soluzioni strutturali studiate nell'ambito del progetto di ricerca *Precasteel*, e considerate nel presente documento. Al fine di valorizzare ed agevolare l'utilizzo di tali soluzioni, la procedura di progetto è stata implementata all'interno di un software automatizzato di elevata qualità, consistente in un'applicazione internet accessibile da parte di qualsiasi utilizzatore (professionista o ingegnere, comodamente dal proprio ufficio) per la progettazione preliminare di un edificio industriale o commerciale realizzato mediante le tecnologie *Precasteel*. L'utente dell'applicazione web, attraverso una semplice interfaccia grafica, inserisce un ridotto quantitativo di dati (input) parametrizzati, ottenendo come output i disegni e una stima dei costi per la struttura, i solai, la copertura e i collegamenti relativi all'edificio industriale/commerciale da realizzare.

3. Input di progetto

La definizione di una procedura di predimensionamento per edifici ad uso commerciale con pareti in c.a., presuppone l'assunzione di alcune ipotesi sui parametri geometrici ed sui livelli di carico:

Ipotesi geometriche:

- altezza interpiano delle pareti:
  H = 6 - 8 m (edifici ad un piano);
  H = 4 - 5 - 6 m (edifici a due piani);
- larghezza delle pareti:
  B = 8 - 10 - 12 m (edifici ad un piano);
  B = 4 - 5 - 6 m (edifici a due piani);
- spessore delle pareti:
  s = 0.20 - 0.25 - 0.30 - 0.35 - 0.40 m.

Ipotesi sui carichi agenti:

- massimi valori di taglio alla base (sisma, vento) per una singola parete in c.a.:
  V_b = 500 - 1000 - 1500 - 2000 kN;
- carico permanente strutturale dei solai di piano/copertura:
  G_{1k} = 2.85 kN/m^2 (peso proprio per tipologie solai in Figura 1);

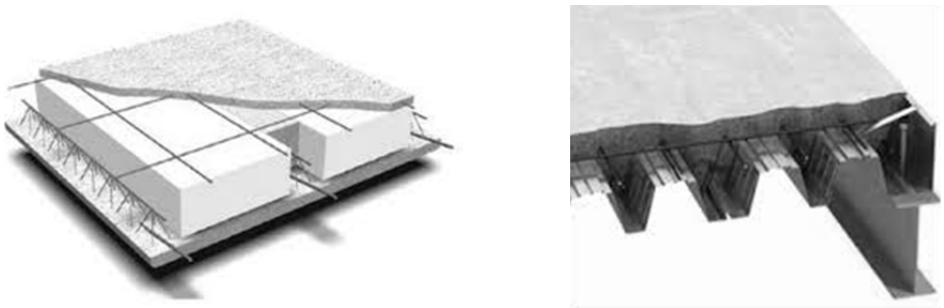


Figura 1: Tipologie adottate di solaio in c.a. (Predalle) e composto (lameiera grecata-cls).

- carico permanente non strutturale:
  G_{2k} = 1.80 kN/m^2;
- sovraccarico d'esercizio pesante:
  Q_k = 8.00 kN/m^2 (attività commerciali);
- sovraccarico d'esercizio normale:

Q_k = 5.00 kN/m^2 (attività commerciali);

- sovraccarico d'esercizio leggero:
  Q_k = 2.00 kN/m^2 (neve);
- livello di sismicità (PGA, accelerazione di picco al suolo):
  a_g = 0.08 g (bassa sismicità);
  a_g = 0.16 g (media sismicità);
  a_g = 0.32 g (alta sismicità);
- le pareti in c.a. sono progettate per resistere sia all'azione sismica che del vento, assumendo le forze di piano con quattro differenti distribuzioni in altezza (distribuzioni A, B, C, D, come mostrato in Figura 2). Nel caso di forzante ventosa, il tagliante di piano è stato distribuito in modo tale da avere una forza applicata al primo piano doppia rispetto a quella in copertura; nel caso di azione sismica, assumendo lineare la prima deformata modale, il taglio alla base è stato distribuito secondo la relazione seguente (in cui M rappresenta la massa sismica di piano):

$$F_1 = V_b\left(\frac{M_1 \cdot H}{M_1 \cdot H + 2 \cdot M_2 \cdot H}\right)$$

$$F_2 = V_b\left(\frac{2 \cdot M_2 \cdot H}{M_1 \cdot H + 2 \cdot M_2 \cdot H}\right)$$

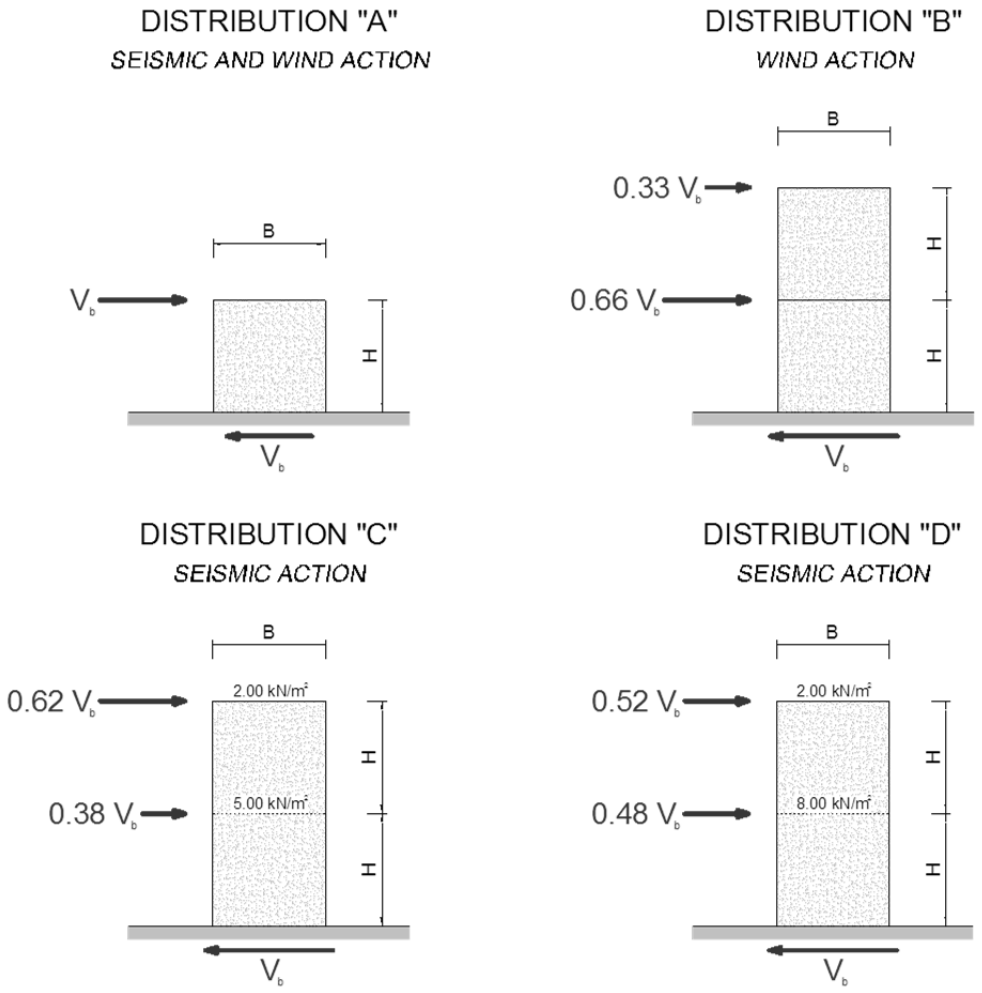


Figura 2: Distribuzioni di forze statiche orizzontali.

Concezione strutturale

Il suddetto metodo di predimensionamento per edifici commerciali con pareti in c.a. è fondato, in particolare, sull'assunzione di alcune ipotesi di comportamento strutturale ideale:

- schemi statici semplificati, ottenuti scomponendo l'edificio in sottostrutture più semplici ma ancora capaci di descrivere il comportamento strutturale nel suo complesso;
- le sottostrutture sono regolari in pianta ed in elevazione, sia in termini di distribuzione di massa che di rigidezza;
- i sistemi di piano (travi e solai) e le colonne sono progettate per resistere ai carichi verticali mentre le pareti, per fronteggiare le azioni sismiche e del vento (Figura 3);

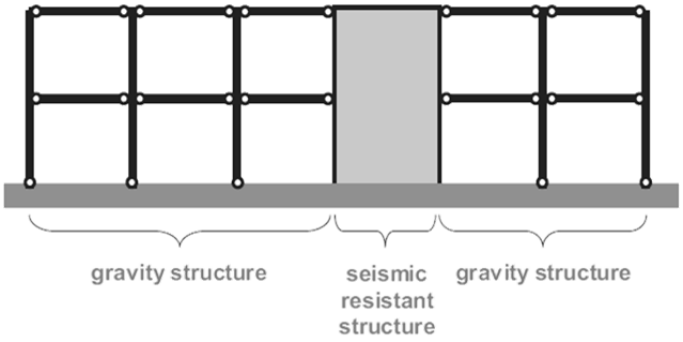


Figura 3: Individuazione delle sottostrutture in funzione delle azioni di competenza .

- gli orizzontamenti sono assunti rigidi nel loro piano (comportamento a diaframma);
- l'effetto della fondazione è modellato mediante vincoli rigidi;
- le analisi sono condotte in campo lineare;
- per il predimensionamento sismico delle pareti duttili (ULS) si adottano analisi statiche lineari, mentre, analisi dinamiche semplificate sono impiegate per valutare il rapporto tra area di influenza e pareti (le masse sono considerate concentrate ad ogni livello di piano);
- i modi di vibrare torsionali sono evitati mediante l'interposizione di giunti tecnici (spazi tra i moduli architettonici) e la distribuzione simmetrica delle pareti;
- le pareti duttili sono disaccoppiate (ovvero, si adottano forme in pianta a C o L per le scale);
- la deformabilità a taglio delle pareti è tenuta in conto attraverso un opportuno modello di rigidezza (modello alla Timoshenko);
- le prestazioni strutturali degli edifici sono ottenute soddisfacendo le prescrizioni tecniche contenute negli Eurocodici, risultando, perciò, in linea con gli standard normativi.

4. Metodologia di progetto

La procedura descritta nel seguito consente di minimizzare il numero di pareti sismo-resistenti necessarie a fronteggiare un assegnato valore di taglio alla base V_b per una determinata zona.

La prima deformata modale è assunta lineare, coerentemente con le distribuzioni delle forze di piano adottate in precedenza, e può esprimersi per mezzo della seguente espressione:

$$a^T = \left[\frac{1}{n} \quad \dots \quad \frac{i}{n} \quad \dots \quad 1 \right] \qquad i = 1, \dots, n \text{ (numero di piano).}$$

Definendo K la matrice di rigidezza alla traslazione per le pareti e M la matrice delle masse per un'area d'influenza unitaria A (incognita), è possibile stimare il periodo fondamentale del sistema mediante l'espressione:

$$T = 2\pi \cdot \sqrt{\frac{a \cdot Ma}{a \cdot Ka}} \cdot \sqrt{A}$$

L'area di competenza di una singola parete A può essere determinata risolvendo la seguente equazione non lineare, ottenuta uguagliando l'assegnato V_b al valore atteso di taglio alla base:

$$V_b = A \cdot \frac{(a \cdot Mr)^2}{a \cdot Ma} \cdot S_d(T)$$

dove $S_d(T)$ è l'ordinata (in corrispondenza del periodo T) dello spettro di progetto in pseudo-accelerazione.

L'approccio appena descritto è valido solo per le distribuzioni di forze statiche di tipo "A", "C" e "D" (Figura 4), derivanti da un taglio alla base di origine sismica; per la distribuzione di tipo "B", che prevede forze derivanti dal vento, non è possibile prevedere l'area di competenza della singola parete a causa della mancata conoscenza dell'effettiva forma dell'edificio e della conseguente superficie esposta al vento. I risultati ottenuti fanno riferimento agli spettri di progetto suggeriti dall'*Eurocodice 8* per sottosuolo di categoria B.

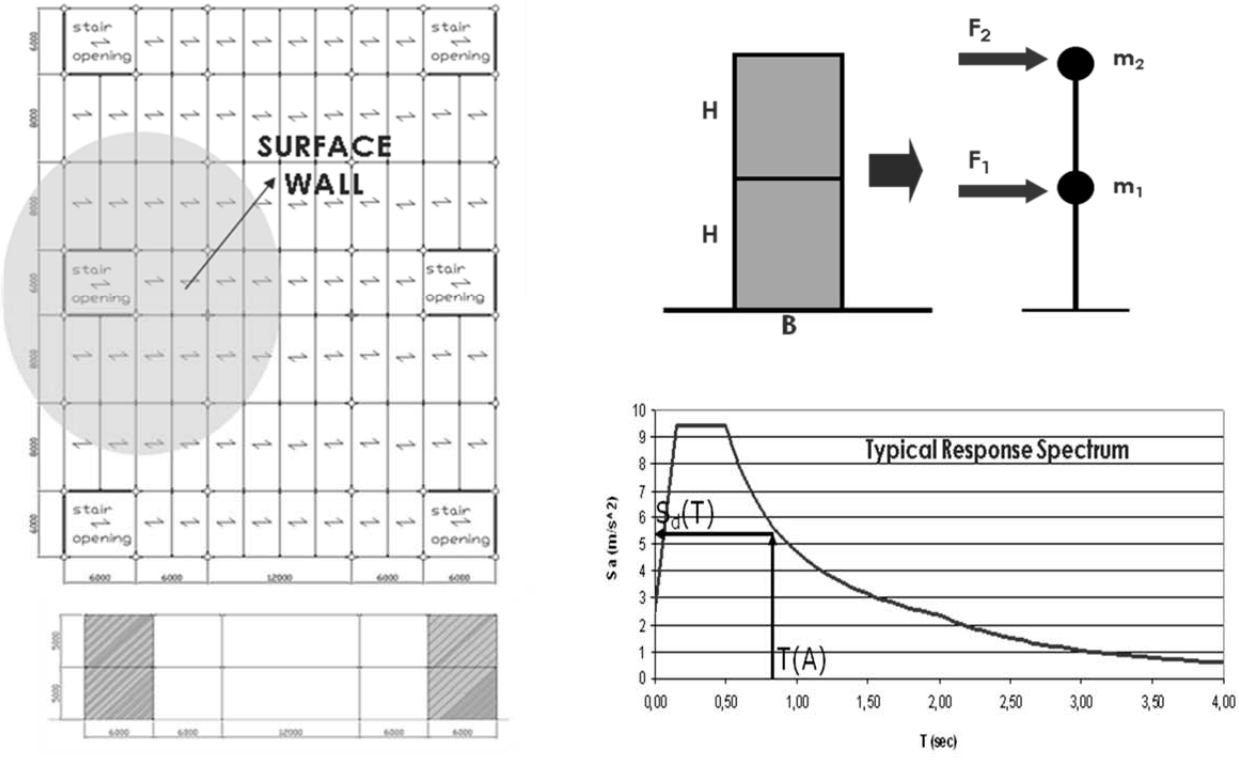


Figura 4: Approccio semplificato per stimare l'area di competenza di una singola parete in c.a.

Riassumendo, i passi che il progettista dovrà seguire sono i seguenti:

a) fissare il massimo valore di taglio alla base (sismico o da vento) per una singola parete in c.a.;
b) definire l'entità dei carichi variabili agenti sull'edificio commerciale (sovraccarichi pesanti, normali o leggeri);
c) definire il livello di sismicità per quel sito (PGA, accelerazione di picco al suolo);
d) assumere una delle quattro possibili distribuzioni di forze statiche di piano (A, B, C o D) con riferimento al numero di piani e alla natura dell'azione considerata (sisma o vento);
e) fissare la classe di duttilità per la struttura (alta DCH e media DCM duttilità per strutture dissipative, bassa DCL per strutture in c.a. che non dissipano energia sotto le azioni cicliche del sisma);
f) stima del fattore di struttura (q) in base alla classe di duttilità e alle proprietà geometriche delle pareti in c.a. (altezza interpiano, larghezza, spessore);

Considerando tutte le ipotesi enunciate in precedenza e applicando la suddetta procedura di progetto semplificata (in accordo agli standard normativi degli Eurocodici), è stato possibile realizzare un database (di cui se ne riporta un esempio in Tabella 1) su cui si baserà il software finale *Precasteel* al fine di fornire ai progettisti un ventaglio di possibili (fattibili) soluzioni strutturali per realizzare un edificio commerciale sismo-resistente con pareti in c.a..

Tabella 1: Esempio di dati di input e output ottenibili per una singola parete in c.a.

INPUT								
Number of storeys	Storey height H [m]	Width B [m]	Thickness s [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor
2	4.00	4.00	0.20	500	C	0.16 g	DCH	4.00
2	4.00	4.00	0.20	500	C	0.16 g	DCM	3.00
2	4.00	4.00	0.20	500	C	0.16 g	DCL	1.00

OUTPUT						
Surface/ Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wall surface [m²]
374	52	6	553	15360	6.40	32
307	52	6	553	15360	6.40	32
156	52	6	553	15360	6.40	32

5. Dettagli costruttivi

La procedura di pre-dimensionamento delle pareti in c.a. come sistema di controvento è semplice, intuitiva e veloce, anche nel definire i dettagli strutturali secondo i suggerimenti e le prescrizioni contenute nelle norme comunitarie quali:

- *Eurocodice 8* per la definizione dei dettagli in zona critica e nelle aree confinate delle pareti in funzione delle classi di duttilità (alta DCH e media DCM duttilità);
- *Eurocodice 2* per la definizione dei dettagli in strutture in c.a. poco dissipative (bassa duttilità DCL) o per sovrastrutture isolate alla base mediante specifici dispositivi d'isolamento.

Le seguenti immagini riportano, per le pareti di controvento in c.a., alcuni tipici dettagli costruttivi relativi a:

- armature di rinforzo in zona d'angolo e tipiche configurazioni planimetriche (Figura 5);
- connessione tra parete e solaio prefabbricato (Figura 6);
- connessione tra parete e fondazione (Figura 7)

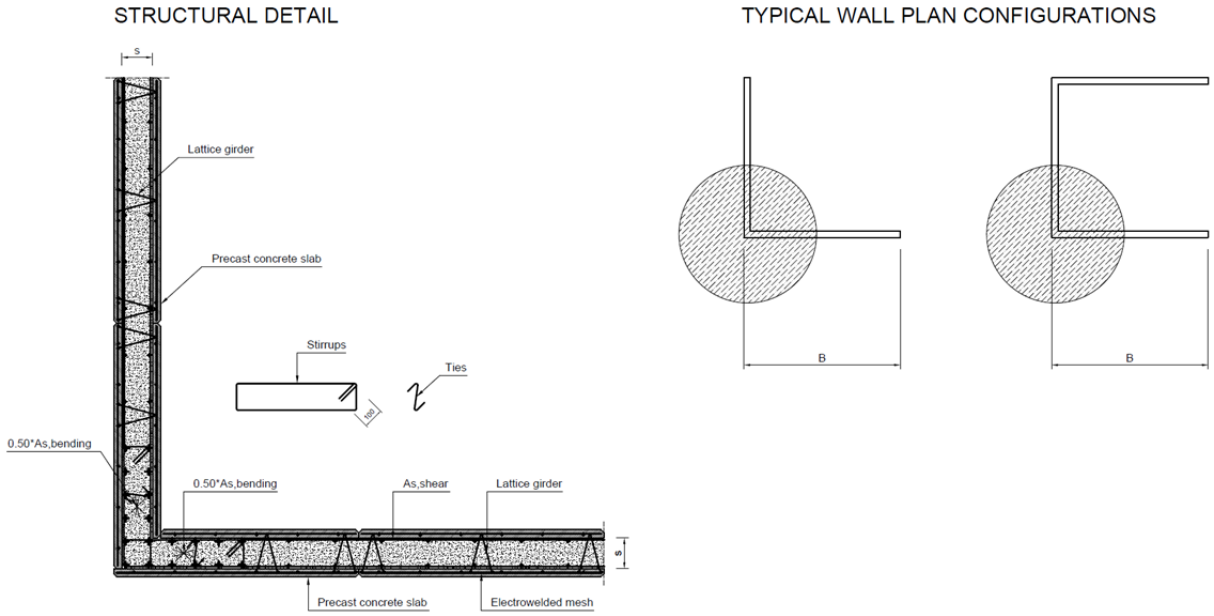


Figura 5: Particolare armature di rinforzo in zona d'angolo e tipiche configurazioni planimetriche (vista dall'alto).

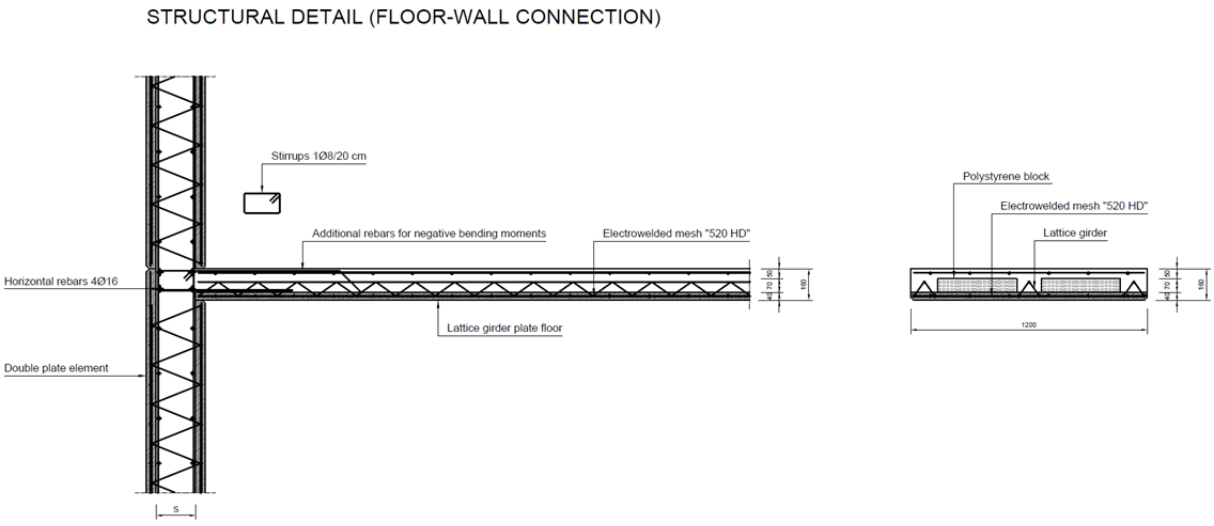


Figura 5: Particolare connessione tra parete e solaio prefabbricato (sezione verticale).

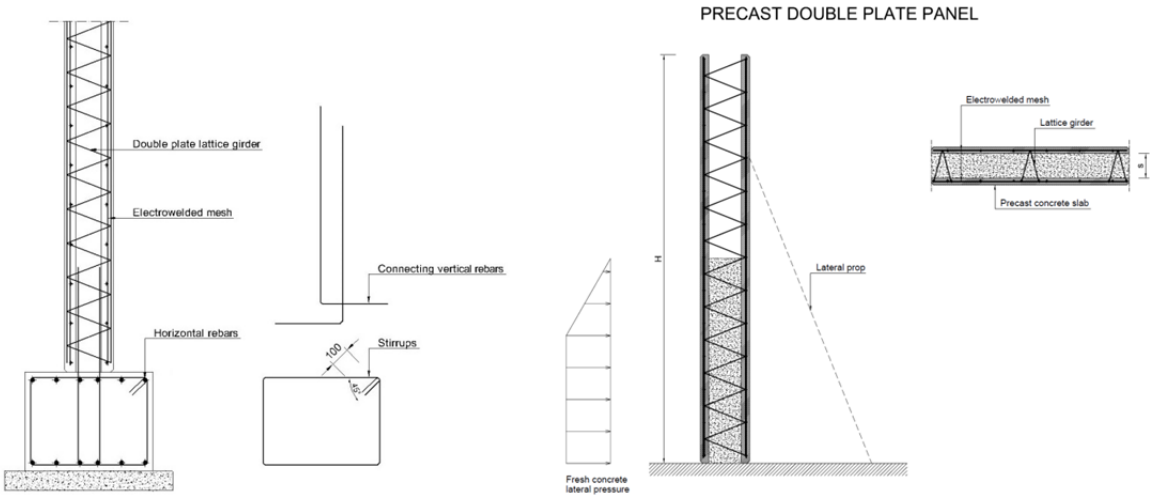


Figura 6: Particolare connessione tra parete e fondazione (sezione verticale).

Prima del getto di calcestruzzo all'interno della parete (doppia soletta armata), l'elemento prefabbricato deve essere puntellato; i puntelli devono ancorarsi ad una piastra capace di sopportare gli sforzi di compressione e trazione esercitati da essi. Nella zona d'angolo occorre fissare la parete a doppia lastra, mediante un piatto d'acciaio opportunamente sagomato, oppure utilizzando altri puntelli.

Figura 7: Operazioni di assemblaggio delle pareti.

La fase di getto del calcestruzzo fresco dovrebbe essere supervisionata al fine di mantenere una velocità al disotto del limite massimo di 50 cm/ora, evitando così che le pressioni laterali possano eccedere i 2500 daN/m^2. Inoltre, il getto deve essere eseguito in tempi diversi in accordo con il progetto dei tralicci di rinforzo delle pareti.

Per quanto riguarda i dettagli delle connessioni tra la struttura in acciaio principale (travi e pilastri) e le pareti in c.a., esistono due possibili soluzioni:

Connessione con disaccoppiamento dei carichi orizzontali e verticali

In questo caso occorre aggiungere una trave ausiliaria che trasferisca i carichi verticali alle colonne in acciaio principali, in modo da poter collegare le pareti di controvento al telaio in acciaio, separando i carichi verticali da quelli orizzontali (Figura 9).

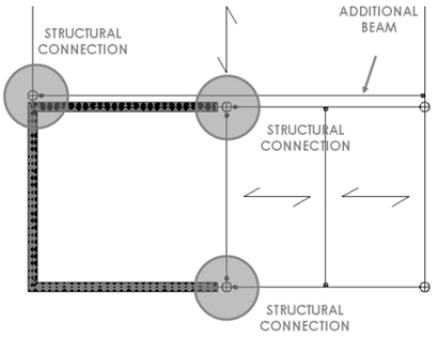


Figura 8: Tipica connessione parete-telaio, con disaccoppiamento dei carichi orizzontali e verticali (vista dall'alto).

Connessione efficace nei confronti dei carichi sia verticali che orizzontali

Con questa soluzione non è necessaria una trave ausiliaria e la connessione può realizzarsi direttamente tra le pareti ed il telaio in acciaio; in tal modo, le pareti possono sopportare anche i carichi verticali senza che questo comprometta il loro comportamento sismo-resistente (Figura 10).

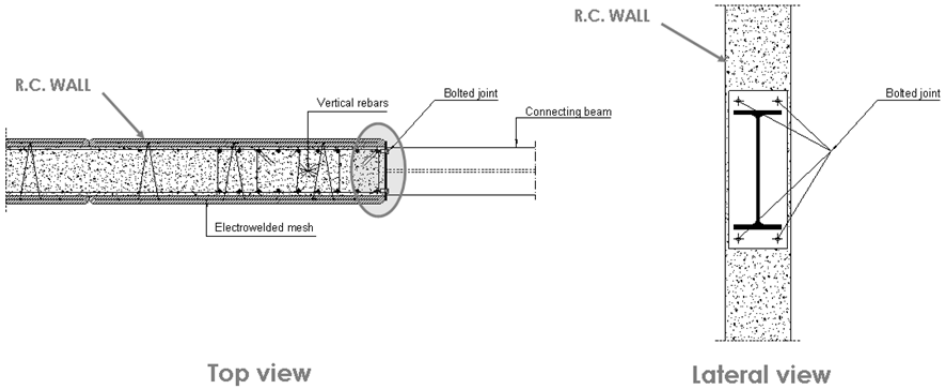


Figura 9: Tipica connessione parete-telaio, efficace per trasmettere sia i carichi verticali che orizzontali.

La connessione tra struttura in acciaio (travi e colonne) e il sistema di controvento a pareti può essere realizzata semplicemente mediante ancoraggio chimico o meccanico, una volta eretta la struttura in calcestruzzo armato.

Oppure, come metodo alternativo, potrebbero usarsi i classici collegamenti bullonati, sagomati e inglobati nella cassaforma prima di gettare il calcestruzzo. Se la struttura principale è isolata mediante dispositivi dissipativi, ad ogni livello di piano saranno previsti opportuni giunti in acciaio idonei a prevenire il martellamento tra le pareti e i solai della struttura.

6. Confronto tra controvento a pareti e controventi in acciaio

Una delle parti della ricerca ampiamente sviluppata dalla FeNO è stata quella del confronto tra il sistema sismo-resistente con pareti in calcestruzzo armato e quello costituito da controventi in acciaio, sia concentrici che eccentrici.

Prima di tutto, il modello di costo è stato aggiornato al corrente anno considerando sia analisi di prezzo dettagliate che le liste dei prezzi ufficiali delle pubbliche amministrazioni (quest'attività è stata riassunta nella Tabella 2), raccogliendo informazioni provenienti da diversi paesi (Italia – Europa del Sud; Germania – Europa Centrale).

Tabella 2: Costi unitari di produzione aggiornati (Italia – Europa del Sud; Germania – Europa Centrale).

VOCE	COSTI UNITARI	U.M.	NOTE
Cls per pareti in c.a (senza cassaforma)	**322.22**	€/m^3	C25/30, XC2, S4.
Cls per lastre in c.a (senza cassaforma)	**222.22**	€/m^3	C25/30, XC2, S4.
Acciaio per strutture in c.a.	**1.90**	€/kg	
Parete prefabbricata a doppia piastra in c.a.	**23.25**	€/m^2	Incluso il costo del traliccio di rinforzo, reti elettrosaldate e montaggio. Escludendo il getto in opera del calcestruzzo fresco.
Solaio prefabbricato in c.a. (Predalle)	**32.99**	€/m^2	Soluzione non puntellata.
Solaio con lamiera grecata	**54.57**	€/m^2	Soluzione non puntellata.
Acciaio per telaio strutturale	**2.74**	€/kg	S355, comprensivo di trattamenti superficiali, posa in opera, giunti bullonati e saldati.

Dal database *Precasteel* completo implementato da FeNO (per il sistema di controvento a pareti in c.a.) e da UniCAM (per il sistema a controventi in acciaio), è importante comprendere la convenienza nella scelta di uno specifico sistema di controvento. Solo allora, è stato possibile confrontare le diverse soluzioni in termini di area d'influenza e costo unitario totale, variando i parametri geometrici, i livelli di carico e la capacità dissipativa per ciascun tipo di sistema di controvento.

Nelle analisi comparative mostrate nel seguito, è possibile osservare come il sistema di orizzontamento in c.a. (Predalle) risulti sempre più conveniente, in termini di costo, dell'alternativo sistema con lamiera grecata; per questo motivo, questa soluzione costruttiva è assunta come parametro costante in ciascuna valutazione comparativa effettuata.

Per le tre distribuzioni di forze A, C e D, le analisi hanno evidenziato i principali vantaggi derivanti dall'uso della soluzione con pareti rispetto a quella con controventi in acciaio (concentrici o eccentrici), sia in termini di area d'influenza che di costo unitario (si vedano la Figura 11 e la Figura 12, per la distribuzione tipo C).

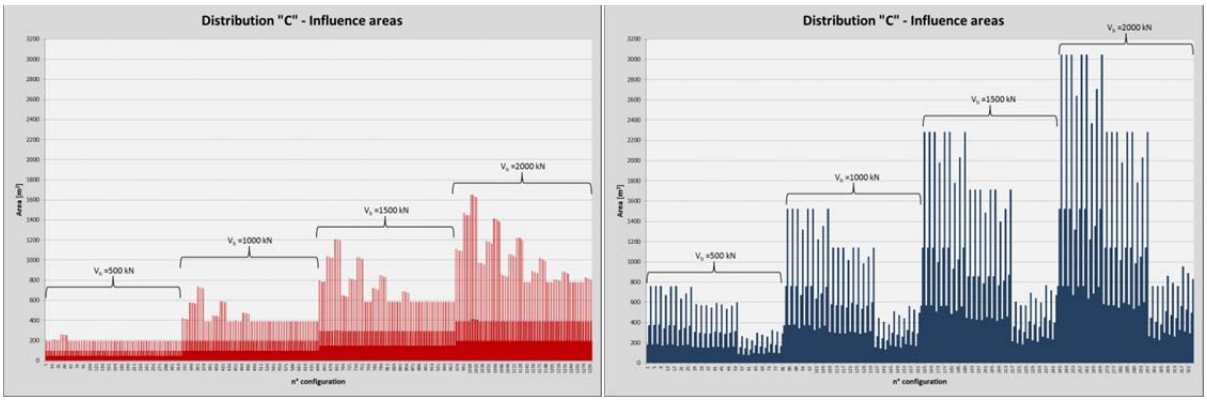


Figura 10: Confronto in termini di area d'influenza – pareti in c.a (sinistra) vs. controventi concentrici in acciaio (destra).

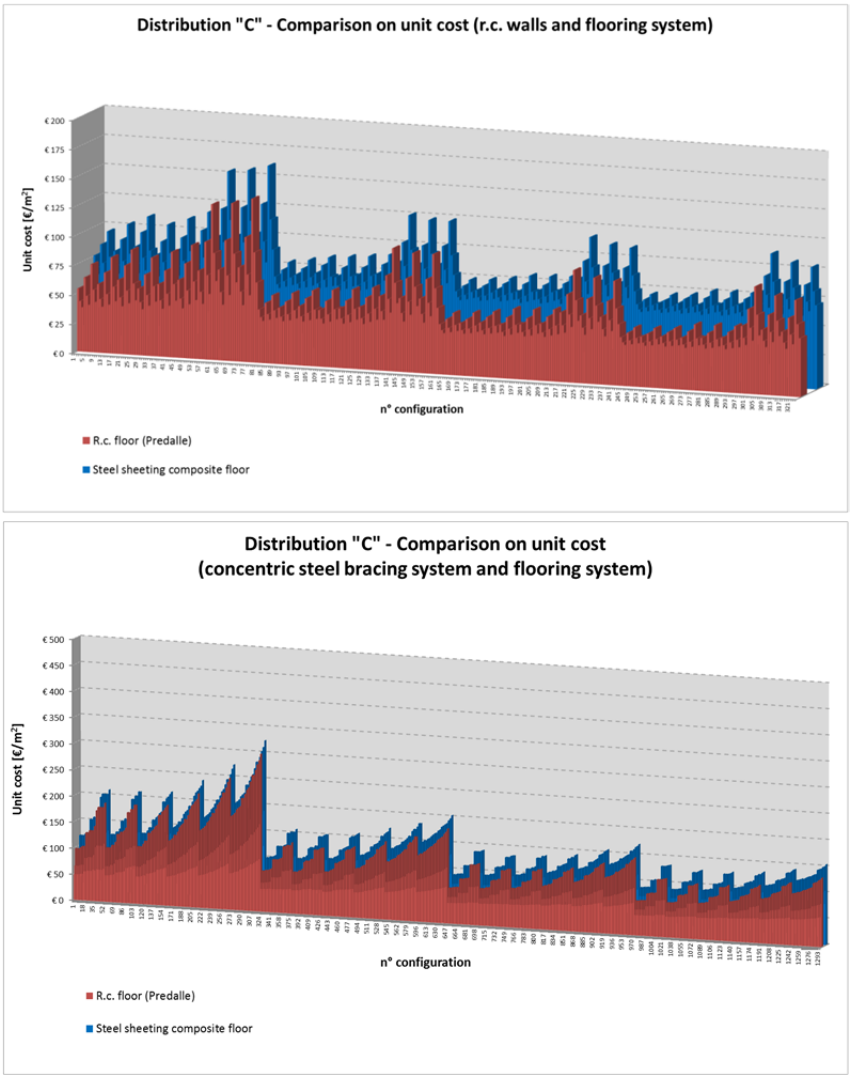


Figura 11: Confronto in termini di costi unitari – pareti in c.a. (sopra) vs. controventi concentrici in acciaio (sotto).

Inoltre, confrontando tutte le possibili configurazioni per entrambe le soluzioni strutturali (pareti e controventi in acciaio), è importante notare come il sistema di controventi in acciaio non sempre resiste nell'intervallo di tagli alla base V_b = 500÷2000 kN ma, spesso, è vincolato dai limiti di progetto imposti sulle forze dalla geometria dei profili commerciali in acciaio.

Al fine di confermare le osservazioni e le scoperte effettuate da FeNO in merito alla convenienza della soluzione a pareti in c.a. rispetto ai controventi in acciaio (concentrici o eccentrici), la Tabella 3 a seguire, mostra il campionamento del database e i risultati scaturiti dalle analisi comparative (estraendo 72 casi da una popolazione di 972 configurazioni; per maggiori dettagli si vedano gli Annessi 1, 2, 3). La suddetta attività di campionamento del database è stata condotta fissando alcuni parametri relativi alla geometria e ai livelli di carico, al fine di valutare le configurazioni di controventamento più rappresentative:

- altezza interpiano delle pareti:
  H = 6 - 8 m (edifici a un piano);
  H = 4 - 6 m (edifici a due piani);
- larghezza pareti:
  B = 8 m (edifici a un piano);
  B = 4 m (edifici a due piani);
- livello di sismicità (PGA, accelerazione di picco al suolo):
  a_g = 0.16 g (media sismicità).

Tabella 3: Campionamento del database e confronto risultati (distribuzione C).

DATABASE SAMPLING - COMPARING ACTIVITY (PARAMETERS: INFLUENCE AREA, UNIT COST)											
COMPARISON n°	DISTRIBUTION	SEISMICITY (a_g)	R.C. WALL BRACING SYSTEM				BASE SHEAR V_b [kN]	STEEL BRACING SYSTEM			RESULTS
			B [m]	H [m]	s [m]	DUCTILITY CLASS		CONCENTRIC	ECCENTRIC 2 DIAGONALS	ECCENTRIC 1 DIAGONAL	
1	C	0.16 g	4.00	4.00	0.20	DCH	500	R.C. WALL SYSTEM	R.C. WALL SYSTEM	R.C. WALL SYSTEM	
2	C	0.16 g	4.00	4.00	0.20	DCM	500	R.C. WALL SYSTEM	R.C. WALL SYSTEM	R.C. WALL SYSTEM	
3	C	0.16 g	4.00	4.00	0.20	DCL	500	R.C. WALL SYSTEM	STEEL BRACING SYSTEM	STEEL BRACING SYSTEM	
4	C	0.16 g	4.00	4.00	0.20	DCH	1000	R.C. WALL SYSTEM	R.C. WALL SYSTEM	R.C. WALL SYSTEM	
5	C	0.16 g	4.00	4.00	0.20	DCM	1000	R.C. WALL SYSTEM	R.C. WALL SYSTEM	R.C. WALL SYSTEM	
6	C	0.16 g	4.00	4.00	0.20	DCL	1000	R.C. WALL SYSTEM	R.C. WALL SYSTEM	R.C. WALL SYSTEM	
7	C	0.16 g	4.00	4.00	0.20	DCH	1500	R.C. WALL SYSTEM	R.C. WALL SYSTEM	R.C. WALL SYSTEM	
8	C	0.16 g	4.00	4.00	0.20	DCM	1500	R.C. WALL SYSTEM	R.C. WALL SYSTEM	R.C. WALL SYSTEM	
9	C	0.16 g	4.00	4.00	0.20	DCL	1500	R.C. WALL SYSTEM	STEEL BRACING SYSTEM	R.C. WALL SYSTEM	
10	C	0.16 g	4.00	4.00	0.20	DCH	2000	R.C. WALL SYSTEM	R.C. WALL SYSTEM	R.C. WALL SYSTEM	
11	C	0.16 g	4.00	4.00	0.20	DCM	2000	R.C. WALL SYSTEM	R.C. WALL SYSTEM	R.C. WALL SYSTEM	
12	C	0.16 g	4.00	4.00	0.20	DCL	2000	R.C. WALL SYSTEM	R.C. WALL SYSTEM	R.C. WALL SYSTEM	
13	C	0.16 g	4.00	6.00	0.30	DCH	500	R.C. WALL SYSTEM	R.C. WALL SYSTEM	R.C. WALL SYSTEM	
14	C	0.16 g	4.00	6.00	0.30	DCM	500	R.C. WALL SYSTEM	R.C. WALL SYSTEM	STEEL BRACING SYSTEM	
15	C	0.16 g	4.00	6.00	0.30	DCL	500	R.C. WALL SYSTEM	STEEL BRACING SYSTEM	STEEL BRACING SYSTEM	
16	C	0.16 g	4.00	6.00	0.30	DCH	1000	R.C. WALL SYSTEM	R.C. WALL SYSTEM	R.C. WALL SYSTEM	
17	C	0.16 g	4.00	6.00	0.30	DCM	1000	R.C. WALL SYSTEM	R.C. WALL SYSTEM	R.C. WALL SYSTEM	
18	C	0.16 g	4.00	6.00	0.30	DCL	1000	R.C. WALL SYSTEM	STEEL BRACING SYSTEM	R.C. WALL SYSTEM	
19	C	0.16 g	4.00	6.00	0.30	DCH	1500	R.C. WALL SYSTEM	R.C. WALL SYSTEM	R.C. WALL SYSTEM	
20	C	0.16 g	4.00	6.00	0.30	DCM	1500	R.C. WALL SYSTEM	R.C. WALL SYSTEM	R.C. WALL SYSTEM	
21	C	0.16 g	4.00	6.00	0.30	DCL	1500	R.C. WALL SYSTEM	STEEL BRACING SYSTEM	R.C. WALL SYSTEM	
22	C	0.16 g	4.00	6.00	0.30	DCH	2000	R.C. WALL SYSTEM	R.C. WALL SYSTEM	R.C. WALL SYSTEM	
23	C	0.16 g	4.00	6.00	0.30	DCM	2000	R.C. WALL SYSTEM	R.C. WALL SYSTEM	R.C. WALL SYSTEM	
24	C	0.16 g	4.00	6.00	0.30	DCL	2000	STEEL BRACING SYSTEM	R.C. WALL SYSTEM	R.C. WALL SYSTEM	

I risultati dell'attività di confronto sono riassunti mediante i successivi diagrammi a torta (si veda la Figura 13, per la distribuzione C), i quali forniscono una stima sull'efficienza di ciascun sistema di controvento analizzato. Le considerazioni scaturite dal confronto sono valide per le distribuzioni A, C, e D, a testimonianza dei significativi vantaggi apportati dalla soluzione con controventi a pareti in c.a. rispetto all'alternativa soluzione con controventi in acciaio, come osservabile dai grafici a torta.

	COMPARISON RESULTS		CONCENTRIC		ECCENTRIC 2 DIAGONALS		ECCENTRIC 1 DIAGONAL	
	N°	%	N°	%	N°	%	N°	%
Total comparisons	72	100%	24	100%	24	100%	24	100%
Comparison in favor of r.c. wall	63	88%	23	96%	19	79%	21	88%
Comparison in favor of steel bracing system	9	13%	1	4%	5	21%	3	13%

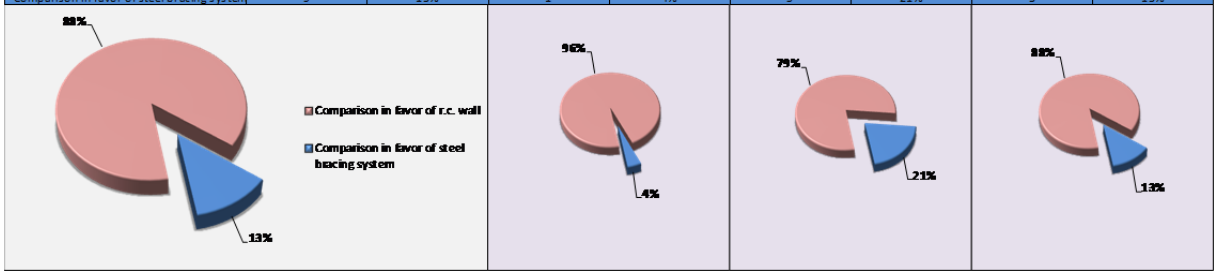


Figura 12: Campionamento del database e confronto - pareti in c.a. vs. controventi in acciaio (concentrici ed eccentrici)

Per mezzo della procedura menzionata, si è arrivati ad ottenere importanti risultati.

Vale la pena notare, ed è importante sottolineare, i seguenti aspetti in merito all'adozione di pareti in c.a. come sistemi di controvento per edifici commerciali: la soluzione con pareti in c.a. risulta quasi sempre (96%) competitiva con la soluzione a controventi concentrici, grazie alla sua capacità di dissipare energia sismica, sebbene essa comporti sull'edificio dei periodi di vibrazione generalmente più bassi; la considerazione appena esposta è spesso vera (79% e 88%) quando si confrontano le prestazioni del sistema a pareti con quelle del sistema a controventi eccentrici in acciaio, i quali, pur possedendo una capacità dissipativa di gran lunga maggiore sotto azioni cicliche (in particolare, azioni sismiche), hanno un limite superiore di resistenza che ne impedisce l'utilizzo in svariate situazioni.

L'ipotesi principale del metodo, di disaccoppiare i carichi orizzontali e verticali nella struttura portante di edifici commerciali deve essere strettamente rispettata quando si adotta la soluzione a controventi in acciaio, specialmente se eccentrici; infatti, in sistemi di questo tipo, la presenza di carichi verticali (permanenti o variabili) potrebbe compromettere il comportamento sismico del link dissipativo, riducendone notevolmente la capacità dissipativa rispetto alla configurazione con soli carichi laterali trasmessi. Al contrario, le pareti in c.a. sono in grado di sopportare anche i carichi verticali durante un terremoto, senza compromettere la capacità di dissipare l'energia sismica; questa caratteristica evidenzia una più ampia versatilità di utilizzo della soluzione a pareti in c.a. e, inoltre, consente ai progettisti di ridurre il numero degli elementi strutturali in acciaio (colonne, travi e nodi, posti nell'intorno del sistema di controvento per sostenere i carichi verticali) con conseguente abbattimento dei costi totali di realizzazione dell'edificio.

ANNESSO 1

CONFRONTO TRA SISTEMA A PARETI IN C.A. E SISTEMA A CONTROVENTI IN ACCIAIO

Distribuzione "A"

COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=8m; H=6m; V_b=500 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wall surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
1	6.00	8.00	0.30	500	A	0.16 g	DCH	3.33	787	24	4	427	34560	14.40	48	32541	49532	41	63
1	6.00	8.00	0.30	500	A	0.16 g	DCM	2.50	673	24	4	427	34560	14.40	48	28781	43312	43	64
1	6.00	8.00	0.30	500	A	0.16 g	DCL	1.00	408	24	4	427	34560	14.40	48	20023	28826	49	71

Database UNICAM (steel bracing system - concentric, 2 diagonals):

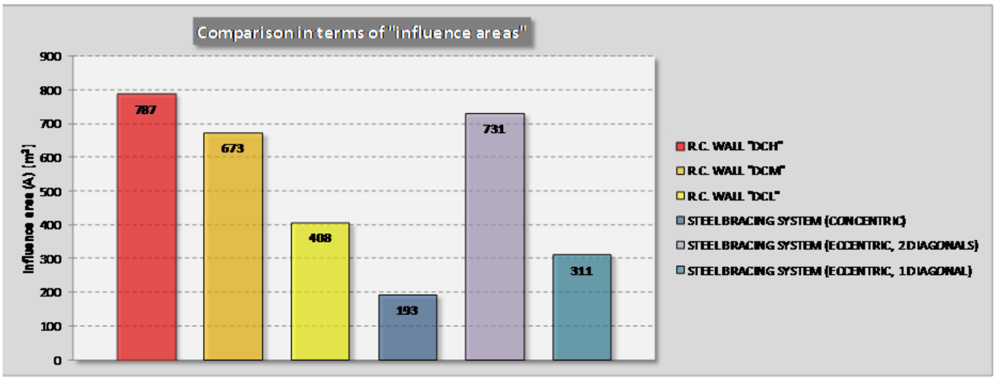
INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	6.00	2.00	0.16	500	HE 180A	HE 220A	HE 160 A	193	1377	10136	14300	53	74
8.00	6.00	2.00	0.16	500	HE 180A	HE 220A	HE 160 A	193	1377	10136	14300	53	74
8.00	6.00	2.00	0.16	500	HE 180A	HE 220A	HE 180 A	193	1438	10304	14468	53	75
8.00	6.00	2.00	0.16	500	HE 180A	HE 220A	HE 180 A	193	1438	10304	14468	53	75
8.00	6.00	2.00	0.16	500	HE 180A	HE 220A	HE 200 A	193	1520	10528	14691	55	76
8.00	6.00	2.00	0.16	500	HE 180A	HE 220A	HE 220 A	193	1618	10797	14961	56	78

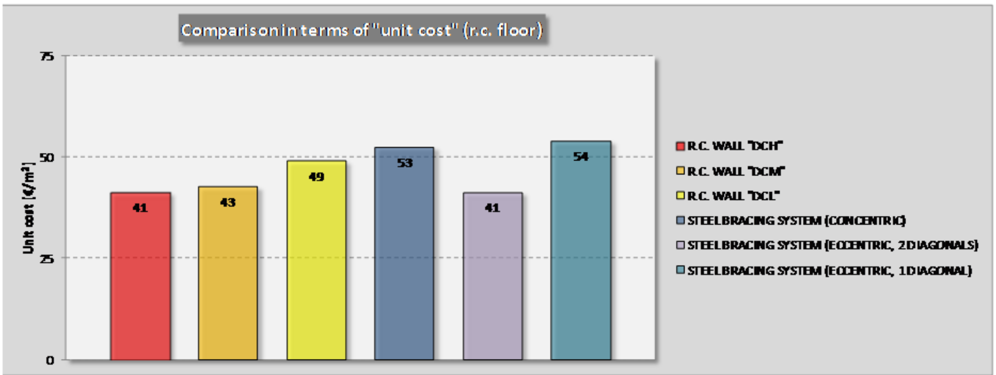
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	6.00	2.00	0.16	500	HE 220B	HE 240 B	HE 160 B	731	2248	30285	46072	41	63
8.00	6.00	2.00	0.16	500	HE 220B	HE 240 B	HE 160 B	731	2248	30285	46072	41	63
8.00	6.00	2.00	0.16	500	HE 220B	HE 240 B	HE 160 B	731	2248	30285	46072	41	63
8.00	6.00	2.00	0.16	500	HE 220B	HE 240 B	HE 180 B	732	2351	30580	46374	42	63
8.00	6.00	2.00	0.16	500	HE 220B	HE 240 B	HE 180 B	732	2351	30580	46374	42	63
8.00	6.00	2.00	0.16	500	HE 220B	HE 240 B	HE 200 B	732	2472	30921	46722	42	64

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	6.00	2.00	0.16	250	HE 160M	HE 240 B	HE 320 B	311	2390	16814	23531	54	76
4.00	6.00	2.00	0.16	250	HE 160M	HE 240 B	HE 340 B	330	2481	17678	24798	54	75
4.00	6.00	2.00	0.16	250	HE 160M	HE 240 B	HE 340 B	330	2481	17678	24798	54	75
4.00	6.00	2.00	0.16	250	HE 160M	HE 240 B	HE 340 B	330	2481	17678	24798	54	75
4.00	6.00	2.00	0.16	250	HE 160M	HE 240 B	HE 340 B	330	2481	17678	24798	54	75
4.00	6.00	2.00	0.16	250	HE 160M	HE 240 B	HE 340 B	330	2481	17678	24798	54	75





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=8m; H=6m; V_b=1000 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness s [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/ Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wall surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
1	6.00	8.00	0.30	1000	A	0.16 g	DCH	3.33	1536	48	6	618	34560	14.40	48	57614	90771	37	59
1	6.00	8.00	0.30	1000	A	0.16 g	DCM	2.50	1256	48	6	618	34560	14.40	48	48351	75450	39	60
1	6.00	8.00	0.30	1000	A	0.16 g	DCL	1.00	703	48	6	618	34560	14.40	48	30113	45279	43	64

Database UNICAM (steel bracing system - concentric, 2 diagonals):

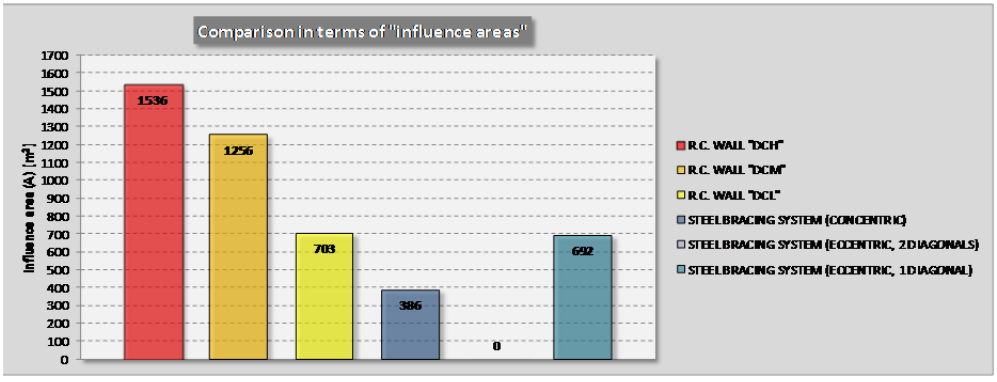
INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	6.00	2.00	0.16	1000	HE 220A	HE 260A	HE 160A	386	1752	17528	25855	45	67
8.00	6.00	2.00	0.16	1000	HE 220A	HE 260A	HE 160A	386	1752	17528	25855	45	67
8.00	6.00	2.00	0.16	1000	HE 220A	HE 260A	HE 180A	386	1814	17695	26022	46	67
8.00	6.00	2.00	0.16	1000	HE 220A	HE 260A	HE 180A	386	1814	17695	26022	46	67
8.00	6.00	2.00	0.16	1000	HE 220A	HE 260A	HE 200A	386	1895	17919	26246	46	68
8.00	6.00	2.00	0.16	1000	HE 220A	HE 260A	HE 220A	386	1994	18189	26516	47	69

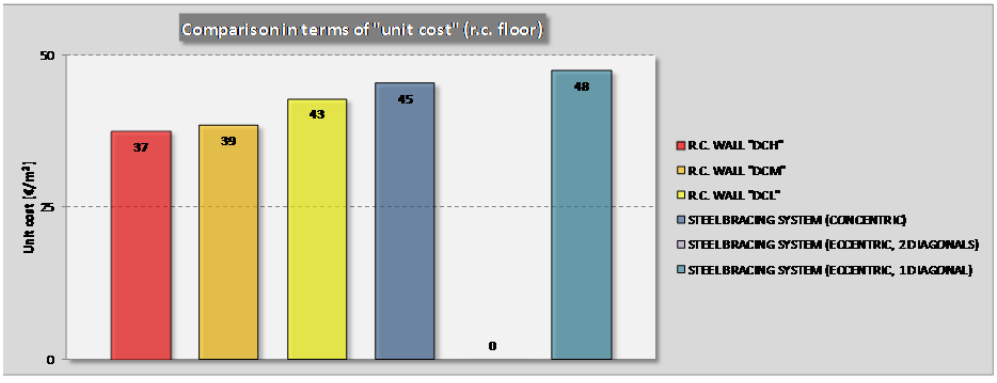
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	6.00	2.00	0.16	1000	-	-	-	-	-	-	-	-	-
8.00	6.00	2.00	0.16	1000	-	-	-	-	-	-	-	-	-
8.00	6.00	2.00	0.16	1000	-	-	-	-	-	-	-	-	-
8.00	6.00	2.00	0.16	1000	-	-	-	-	-	-	-	-	-
8.00	6.00	2.00	0.16	1000	-	-	-	-	-	-	-	-	-
8.00	6.00	2.00	0.16	1000	-	-	-	-	-	-	-	-	-

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	6.00	2.00	0.16	500	HE 240M	HE 300B	HE 500B	692	3670	32897	47842	48	69
4.00	6.00	2.00	0.16	500	HE 240M	HE 300B	HE 500B	692	3670	32897	47842	48	69
4.00	6.00	2.00	0.16	500	HE 240M	HE 300B	HE 500B	692	3670	32897	47842	48	69
4.00	6.00	2.00	0.16	500	HE 240M	HE 300B	HE 550B	665	3816	32396	46752	49	70
4.00	6.00	2.00	0.16	500	HE 240M	HE 300B	HE 550B	665	3816	32396	46752	49	70
4.00	6.00	2.00	0.16	500	HE 240M	HE 300B	HE 550B	665	3816	32396	46752	49	70





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=8m; H=6m; V_b=1500 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/ Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wall surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
1	6.00	8.00	0.30	1500	A	0.16 g	DCH	3.33	2263	72	9	848	34560	14.40	48	82028	130872	36	58
1	6.00	8.00	0.30	1500	A	0.16 g	DCM	2.50	1795	72	9	848	34560	14.40	48	66574	105308	37	59
1	6.00	8.00	0.30	1500	A	0.16 g	DCL	1.00	960	72	9	848	34560	14.40	48	39033	59748	41	62

Database UNICAM (steel bracing system - concentric, 2 diagonals):

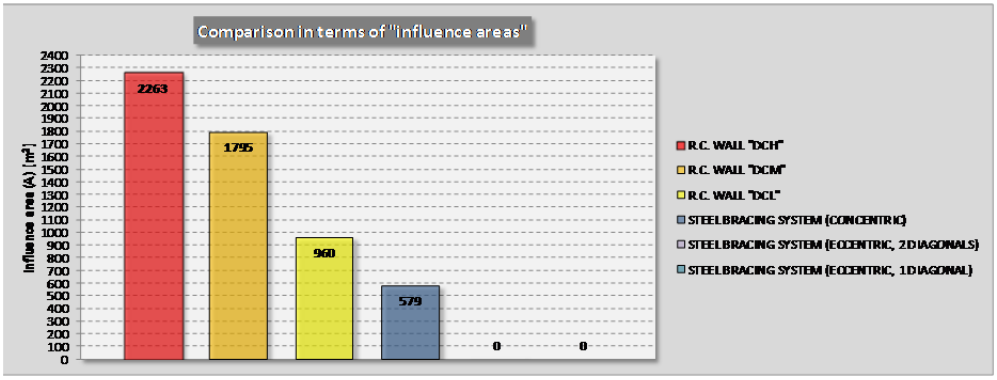
INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	6.00	2.00	0.16	1500	HE 240 A	HE 300 A	HE 160 A	579	2121	24900	37391	43	65
8.00	6.00	2.00	0.16	1500	HE 240 A	HE 300 A	HE 160 A	579	2121	24900	37391	43	65
8.00	6.00	2.00	0.16	1500	HE 240 A	HE 300 A	HE 180 A	579	2182	25068	37558	43	65
8.00	6.00	2.00	0.16	1500	HE 240 A	HE 300 A	HE 180 A	579	2182	25068	37558	43	65
8.00	6.00	2.00	0.16	1500	HE 240 A	HE 300 A	HE 200 A	579	2263	25291	37782	44	65
8.00	6.00	2.00	0.16	1500	HE 240 A	HE 300 A	HE 220 A	579	2362	25561	38051	44	66

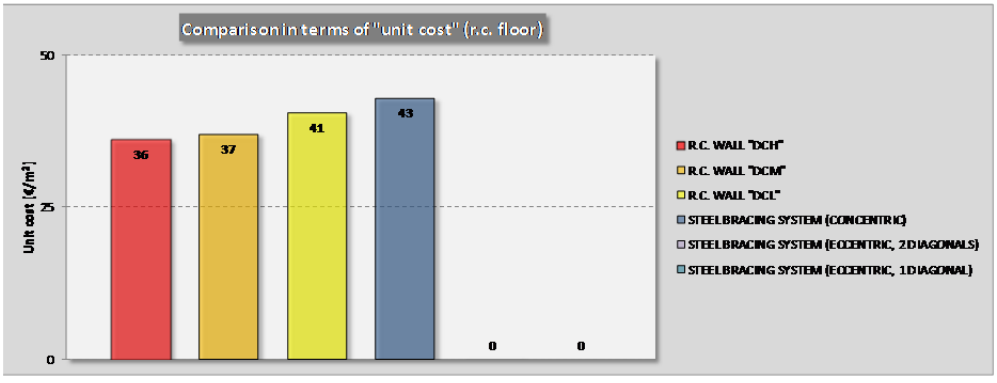
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	6.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-
8.00	6.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-
8.00	6.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-
8.00	6.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-
8.00	6.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-
8.00	6.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	6.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-
4.00	6.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-
4.00	6.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-
4.00	6.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-
4.00	6.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-
4.00	6.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=8m; H=6m; V_b=2000 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/ Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wall surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
1	6.00	8.00	0.30	2000	A	0.16 g	DCH	3.33	2987	96	12	1078	34560	14.40	48	106329	170785	36	57
1	6.00	8.00	0.30	2000	A	0.16 g	DCM	2.50	2305	96	12	1078	34560	14.40	48	83832	133571	36	58
1	6.00	8.00	0.30	2000	A	0.16 g	DCL	1.00	1195	96	12	1078	34560	14.40	48	47207	72985	40	61

Database UNICAM (steel bracing system - concentric, 2 diagonals):

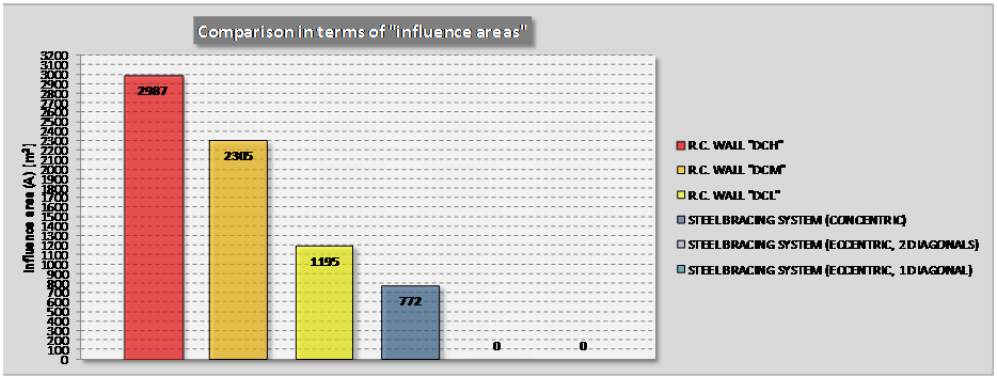
INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	6.00	2.00	0.16	2000	HE 280 A	HE 360 A	HE 160 A	772	2591	32552	49207	42	64
8.00	6.00	2.00	0.16	2000	HE 280 A	HE 360 A	HE 160 A	772	2591	32552	49207	42	64
8.00	6.00	2.00	0.16	2000	HE 280 A	HE 360 A	HE 180 A	772	2652	32720	49374	42	64
8.00	6.00	2.00	0.16	2000	HE 280 A	HE 360 A	HE 180 A	772	2652	32720	49374	42	64
8.00	6.00	2.00	0.16	2000	HE 280 A	HE 360 A	HE 200 A	772	2734	32944	49598	43	64
8.00	6.00	2.00	0.16	2000	HE 280 A	HE 360 A	HE 220 A	772	2832	33213	49867	43	65

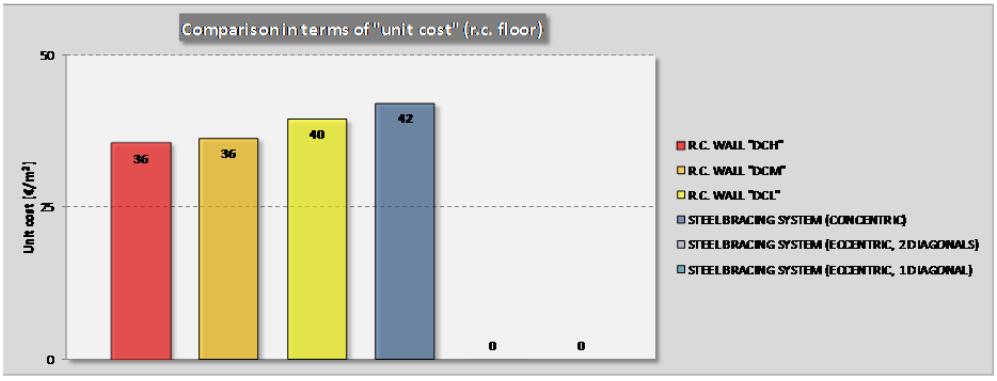
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	6.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-
8.00	6.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-
8.00	6.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-
8.00	6.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-
8.00	6.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-
8.00	6.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	6.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-
4.00	6.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-
4.00	6.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-
4.00	6.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-
4.00	6.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-
4.00	6.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=8m; H=8m; V_b=500 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wall surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
1	8.00	8.00	0.40	500	A	0.16 g	DCH	4.00	876	32	4	693	61440	25.60	64	39940	58839	46	67
1	8.00	8.00	0.40	500	A	0.16 g	DCM	3.00	731	32	4	693	61440	25.60	64	35172	50951	48	70
1	8.00	8.00	0.40	500	A	0.16 g	DCL	1.00	384	32	4	693	61440	25.60	64	23723	32012	62	83

Database UNICAM (steel bracing system - concentric, 2 diagonals):

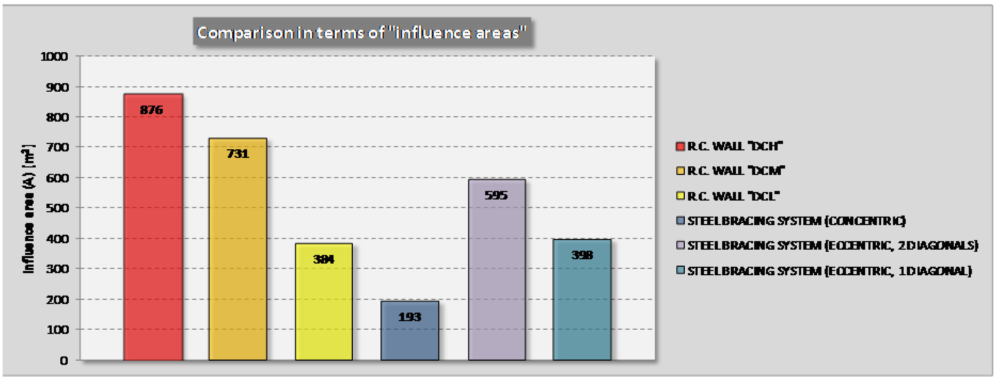
INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	8.00	2.00	0.16	500	HE 180 A	HE 260 A	HE 220 A	193	2312	12698	16861	66	87
8.00	8.00	2.00	0.16	500	HE 180 A	HE 260 A	HE 220 A	193	2312	12698	16861	66	87
8.00	8.00	2.00	0.16	500	HE 180 A	HE 260 A	HE 220 A	193	2312	12698	16861	66	87
8.00	8.00	2.00	0.16	500	HE 180 A	HE 260 A	HE 220 A	193	2312	12698	16861	66	87
8.00	8.00	2.00	0.16	500	HE 180 A	HE 260 A	HE 220 A	193	2312	12698	16861	66	87
8.00	8.00	2.00	0.16	500	HE 180 A	HE 260 A	HE 240 A	193	2469	13128	17291	68	90

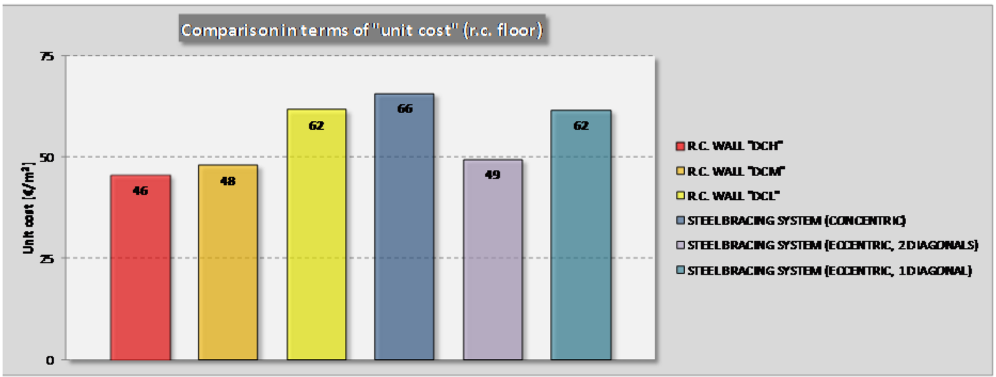
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	8.00	2.00	0.16	500	HE 180M	HE 300 B	HE 180 B	595	3583	29433	42267	49	71
8.00	8.00	2.00	0.16	500	HE 180M	HE 300 B	HE 200 B	595	3745	29886	42728	50	72
8.00	8.00	2.00	0.16	500	HE 180M	HE 300 B	HE 200 B	595	3745	29886	42728	50	72
8.00	8.00	2.00	0.16	500	HE 180M	HE 300 B	HE 220 B	595	3908	30342	43189	51	73
8.00	8.00	2.00	0.16	500	HE 180M	HE 300 B	HE 220 B	595	3908	30342	43189	51	73
8.00	8.00	2.00	0.16	500	HE 180M	HE 300 B	HE 220 B	595	3908	30342	43189	51	73

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	8.00	2.00	0.16	250	HE 200M	HE 300 B	HE 450 B	398	4159	24514	33098	62	83
4.00	8.00	2.00	0.16	250	HE 200M	HE 300 B	HE 450 B	398	4159	24514	33098	62	83
4.00	8.00	2.00	0.16	250	HE 200M	HE 300 B	HE 450 B	398	4159	24514	33098	62	83
4.00	8.00	2.00	0.16	250	HE 200M	HE 300 B	HE 450 B	398	4159	24514	33098	62	83
4.00	8.00	2.00	0.16	250	HE 200M	HE 300 B	HE 450 B	398	4159	24514	33098	62	83
4.00	8.00	2.00	0.16	250	HE 200M	HE 300 B	HE 500 B	423	4418	26055	35184	62	83





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=8m; H=8m; V_b=1000 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness s [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wall surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
1	8.00	8.00	0.40	1000	A	0.16 g	DCH	4.00	1784	64	6	999	61440	25.60	64	70476	108970	40	61
1	8.00	8.00	0.40	1000	A	0.16 g	DCM	3.00	1394	64	6	999	61440	25.60	64	57604	87679	41	63
1	8.00	8.00	0.40	1000	A	0.16 g	DCL	1.00	658	64	6	999	61440	25.60	64	33336	47534	51	72

Database UNICAM (steel bracing system - concentric, 2 diagonals):

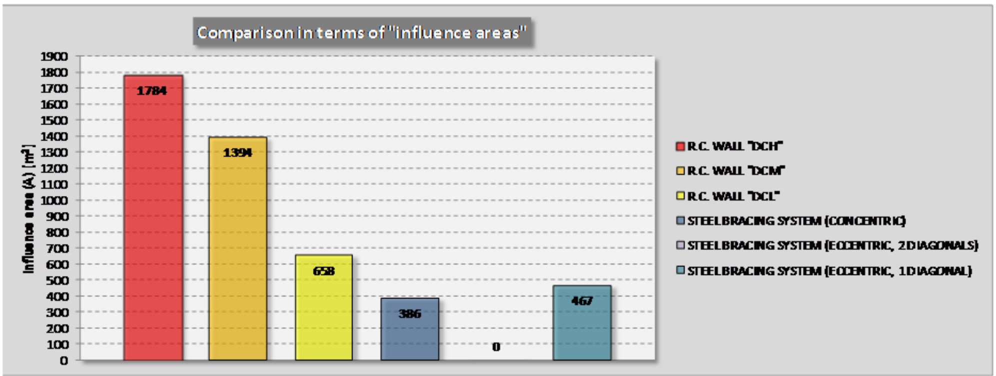
INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	8.00	2.00	0.16	1000	HE 220 A	HE 320 A	HE 220 A	386	2958	20831	29158	54	76
8.00	8.00	2.00	0.16	1000	HE 220 A	HE 320 A	HE 220 A	386	2958	20831	29158	54	76
8.00	8.00	2.00	0.16	1000	HE 220 A	HE 320 A	HE 220 A	386	2958	20831	29158	54	76
8.00	8.00	2.00	0.16	1000	HE 220 A	HE 320 A	HE 220 A	386	2958	20831	29158	54	76
8.00	8.00	2.00	0.16	1000	HE 220 A	HE 320 A	HE 220 A	386	2958	20831	29158	54	76
8.00	8.00	2.00	0.16	1000	HE 220 A	HE 320 A	HE 240 A	386	3115	21260	29588	55	77

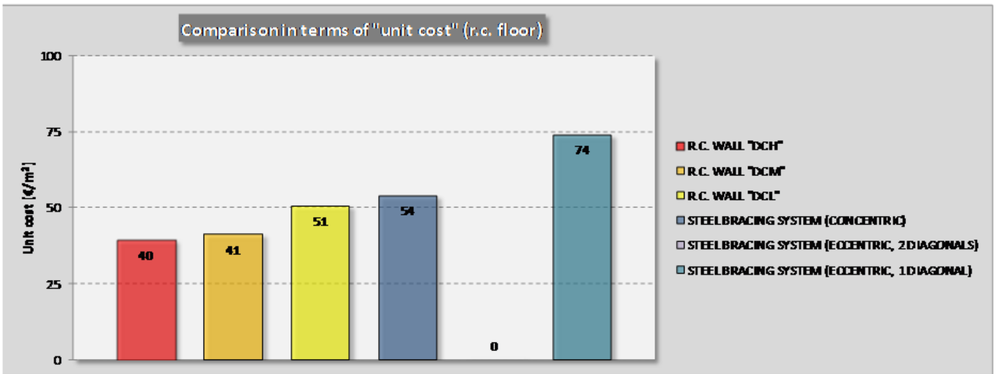
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	8.00	2.00	0.16	1000	-	-	-	-	-	-	-	-	-
8.00	8.00	2.00	0.16	1000	-	-	-	-	-	-	-	-	-
8.00	8.00	2.00	0.16	1000	-	-	-	-	-	-	-	-	-
8.00	8.00	2.00	0.16	1000	-	-	-	-	-	-	-	-	-
8.00	8.00	2.00	0.16	1000	-	-	-	-	-	-	-	-	-
8.00	8.00	2.00	0.16	1000	-	-	-	-	-	-	-	-	-

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	8.00	2.00	0.16	500	HE 500 A	HE 650 B	HE 550 M	467	7008	34604	44682	74	96
4.00	8.00	2.00	0.16	500	HE 500 A	HE 650 B	HE 550 M	467	7008	34604	44682	74	96
4.00	8.00	2.00	0.16	500	HE 500 A	HE 650 B	HE 550 M	467	7008	34604	44682	74	96
4.00	8.00	2.00	0.16	500	HE 500 A	HE 650 B	HE 550 M	467	7008	34604	44682	74	96
4.00	8.00	2.00	0.16	500	HE 500 A	HE 650 B	HE 600 M	443	7125	34133	43693	77	99
4.00	8.00	2.00	0.16	500	HE 500 A	HE 600 B	HE 650 M	456	7140	34595	44430	76	98





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=8m; H=8m; V_b=1500 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wall surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
1	8.00	8.00	0.40	1500	A	0.16 g	DCH	4.00	2688	96	9	1357	61440	25.60	64	100988	158999	38	59
1	8.00	8.00	0.40	1500	A	0.16 g	DCM	3.00	2020	96	9	1357	61440	25.60	64	78953	122548	39	61
1	8.00	8.00	0.40	1500	A	0.16 g	DCL	1.00	896	96	9	1357	61440	25.60	64	41867	61201	47	68

Database UNICAM (steel bracing system - concentric, 2 diagonals):

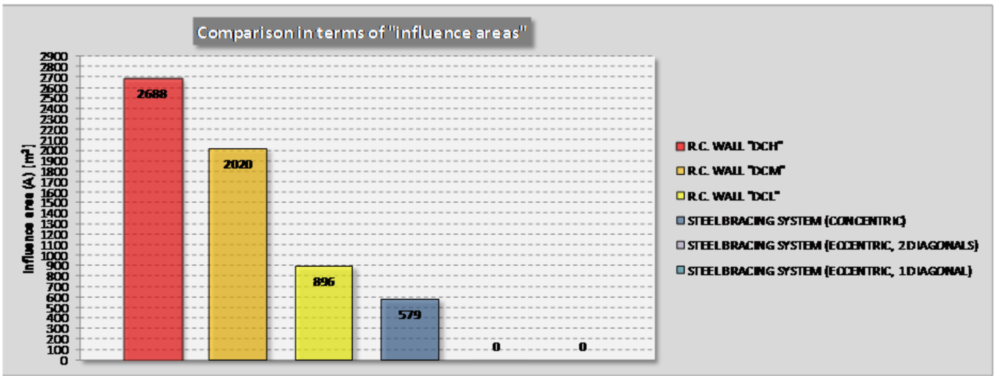
INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	8.00	2.00	0.16	1500	HE 240 A	HE 360 B	HE 220 A	579	3831	29585	42076	51	73
8.00	8.00	2.00	0.16	1500	HE 240 A	HE 360 B	HE 220 A	579	3831	29585	42076	51	73
8.00	8.00	2.00	0.16	1500	HE 240 A	HE 360 B	HE 220 A	579	3831	29585	42076	51	73
8.00	8.00	2.00	0.16	1500	HE 240 A	HE 360 B	HE 220 A	579	3831	29585	42076	51	73
8.00	8.00	2.00	0.16	1500	HE 240 A	HE 360 B	HE 220 A	579	3831	29585	42076	51	73
8.00	8.00	2.00	0.16	1500	HE 240 A	HE 360 B	HE 240 A	579	3987	30015	42505	52	73

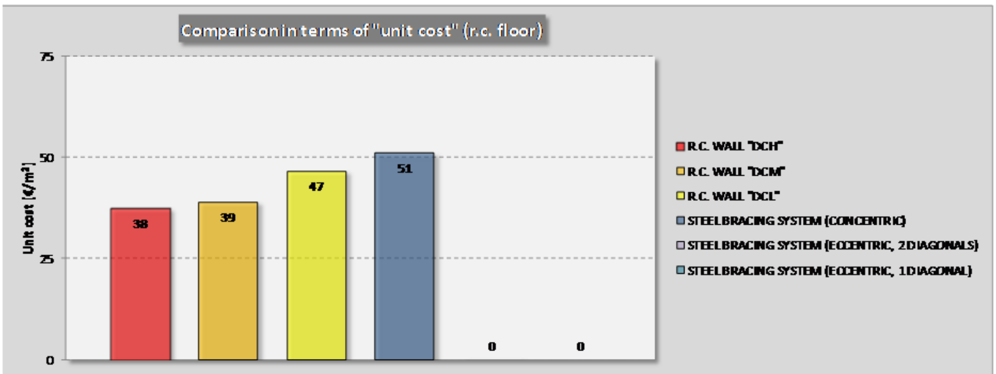
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	8.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-
8.00	8.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-
8.00	8.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-
8.00	8.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-
8.00	8.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-
8.00	8.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	8.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-
4.00	8.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-
4.00	8.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-
4.00	8.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-
4.00	8.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-
4.00	8.00	2.00	0.16	1500	-	-	-	-	-	-	-	-	-





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=8m; H=8m; V_b=2000 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness s [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wall surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
1	8.00	8.00	0.40	2000	A	0.16 g	DCH	4.00	3584	128	12	1716	61440	25.60	64	131227	208574	37	58
1	8.00	8.00	0.40	2000	A	0.16 g	DCM	3.00	2688	128	12	1716	61440	25.60	64	101669	159680	38	59
1	8.00	8.00	0.40	2000	A	0.16 g	DCL	1.00	1113	128	12	1716	61440	25.60	64	49695	73703	45	66

Database UNICAM (steel bracing system - concentric, 2 diagonals):

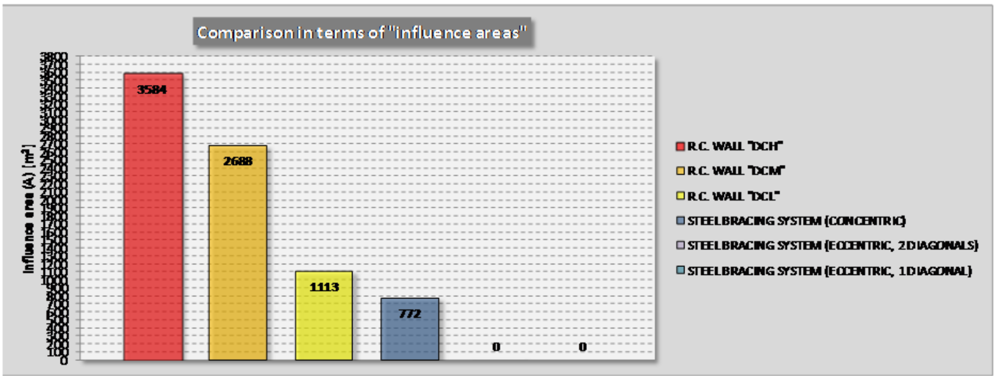
INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	8.00	2.00	0.16	2000	HE 280 A	HE 280 M	HE 220 A	772	4800	38605	55259	50	72
8.00	8.00	2.00	0.16	2000	HE 280 A	HE 280 M	HE 220 A	772	4800	38605	55259	50	72
8.00	8.00	2.00	0.16	2000	HE 280 A	HE 280 M	HE 220 A	772	4800	38605	55259	50	72
8.00	8.00	2.00	0.16	2000	HE 280 A	HE 280 M	HE 220 A	772	4800	38605	55259	50	72
8.00	8.00	2.00	0.16	2000	HE 280 A	HE 280 M	HE 220 A	772	4800	38605	55259	50	72
8.00	8.00	2.00	0.16	2000	HE 280 A	HE 280 M	HE 240 A	772	4957	39034	55688	51	72

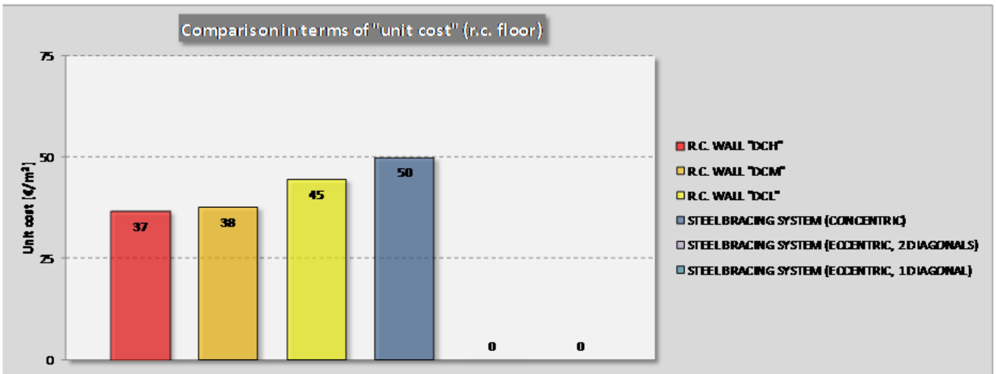
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	8.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-
8.00	8.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-
8.00	8.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-
8.00	8.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-
8.00	8.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-
8.00	8.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT					COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	DIAG [ ]	COL [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	8.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-
4.00	8.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-
4.00	8.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-
4.00	8.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-
4.00	8.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-
4.00	8.00	2.00	0.16	2000	-	-	-	-	-	-	-	-	-





ANNESSO 2

CONFRONTO TRA SISTEMA A PARETI IN C.A. E SISTEMA A CONTROVENTI IN ACCIAIO

Distribuzione "C"

COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=4m; H=4m; V_b=500 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness s [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/ Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wal surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
2	4.00	4.00	0.20	500	C	0.16 g	DCH	4.00	374	52	6	553	15360	6.40	32	16190	24257	43	65
2	4.00	4.00	0.20	500	C	0.16 g	DCM	3.00	307	52	6	553	15360	6.40	32	13970	20585	46	67
2	4.00	4.00	0.20	500	C	0.16 g	DCL	1.00	156	52	6	553	15360	6.40	32	9002	12367	58	79

Database UNICAM (steel bracing system - concentric, 2 diagonals):

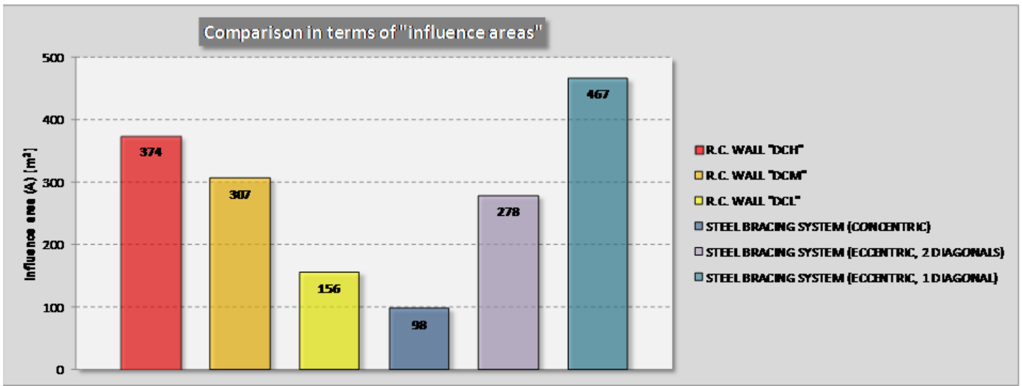
INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	BEAM1 [ ]	DIAG2 [ ]	DIAG1 [ ]	COL2 [ ]	COL1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	4.00	5.00	0.16	500	HE 100 A	HE 100A	HE 160 A	HE 180 A	HE 120 A	HE 180 A	98	1166	6422	8532	66	87
4.00	4.00	5.00	0.16	500	HE 100 A	HE 100A	HE 160 A	HE 180 A	HE 120 A	HE 180 A	98	1166	6422	8532	66	87
4.00	4.00	5.00	0.16	500	HE 100 A	HE 100A	HE 160 A	HE 180 A	HE 120 A	HE 180 A	98	1166	6422	8532	66	87
4.00	4.00	5.00	0.16	500	HE 100 A	HE 100A	HE 160 A	HE 180 A	HE 120 A	HE 200 A	98	1221	6571	8682	67	89
4.00	4.00	5.00	0.16	500	HE 100 A	HE 100A	HE 160 A	HE 180 A	HE 140 A	HE 200 A	98	1259	6676	8787	68	90
4.00	4.00	5.00	0.16	500	HE 100 A	HE 100A	HE 160 A	HE 180 A	HE 140 A	HE 200 A	98	1259	6676	8787	68	90

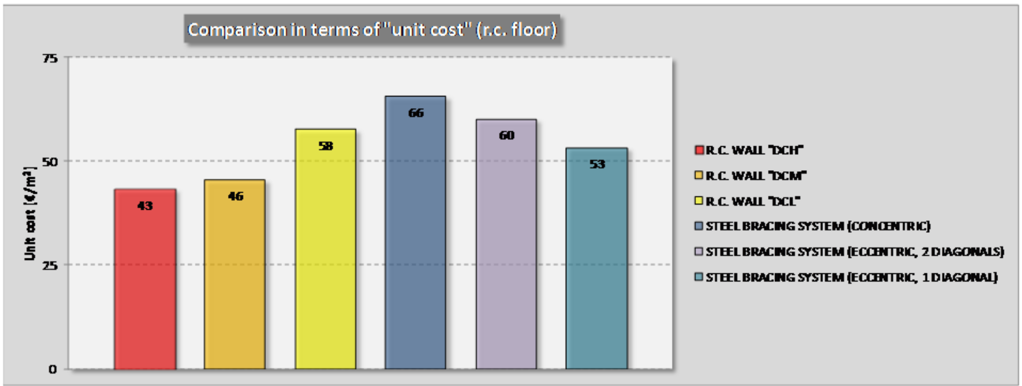
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 []	link1 []	diag2 []	diag1 []	pil2 []	pil1 []	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	4.00	5.00	0.16	500	HE 180 B	HE 180B	HE 180 B	HE 220 B	HE 120 B	HE 180 B	278	2763	16750	22756	60	82
8.00	4.00	5.00	0.16	500	HE 180 B	HE 180B	HE 180 B	HE 220 B	HE 120 B	HE 180 B	278	2763	16750	22756	60	82
8.00	4.00	5.00	0.16	500	HE 180 B	HE 180B	HE 180 B	HE 220 B	HE 140 B	HE 180 B	278	2819	16903	22909	61	82
8.00	4.00	5.00	0.16	500	HE 180 B	HE 180B	HE 180 B	HE 220 B	HE 140 B	HE 200 B	278	2900	17118	23120	62	83
8.00	4.00	5.00	0.16	500	HE 180 B	HE 180B	HE 180 B	HE 220 B	HE 160 B	HE 200 B	278	2971	17313	23316	62	84
8.00	4.00	5.00	0.16	500	HE 180 B	HE 180B	HE 180 B	HE 220 B	HE 160 B	HE 220 B	278	3053	17533	23532	63	85

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 []	link1 []	diag2 []	diag1 []	pil2 []	pil1 []	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	4.00	5.00	0.16	500	HE 140 M	HE 300B	HE 200 B	HE 260 B	HE 300 B	HE 320 B	467	3461	24878	34952	53	75
4.00	4.00	5.00	0.16	500	HE 140 M	HE 300B	HE 200 B	HE 260 B	HE 300 B	HE 320 B	467	3461	24878	34952	53	75
4.00	4.00	5.00	0.16	500	HE 140 M	HE 300B	HE 200 B	HE 260 B	HE 300 B	HE 320 B	467	3461	24878	34952	53	75
4.00	4.00	5.00	0.16	500	HE 140 M	HE 300B	HE 200 B	HE 260 B	HE 300 B	HE 320 B	467	3461	24878	34952	53	75
4.00	4.00	5.00	0.16	500	HE 140 M	HE 300B	HE 200 B	HE 260 B	HE 300 B	HE 340 B	467	3521	25061	35147	54	75
4.00	4.00	5.00	0.16	500	HE 140 M	HE 300B	HE 200 B	HE 260 B	HE 300 B	HE 340 B	467	3521	25061	35147	54	75





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=4m; H=4m; V_b=1000 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness s [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/ Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wal surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
2	4.00	4.00	0.20	1000	C	0.16 g	DCH	4.00	761	104	12	1036	15360	6.40	32	29891	46321	39	61
2	4.00	4.00	0.20	1000	C	0.16 g	DCM	3.00	582	104	12	1036	15360	6.40	32	23976	36537	41	63
2	4.00	4.00	0.20	1000	C	0.16 g	DCL	1.00	266	104	12	1036	15360	6.40	32	13551	19292	51	73

Database UNICAM (steel bracing system - concentric, 2 diagonals):

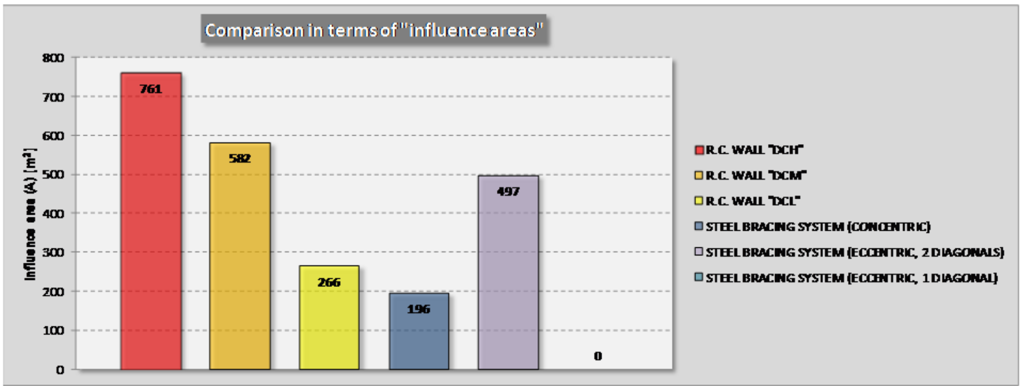
INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	BEAM1 [ ]	DIAG2 [ ]	DIAG1 [ ]	COL2 [ ]	COL1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	4.00	5.00	0.16	1000	HE 140 A	HE 140 A	HE 200 A	HE 240 A	HE 120 A	HE 200 A	196	1613	10871	15093	56	77
4.00	4.00	5.00	0.16	1000	HE 140 A	HE 140 A	HE 200 A	HE 240 A	HE 120 A	HE 200 A	196	1613	10871	15093	56	77
4.00	4.00	5.00	0.16	1000	HE 140 A	HE 140 A	HE 200 A	HE 240 A	HE 120 A	HE 220 A	196	1678	11051	15273	56	78
4.00	4.00	5.00	0.16	1000	HE 140 A	HE 140 A	HE 200 A	HE 240 A	HE 120 A	HE 220 A	196	1678	11051	15273	56	78
4.00	4.00	5.00	0.16	1000	HE 140 A	HE 140 A	HE 200 A	HE 240 A	HE 140 A	HE 220 A	196	1717	11156	15378	57	79
4.00	4.00	5.00	0.16	1000	HE 140 A	HE 140 A	HE 200 A	HE 240 A	HE 140 A	HE 240 A	196	1795	11371	15593	58	80

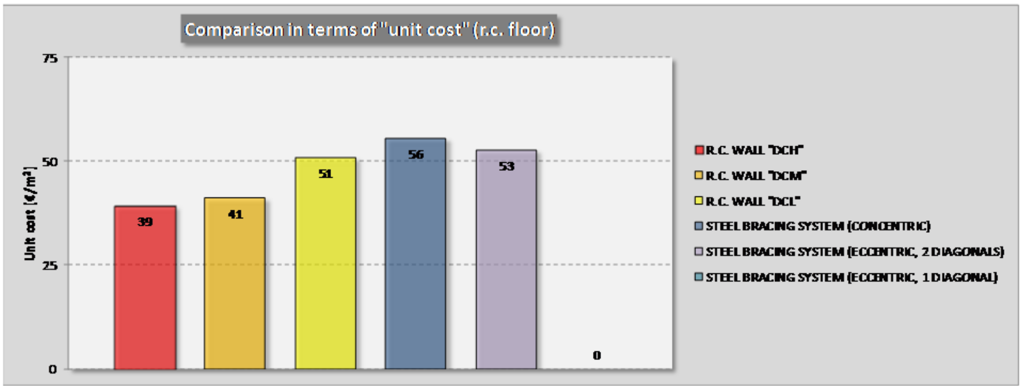
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 [ ]	link1 [ ]	diag2 [ ]	diag1 [ ]	pil2 [ ]	pil1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	4.00	5.00	0.16	1000	HE 200 B	HE 180 M	HE 220 B	HE 260 B	HE 120 B	HE 180 B	497	3595	26243	36969	53	74
8.00	4.00	5.00	0.16	1000	HE 200 B	HE 180 M	HE 220 B	HE 260 B	HE 140 B	HE 200 B	496	3732	26598	37311	54	75
8.00	4.00	5.00	0.16	1000	HE 200 B	HE 180 M	HE 220 B	HE 260 B	HE 140 B	HE 200 B	496	3732	26598	37311	54	75
8.00	4.00	5.00	0.16	1000	HE 200 B	HE 180 M	HE 220 B	HE 260 B	HE 140 B	HE 220 B	496	3814	26808	37511	54	76
8.00	4.00	5.00	0.16	1000	HE 200 B	HE 180 M	HE 220 B	HE 260 B	HE 160 B	HE 220 B	496	3885	27003	37707	54	76
8.00	4.00	5.00	0.16	1000	HE 200 B	HE 180 M	HE 220 B	HE 260 B	HE 160 B	HE 240 B	496	3978	27247	37943	55	77

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 [ ]	link1 [ ]	diag2 [ ]	diag1 [ ]	pil2 [ ]	pil1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	4.00	5.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	5.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	5.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	5.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	5.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	5.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=4m; H=4m; V_b=1500 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/ Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wal surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
2	4.00	4.00	0.20	1500	C	0.16 g	DCH	4.00	1142	155	18	1519	15360	6.40	32	43366	68012	38	60
2	4.00	4.00	0.20	1500	C	0.16 g	DCM	3.00	857	155	18	1519	15360	6.40	32	33948	52432	40	61
2	4.00	4.00	0.20	1500	C	0.16 g	DCL	1.00	361	155	18	1519	15360	6.40	32	17617	25418	49	70

Database UNICAM (steel bracing system - concentric, 2 diagonals):

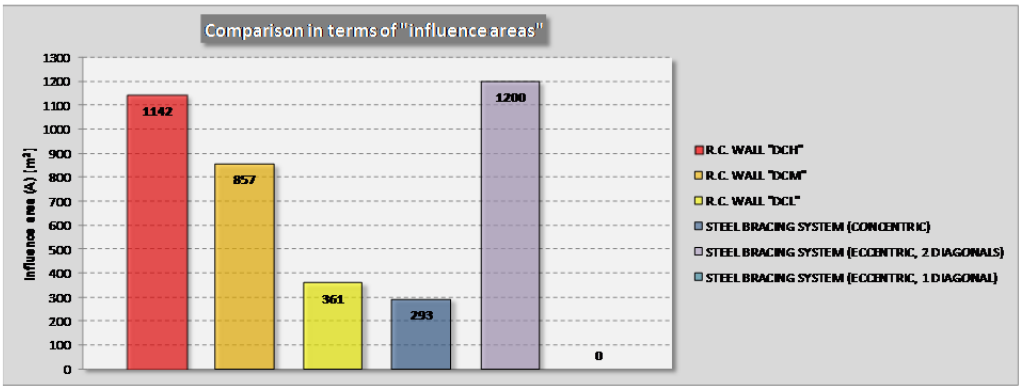
INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	BEAM1 [ ]	DIAG2 [ ]	DIAG1 [ ]	COL2 [ ]	COL1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	4.00	5.00	0.16	1500	HE 160 A	HE 180 A	HE 220 A	HE 260 A	HE 120 A	HE 220 A	293	1888	14853	21185	51	72
4.00	4.00	5.00	0.16	1500	HE 160 A	HE 180 A	HE 220 A	HE 260 A	HE 120 A	HE 220 A	293	1888	14853	21185	51	72
4.00	4.00	5.00	0.16	1500	HE 160 A	HE 180 A	HE 220 A	HE 260 A	HE 120 A	HE 240 A	293	1967	15067	21400	51	73
4.00	4.00	5.00	0.16	1500	HE 160 A	HE 180 A	HE 220 A	HE 260 A	HE 120 A	HE 240 A	293	1967	15067	21400	51	73
4.00	4.00	5.00	0.16	1500	HE 160 A	HE 180 A	HE 220 A	HE 260 A	HE 140 A	HE 240 A	293	2005	15173	21505	52	73
4.00	4.00	5.00	0.16	1500	HE 160 A	HE 180 A	HE 220 A	HE 260 A	HE 140 A	HE 240 A	293	2005	15173	21505	52	73

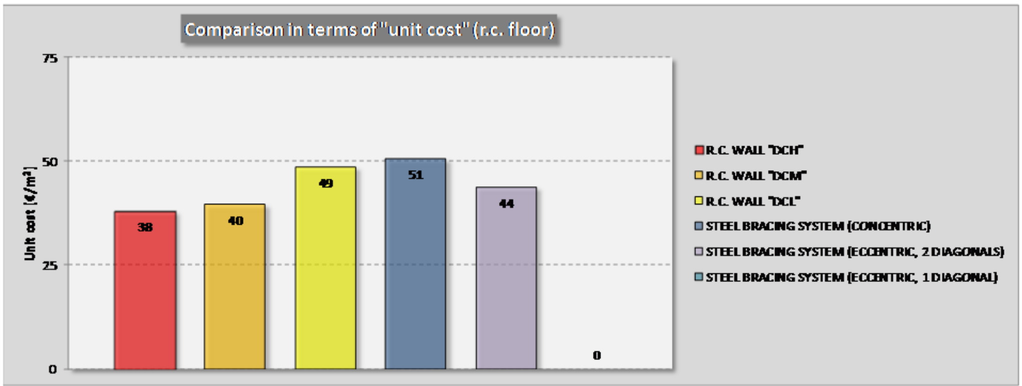
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 []	link1 []	diag2 []	diag1 []	pil2 []	pil1 []	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	4.00	5.00	0.16	1500	HE 260 B	HE 340B	HE 240 B	HE 300 B	HE 140 B	HE 200 B	1200	4731	52558	78467	44	65
8.00	4.00	5.00	0.16	1500	HE 260 B	HE 340B	HE 240 B	HE 300 B	HE 140 B	HE 200 B	1200	4731	52558	78467	44	65
8.00	4.00	5.00	0.16	1500	HE 260 B	HE 340B	HE 240 B	HE 300 B	HE 140 B	HE 220 B	1198	4812	52698	78552	44	66
8.00	4.00	5.00	0.16	1500	HE 260 B	HE 340B	HE 240 B	HE 300 B	HE 160 B	HE 220 B	1198	4884	52893	78747	44	66
8.00	4.00	5.00	0.16	1500	HE 260 B	HE 340B	HE 240 B	HE 300 B	HE 160 B	HE 240 B	1196	4977	53078	78886	44	66
8.00	4.00	5.00	0.16	1500	HE 260 B	HE 340B	HE 240 B	HE 300 B	HE 160 B	HE 240 B	1196	4977	53078	78886	44	66

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 []	link1 []	diag2 []	diag1 []	pil2 []	pil1 []	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	4.00	5.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	5.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	5.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	5.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	5.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	5.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=4m; H=4m; V_b=2000 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT								COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness s [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wall surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
2	4.00	4.00	0.20	2000	C	0.16 g	DCH	4.00	1523	207	24	2002	15360	6.40	32	56841	89703	37	59
2	4.00	4.00	0.20	2000	C	0.16 g	DCM	3.00	1142	207	24	2002	15360	6.40	32	44284	68930	39	60
2	4.00	4.00	0.20	2000	C	0.16 g	DCL	1.00	448	207	24	2002	15360	6.40	32	21397	31071	48	69

Database UNICAM (steel bracing system - concentric, 2 diagonals):

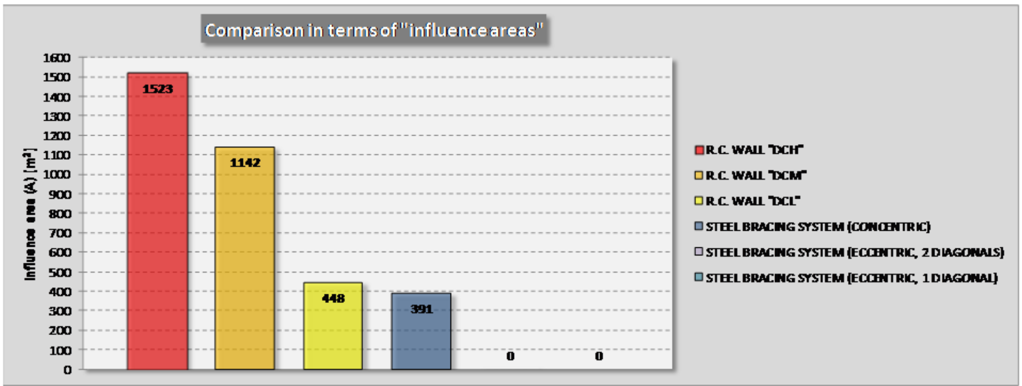
INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	BEAM1 [ ]	DIAG2 [ ]	DIAG1 [ ]	COL2 [ ]	COL1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	4.00	5.00	0.16	2000	HE 200 A	HE 200 A	HE 260 A	HE 300 A	HE 120 A	HE 240 A	391	2380	19425	27869	50	71
4.00	4.00	5.00	0.16	2000	HE 200 A	HE 200 A	HE 260 A	HE 300 A	HE 120 A	HE 240 A	391	2380	19425	27869	50	71
4.00	4.00	5.00	0.16	2000	HE 200 A	HE 200 A	HE 260 A	HE 300 A	HE 120 A	HE 260 A	391	2443	19598	28042	50	72
4.00	4.00	5.00	0.16	2000	HE 200 A	HE 200 A	HE 260 A	HE 300 A	HE 120 A	HE 260 A	391	2443	19598	28042	50	72
4.00	4.00	5.00	0.16	2000	HE 200 A	HE 200 A	HE 260 A	HE 300 A	HE 140 A	HE 260 A	391	2481	19703	28147	50	72
4.00	4.00	5.00	0.16	2000	HE 200 A	HE 200 A	HE 260 A	HE 300 A	HE 140 A	HE 260 A	391	2481	19703	28147	50	72

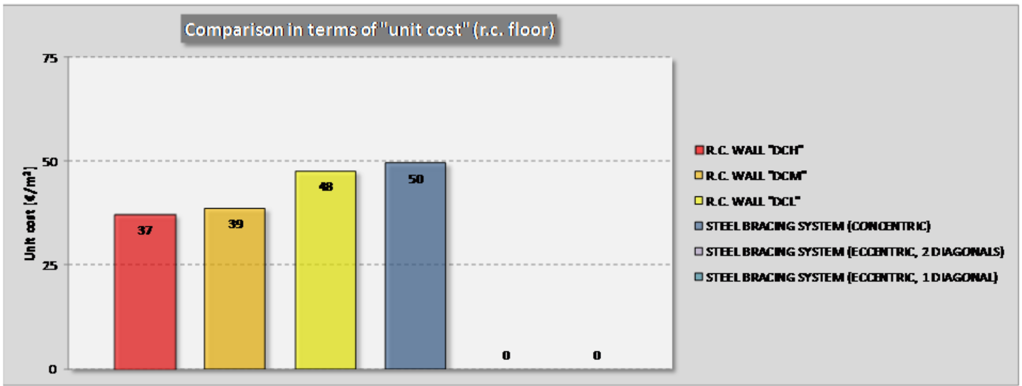
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 [ ]	link1 [ ]	diag2 [ ]	diag1 [ ]	pil2 [ ]	pil1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
8.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
8.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
8.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
8.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
8.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 [ ]	link1 [ ]	diag2 [ ]	diag1 [ ]	pil2 [ ]	pil1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=4m; H=6m; V_b=500 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT								COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness s [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wal surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
2	6.00	4.00	0.30	500	C	0.16 g	DCH	4.00	381	78	6	1132	34560	14.40	48	20465	28680	54	75
2	6.00	4.00	0.30	500	C	0.16 g	DCM	3.00	292	78	6	1132	34560	14.40	48	17546	23851	60	82
2	6.00	4.00	0.30	500	C	0.16 g	DCL	1.00	135	78	6	1132	34560	14.40	48	12345	15248	92	113

Database UNICAM (steel bracing system - concentric, 2 diagonals):

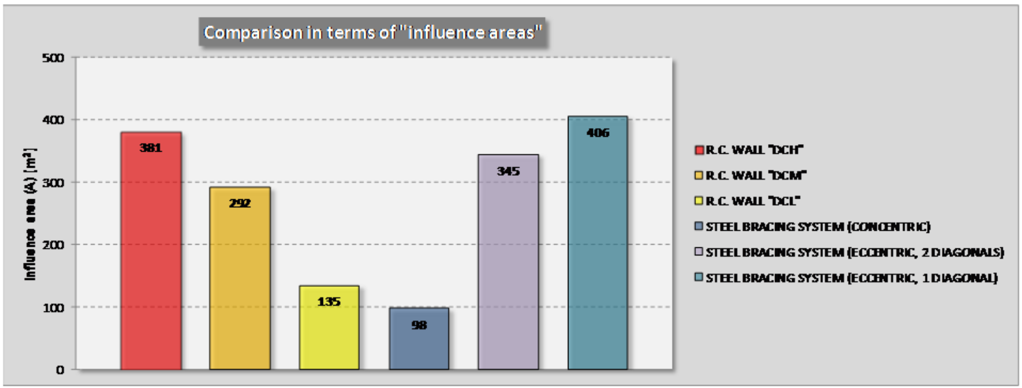
INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	BEAM1 [ ]	DIAG2 [ ]	DIAG1 [ ]	COL2 [ ]	COL1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	6.00	5.00	0.16	500	HE 100 A	HE 100 A	HE 220 A	HE 240 A	HE 160 A	HE 220 A	98	2506	10092	12203	103	125
4.00	6.00	5.00	0.16	500	HE 100 A	HE 100A	HE 220 A	HE 240 A	HE 160 A	HE 240 A	98	2624	10415	12525	106	128
4.00	6.00	5.00	0.16	500	HE 100 A	HE 100A	HE 220 A	HE 240 A	HE 160 A	HE 240 A	98	2624	10415	12525	106	128
4.00	6.00	5.00	0.16	500	HE 100 A	HE 100A	HE 220 A	HE 240 A	HE 160 A	HE 240 A	98	2624	10415	12525	106	128
4.00	6.00	5.00	0.16	500	HE 100 A	HE 100A	HE 220 A	HE 240 A	HE 160 A	HE 240 A	98	2624	10415	12525	106	128
4.00	6.00	5.00	0.16	500	HE 100 A	HE 100A	HE 220 A	HE 240 A	HE 180 A	HE 260 A	98	2780	10842	12953	111	132

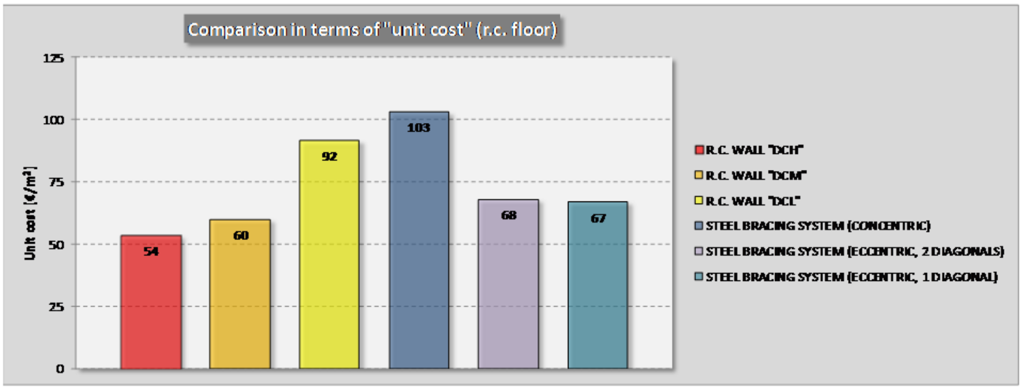
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 []	link1 []	diag2 []	diag1 []	pil2 []	pil1 []	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	6.00	5.00	0.16	500	HE 180 B	HE 220B	HE 220 B	HE 240 B	HE 140 B	HE 220 B	345	4409	23445	30882	68	90
8.00	6.00	5.00	0.16	500	HE 180 B	HE 220B	HE 220 B	HE 240 B	HE 160 B	HE 220 B	345	4516	23738	31174	69	90
8.00	6.00	5.00	0.16	500	HE 180 B	HE 220B	HE 220 B	HE 240 B	HE 160 B	HE 220 B	345	4516	23738	31174	69	90
8.00	6.00	5.00	0.16	500	HE 180 B	HE 220B	HE 220 B	HE 240 B	HE 180 B	HE 240 B	344	4759	24392	31820	71	92
8.00	6.00	5.00	0.16	500	HE 180 B	HE 220B	HE 220 B	HE 240 B	HE 180 B	HE 260 B	344	4877	24706	32128	72	93
8.00	6.00	5.00	0.16	500	HE 180 B	HE 220B	HE 220 B	HE 240 B	HE 200 B	HE 260 B	344	4998	25038	32460	73	94

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 []	link1 []	diag2 []	diag1 []	pil2 []	pil1 []	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	6.00	5.00	0.16	500	HE 240 B	HE 360B	HE 240 B	HE 300 B	HE 100 B	HE 550 B	377	4900	25877	34024	69	90
4.00	6.00	5.00	0.16	500	HE 240 B	HE 360B	HE 240 B	HE 300 B	HE 100 B	HE 550 B	377	4900	25877	34024	69	90
4.00	6.00	5.00	0.16	500	HE 240 B	HE 360B	HE 240 B	HE 300 B	HE 100 B	HE 600 B	406	5050	27221	35979	67	89
4.00	6.00	5.00	0.16	500	HE 240 B	HE 360B	HE 240 B	HE 300 B	HE 100 B	HE 600 B	406	5050	27221	35979	67	89
4.00	6.00	5.00	0.16	500	HE 240 B	HE 360B	HE 240 B	HE 300 B	HE 100 B	HE 600 B	406	5050	27221	35979	67	89
4.00	6.00	5.00	0.16	500	HE 240 B	HE 360B	HE 240 B	HE 300 B	HE 100 B	HE 600 B	429	5050	27977	37229	65	87





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=4m; H=6m; V_b=1000 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness s [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wal surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
2	6.00	4.00	0.30	1000	C	0.16 g	DCH	4.00	761	155	12	2106	34560	14.40	48	34873	51304	46	67
2	6.00	4.00	0.30	1000	C	0.16 g	DCM	3.00	571	155	12	2106	34560	14.40	48	28594	40917	50	72
2	6.00	4.00	0.30	1000	C	0.16 g	DCL	1.00	227	155	12	2106	34560	14.40	48	17241	22137	76	98

Database UNICAM (steel bracing system - concentric, 2 diagonals):

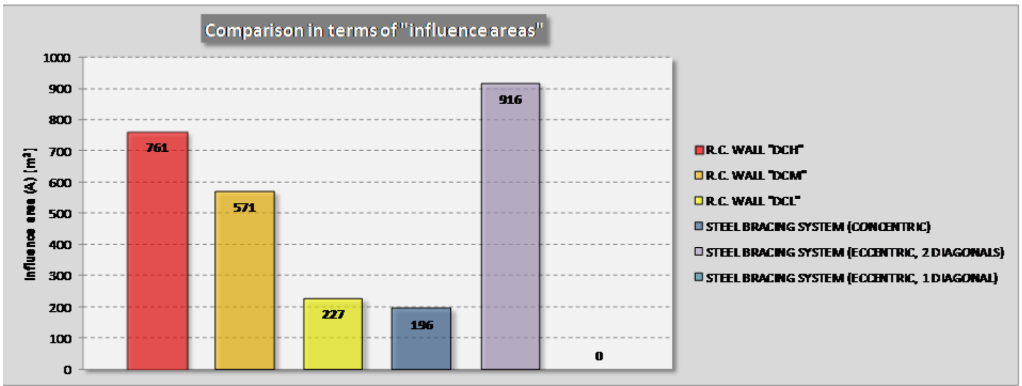
INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	BEAM1 [ ]	DIAG2 [ ]	DIAG1 [ ]	COL2 [ ]	COL1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	6.00	5.00	0.16	1000	HE 140 A	HE 140 A	HE 260 A	HE 300 A	HE 160 A	HE 260 A	196	3360	15660	19881	80	102
4.00	6.00	5.00	0.16	1000	HE 140 A	HE 140 A	HE 260 A	HE 300 A	HE 160 A	HE 260 A	196	3360	15660	19881	80	102
4.00	6.00	5.00	0.16	1000	HE 140 A	HE 140 A	HE 260 A	HE 300 A	HE 160 A	HE 280 A	196	3459	15929	20151	81	103
4.00	6.00	5.00	0.16	1000	HE 140 A	HE 140 A	HE 260 A	HE 300 A	HE 160 A	HE 280 A	196	3459	15929	20151	81	103
4.00	6.00	5.00	0.16	1000	HE 140 A	HE 140 A	HE 260 A	HE 300 A	HE 160 A	HE 280 A	196	3459	15929	20151	81	103
4.00	6.00	5.00	0.16	1000	HE 140 A	HE 140 A	HE 260 A	HE 300 A	HE 180 A	HE 300 A	196	3663	16488	20710	84	106

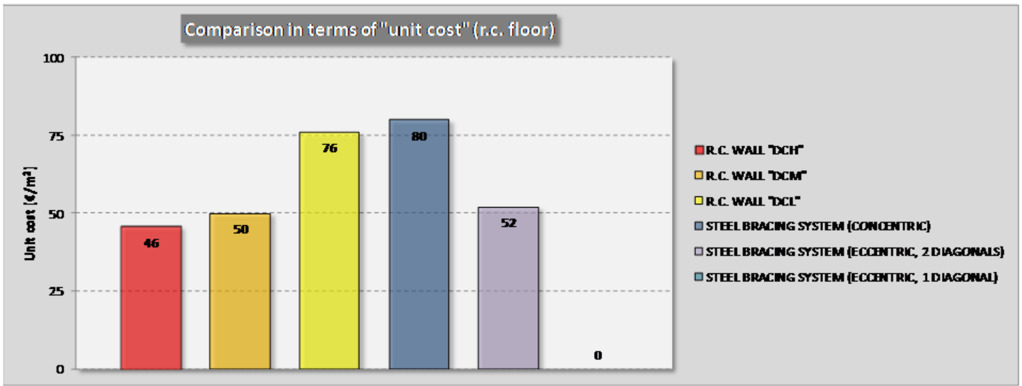
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 [ ]	link1 [ ]	diag2 [ ]	diag1 [ ]	pil2 [ ]	pil1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	6.00	5.00	0.16	1000	HE 260 B	HE 340 B	HE 260 B	HE 320 B	HE 160 B	HE 240 B	916	6404	47753	67517	52	74
8.00	6.00	5.00	0.16	1000	HE 260 B	HE 340 B	HE 260 B	HE 320 B	HE 160 B	HE 240 B	916	6404	47753	67517	52	74
8.00	6.00	5.00	0.16	1000	HE 260 B	HE 340 B	HE 260 B	HE 320 B	HE 180 B	HE 260 B	914	6625	48299	68024	53	74
8.00	6.00	5.00	0.16	1000	HE 260 B	HE 340 B	HE 260 B	HE 320 B	HE 180 B	HE 260 B	914	6625	48299	68024	53	74
8.00	6.00	5.00	0.16	1000	HE 260 B	HE 340 B	HE 260 B	HE 320 B	HE 200 B	HE 280 B	912	6866	48909	68602	54	75
8.00	6.00	5.00	0.16	1000	HE 260 B	HE 340 B	HE 260 B	HE 320 B	HE 200 B	HE 280 B	912	6866	48909	68602	54	75

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 [ ]	link1 [ ]	diag2 [ ]	diag1 [ ]	pil2 [ ]	pil1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	6.00	5.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	5.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	5.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	5.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	5.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	5.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=4m; H=6m; V_b=1500 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness s [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wall surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
2	6.00	4.00	0.30	1500	C	0.16 g	DCH	4.00	1142	233	18	3080	34560	14.40	48	49281	73927	43	65
2	6.00	4.00	0.30	1500	C	0.16 g	DCM	3.00	857	233	18	3080	34560	14.40	48	39862	58347	47	68
2	6.00	4.00	0.30	1500	C	0.16 g	DCL	1.00	306	233	18	3080	34560	14.40	48	21715	28328	71	92

Database UNICAM (steel bracing system - concentric, 2 diagonals):

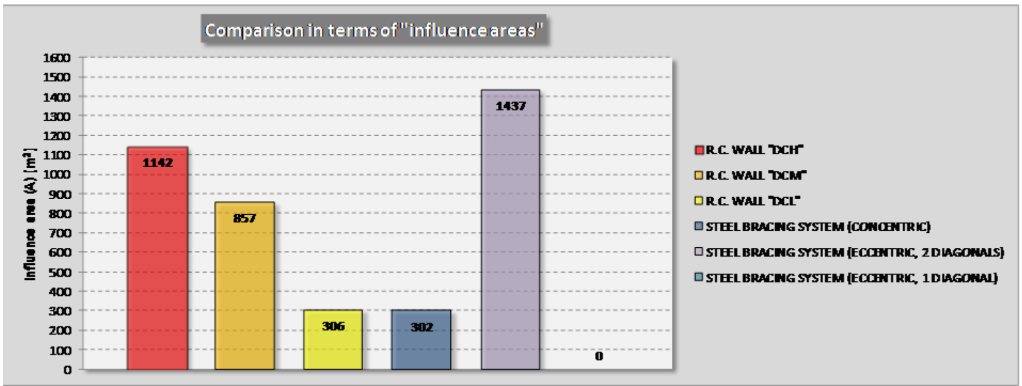
INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	BEAM1 [ ]	DIAG2 [ ]	DIAG1 [ ]	COL2 [ ]	COL1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	6.00	5.00	0.16	1500	HE 160 A	HE 180 A	HE 300 A	HE 400 A	HE 160 A	HE 300 A	302	4386	21982	28502	73	94
4.00	6.00	5.00	0.16	1500	HE 160 A	HE 180 A	HE 300 A	HE 400 A	HE 160 A	HE 300 A	302	4386	21982	28502	73	94
4.00	6.00	5.00	0.16	1500	HE 160 A	HE 180 A	HE 300 A	HE 400 A	HE 160 A	HE 300 A	302	4386	21982	28502	73	94
4.00	6.00	5.00	0.16	1500	HE 160 A	HE 180 A	HE 300 A	HE 400 A	HE 160 A	HE 300 A	302	4386	21982	28502	73	94
4.00	6.00	5.00	0.16	1500	HE 160 A	HE 180 A	HE 300 A	HE 400 A	HE 160 A	HE 320 A	298	4498	22162	28600	74	96
4.00	6.00	5.00	0.16	1500	HE 160 A	HE 180 A	HE 300 A	HE 400 A	HE 180 A	HE 320 A	298	4559	22330	28768	75	96

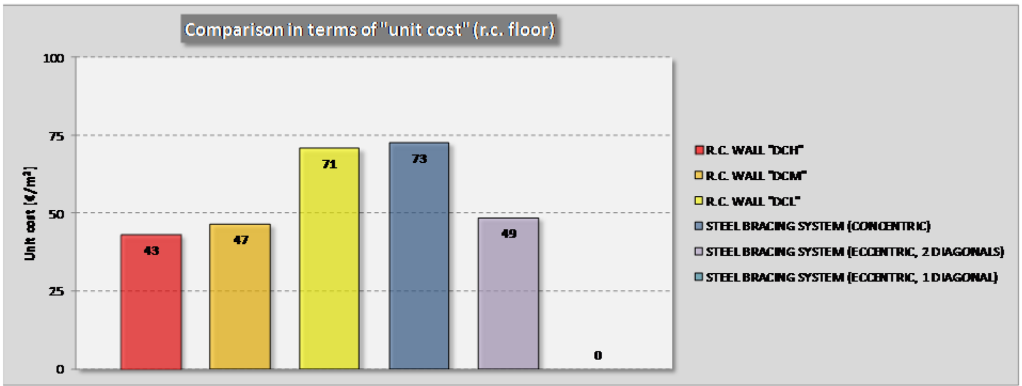
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 []	link1 []	diag2 []	diag1 []	pil2 []	pil1 []	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	6.00	5.00	0.16	1500	HE 320 B	HE 450 B	HE 300 B	HE 500 B	HE 160 B	HE 260 B	1437	8265	70036	101044	49	70
8.00	6.00	5.00	0.16	1500	HE 320 B	HE 450 B	HE 300 B	HE 500 B	HE 180 B	HE 280 B	1463	8489	71521	103100	49	70
8.00	6.00	5.00	0.16	1500	HE 320 B	HE 450 B	HE 300 B	HE 500 B	HE 180 B	HE 280 B	1463	8489	71521	103100	49	70
8.00	6.00	5.00	0.16	1500	HE 320 B	HE 450 B	HE 300 B	HE 500 B	HE 180 B	HE 280 B	1463	8489	71521	103100	49	70
8.00	6.00	5.00	0.16	1500	HE 320 B	HE 450 B	HE 300 B	HE 500 B	HE 200 B	HE 300 B	1492	8778	73280	105492	49	71
8.00	6.00	5.00	0.16	1500	HE 320 B	HE 450 B	HE 300 B	HE 500 B	HE 200 B	HE 300 B	1492	8778	73280	105492	49	71

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 []	link1 []	diag2 []	diag1 []	pil2 []	pil1 []	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	6.00	5.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	5.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	5.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	5.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	5.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	5.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=4m; H=6m; V_b=2000 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness s [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wall surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
2	6.00	4.00	0.30	2000	C	0.16 g	DCH	4.00	1523	311	24	4054	34560	14.40	48	63689	96550	42	63
2	6.00	4.00	0.30	2000	C	0.16 g	DCM	3.00	1142	311	24	4054	34560	14.40	48	51131	75777	45	66
2	6.00	4.00	0.30	2000	C	0.16 g	DCL	1.00	381	311	24	4054	34560	14.40	48	26016	34231	68	90

Database UNICAM (steel bracing system - concentric, 2 diagonals):

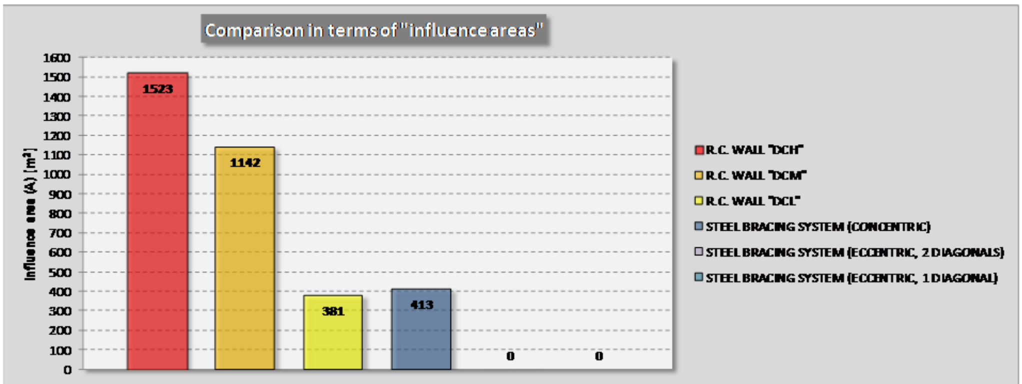
INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	BEAM1 [ ]	DIAG2 [ ]	DIAG1 [ ]	COL2 [ ]	COL1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	6.00	5.00	0.16	2000	HE 200 A	HE 200 A	HE 340 A	HE 450 B	HE 160 A	HE 340 A	413	5454	28561	37471	69	91
4.00	6.00	5.00	0.16	2000	HE 200 A	HE 200 A	HE 340 A	HE 450 B	HE 160 A	HE 340 A	413	5454	28561	37471	69	91
4.00	6.00	5.00	0.16	2000	HE 200 A	HE 200 A	HE 340 A	HE 450 B	HE 160 A	HE 340 A	413	5454	28561	37471	69	91
4.00	6.00	5.00	0.16	2000	HE 200 A	HE 200 A	HE 340 A	HE 450 B	HE 160 A	HE 360 A	409	5538	28682	37520	70	92
4.00	6.00	5.00	0.16	2000	HE 200 A	HE 200 A	HE 340 A	HE 450 B	HE 160 A	HE 300 B	407	5598	28778	37571	71	92
4.00	6.00	5.00	0.16	2000	HE 200 A	HE 200 A	HE 340 A	HE 450 B	HE 180 A	HE 300 B	407	5660	28945	37738	71	93

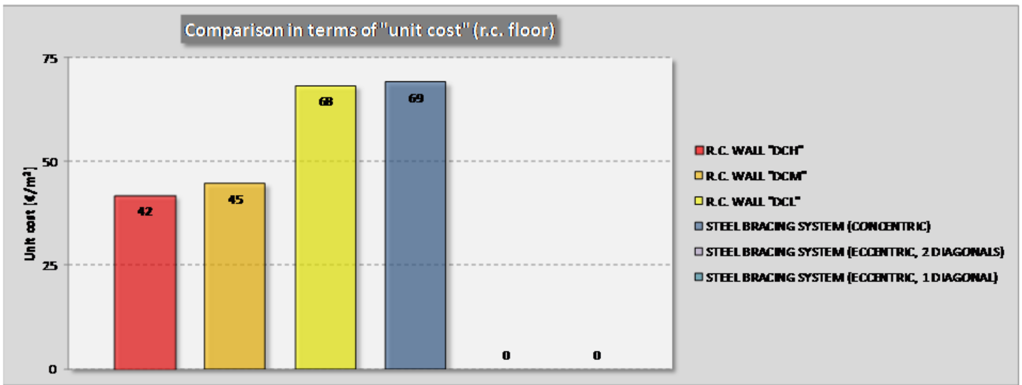
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 [ ]	link1 [ ]	diag2 [ ]	diag1 [ ]	pil2 [ ]	pil1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	6.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
8.00	6.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
8.00	6.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
8.00	6.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
8.00	6.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
8.00	6.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 [ ]	link1 [ ]	diag2 [ ]	diag1 [ ]	pil2 [ ]	pil1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	6.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-





ANNESSO 3

CONFRONTO TRA SISTEMA A PARETI IN C.A. E SISTEMA A CONTROVENTI IN ACCIAIO

Distribuzione "D"

COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=4m; H=4m; V_b=500 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness s [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/ Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wal surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
2	4.00	4.00	0.20	500	D	0.16 g	DCH	4.00	326	49	6	533	15360	6.40	32	14571	21604	45	66
2	4.00	4.00	0.20	500	D	0.16 g	DCM	3.00	269	49	6	533	15360	6.40	32	12690	18493	47	69
2	4.00	4.00	0.20	500	D	0.16 g	DCL	1.00	138	49	6	533	15360	6.40	32	8380	11364	61	82

Database UNICAM (steel bracing system - concentric, 2 diagonals):

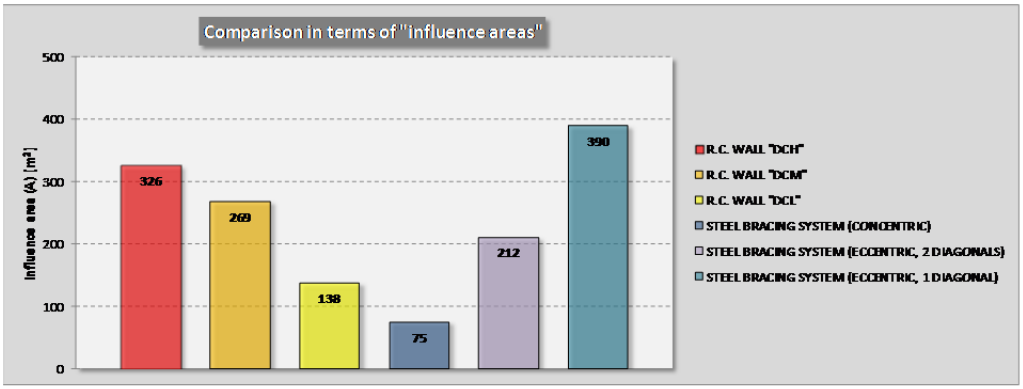
INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	BEAM1 [ ]	DIAG2 [ ]	DIAG1 [ ]	COL2 [ ]	COL1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	4.00	8.00	0.16	500	HE 100 A	HE 120 A	HE 160 A	HE 180 A	HE 120 A	HE 180 A	75	1179	5721	7350	76	97
4.00	4.00	8.00	0.16	500	HE 100 A	HE 120 A	HE 160 A	HE 180 A	HE 120 A	HE 180 A	75	1179	5721	7350	76	97
4.00	4.00	8.00	0.16	500	HE 100 A	HE 120 A	HE 160 A	HE 180 A	HE 120 A	HE 180 A	75	1179	5721	7350	76	97
4.00	4.00	8.00	0.16	500	HE 100 A	HE 120 A	HE 160 A	HE 180 A	HE 120 A	HE 200 A	75	1233	5870	7500	78	99
4.00	4.00	8.00	0.16	500	HE 100 A	HE 120 A	HE 160 A	HE 180 A	HE 140 A	HE 200 A	75	1272	5975	7605	79	101
4.00	4.00	8.00	0.16	500	HE 100 A	HE 120 A	HE 160 A	HE 180 A	HE 140 A	HE 220 A	75	1337	6155	7785	82	103

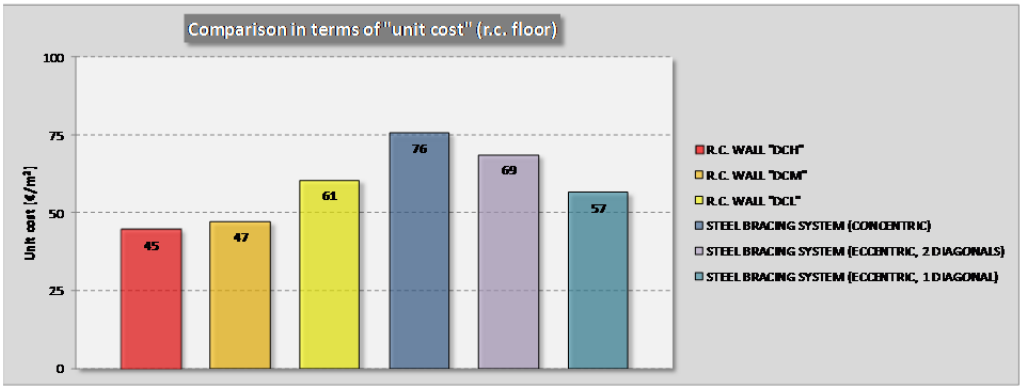
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 [ ]	link1 [ ]	diag2 [ ]	diag1 [ ]	pil2 [ ]	pil1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	4.00	8.00	0.16	500	HE 180 B	HE 180 B	HE 180 B	HE 220 B	HE 120 B	HE 180 B	212	2763	14548	19114	69	90
8.00	4.00	8.00	0.16	500	HE 180 B	HE 180 B	HE 180 B	HE 220 B	HE 120 B	HE 180 B	212	2763	14548	19114	69	90
8.00	4.00	8.00	0.16	500	HE 180 B	HE 180 B	HE 180 B	HE 220 B	HE 140 B	HE 200 B	211	2900	14919	19482	71	92
8.00	4.00	8.00	0.16	500	HE 180 B	HE 180 B	HE 180 B	HE 220 B	HE 140 B	HE 200 B	211	2900	14919	19482	71	92
8.00	4.00	8.00	0.16	500	HE 180 B	HE 180 B	HE 180 B	HE 220 B	HE 160 B	HE 220 B	211	3053	15335	19897	73	94
8.00	4.00	8.00	0.16	500	HE 180 B	HE 180 B	HE 180 B	HE 220 B	HE 160 B	HE 240 B	211	3146	15589	20149	74	95

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 [ ]	link1 [ ]	diag2 [ ]	diag1 [ ]	pil2 [ ]	pil1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	4.00	8.00	0.16	500	HE 180 B	HE 300 B	HE 200 B	HE 260 B	HE 280 B	HE 340 B	390	3362	22091	30519	57	78
4.00	4.00	8.00	0.16	500	HE 180 B	HE 300 B	HE 200 B	HE 260 B	HE 280 B	HE 340 B	390	3362	22091	30519	57	78
4.00	4.00	8.00	0.16	500	HE 180 B	HE 300 B	HE 200 B	HE 260 B	HE 280 B	HE 360 B	404	3423	22690	31400	56	78
4.00	4.00	8.00	0.16	500	HE 180 B	HE 300 B	HE 200 B	HE 260 B	HE 280 B	HE 360 B	404	3423	22690	31400	56	78
4.00	4.00	8.00	0.16	500	HE 180 B	HE 300 B	HE 200 B	HE 260 B	HE 280 B	HE 360 B	404	3423	22690	31400	56	78
4.00	4.00	8.00	0.16	500	HE 180 B	HE 300 B	HE 200 B	HE 260 B	HE 280 B	HE 400 B	427	3531	23770	32994	56	77





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=4m; H=4m; V_b=1000 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness s [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wall surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
2	4.00	4.00	0.20	1000	D	0.16 g	DCH	4.00	665	97	12	996	15360	6.40	32	26631	40979	40	62
2	4.00	4.00	0.20	1000	D	0.16 g	DCM	3.00	511	97	12	996	15360	6.40	32	21563	32596	42	64
2	4.00	4.00	0.20	1000	D	0.16 g	DCL	1.00	236	97	12	996	15360	6.40	32	12490	17586	53	74

Database UNICAM (steel bracing system - concentric, 2 diagonals):

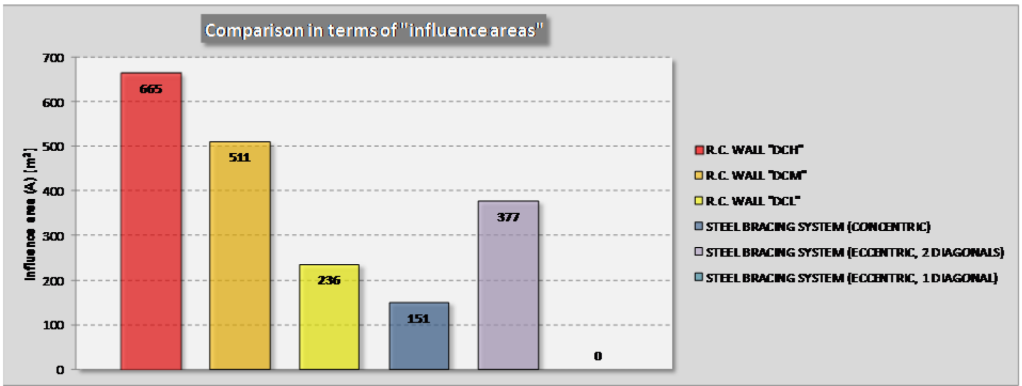
INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	BEAM1 [ ]	DIAG2 [ ]	DIAG1 [ ]	COL2 [ ]	COL1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	4.00	8.00	0.16	1000	HE 140 A	HE 160 A	HE 200 A	HE 240 A	HE 120 A	HE 200 A	151	1636	9463	12722	63	84
4.00	4.00	8.00	0.16	1000	HE 140 A	HE 160 A	HE 200 A	HE 240 A	HE 120 A	HE 200 A	151	1636	9463	12722	63	84
4.00	4.00	8.00	0.16	1000	HE 140 A	HE 160 A	HE 200 A	HE 240 A	HE 120 A	HE 220 A	151	1701	9642	12901	64	85
4.00	4.00	8.00	0.16	1000	HE 140 A	HE 160 A	HE 200 A	HE 240 A	HE 120 A	HE 220 A	151	1701	9642	12901	64	85
4.00	4.00	8.00	0.16	1000	HE 140 A	HE 160 A	HE 200 A	HE 240 A	HE 140 A	HE 220 A	151	1740	9748	13007	65	86
4.00	4.00	8.00	0.16	1000	HE 140 A	HE 160 A	HE 200 A	HE 240 A	HE 140 A	HE 240 A	151	1818	9962	13221	66	88

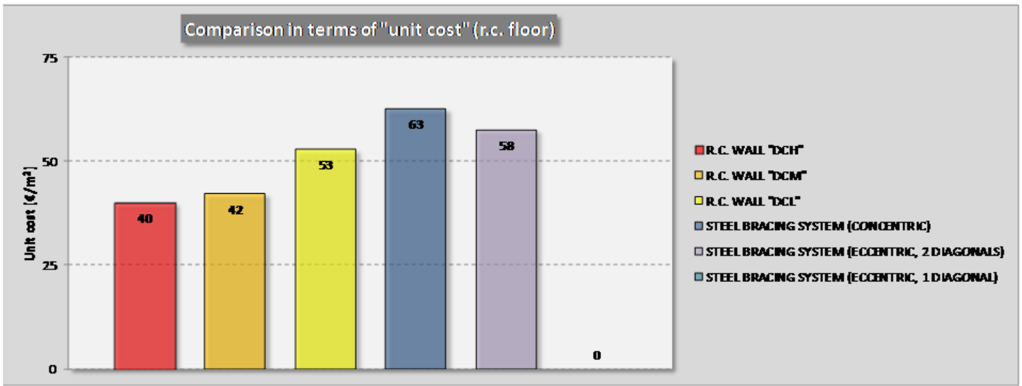
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 []	link1 []	diag2 []	diag1 []	pil2 []	pil1 []	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	4.00	8.00	0.16	1000	HE 180 B	HE 180M	HE 200 B	HE 260 B	HE 120 B	HE 180 B	377	3405	21778	29924	58	79
8.00	4.00	8.00	0.16	1000	HE 180 B	HE 180M	HE 200 B	HE 260 B	HE 120 B	HE 200 B	377	3486	21988	30126	58	80
8.00	4.00	8.00	0.16	1000	HE 180 B	HE 180M	HE 200 B	HE 260 B	HE 140 B	HE 200 B	377	3542	22141	30279	59	80
8.00	4.00	8.00	0.16	1000	HE 180 B	HE 180M	HE 200 B	HE 260 B	HE 140 B	HE 220 B	377	3623	22356	30489	59	81
8.00	4.00	8.00	0.16	1000	HE 180 B	HE 180M	HE 200 B	HE 260 B	HE 160 B	HE 220 B	377	3694	22551	30684	60	81
8.00	4.00	8.00	0.16	1000	HE 180 B	HE 180M	HE 200 B	HE 260 B	HE 160 B	HE 240 B	377	3788	22801	30929	61	82

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 []	link1 []	diag2 []	diag1 []	pil2 []	pil1 []	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	4.00	8.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	8.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	8.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	8.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	8.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	8.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=4m; H=4m; V_b=1500 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/ Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wal surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
2	4.00	4.00	0.20	1500	D	0.16 g	DCH	4.00	997	146	18	1459	15360	6.40	32	38477	59999	39	60
2	4.00	4.00	0.20	1500	D	0.16 g	DCM	3.00	748	146	18	1459	15360	6.40	32	30252	46394	40	62
2	4.00	4.00	0.20	1500	D	0.16 g	DCL	1.00	321	146	18	1459	15360	6.40	32	16172	23102	50	72

Database UNICAM (steel bracing system - concentric, 2 diagonals):

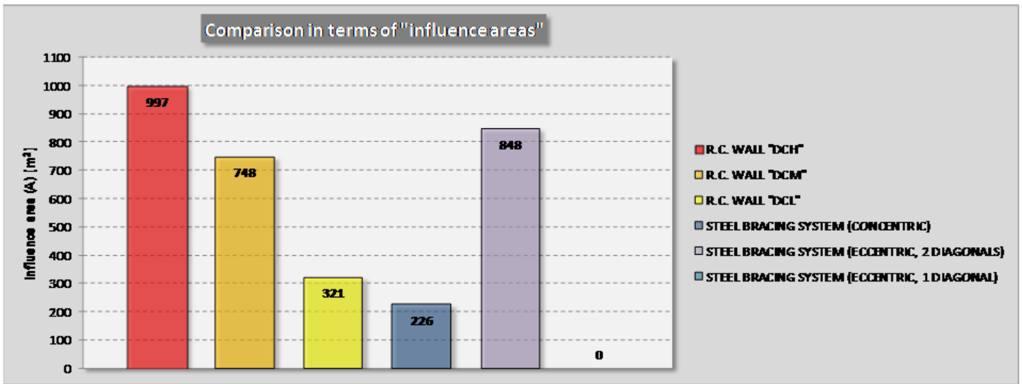
INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	BEAM1 [ ]	DIAG2 [ ]	DIAG1 [ ]	COL2 [ ]	COL1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	4.00	8.00	0.16	1500	HE 160 A	HE 180 A	HE 220 A	HE 260 A	HE 120 A	HE 220 A	226	1888	12646	17534	56	77
4.00	4.00	8.00	0.16	1500	HE 160 A	HE 180 A	HE 220 A	HE 260 A	HE 120 A	HE 220 A	226	1888	12646	17534	56	77
4.00	4.00	8.00	0.16	1500	HE 160 A	HE 180 A	HE 220 A	HE 260 A	HE 120 A	HE 220 A	226	1888	12646	17534	56	77
4.00	4.00	8.00	0.16	1500	HE 160 A	HE 180 A	HE 220 A	HE 260 A	HE 120 A	HE 240 A	226	1967	12860	17749	57	78
4.00	4.00	8.00	0.16	1500	HE 160 A	HE 180 A	HE 220 A	HE 260 A	HE 140 A	HE 240 A	226	2005	12966	17854	57	79
4.00	4.00	8.00	0.16	1500	HE 160 A	HE 180 A	HE 220 A	HE 260 A	HE 140 A	HE 240 A	226	2005	12966	17854	57	79

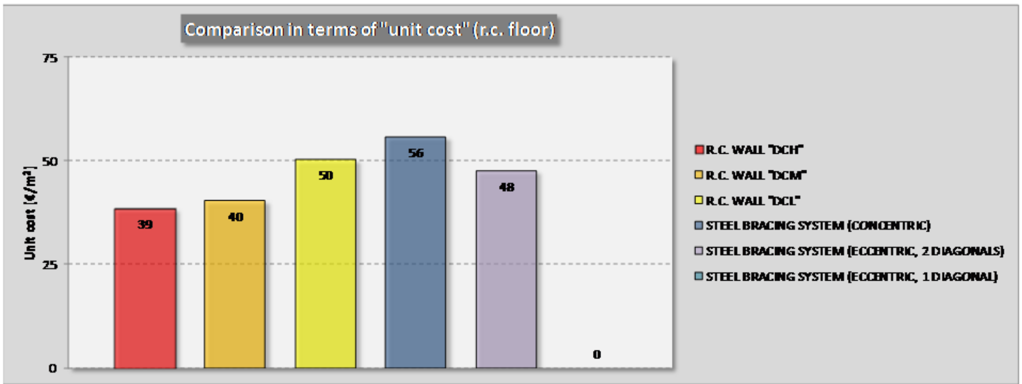
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 []	link1 []	diag2 []	diag1 []	pil2 []	pil1 []	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	4.00	8.00	0.16	1500	HE 220 B	HE 340 B	HE 240 B	HE 300 B	HE 120 B	HE 200 B	848	4503	40316	58623	48	69
8.00	4.00	8.00	0.16	1500	HE 220 B	HE 340 B	HE 240 B	HE 300 B	HE 140 B	HE 200 B	849	4559	40496	58821	48	69
8.00	4.00	8.00	0.16	1500	HE 220 B	HE 340 B	HE 240 B	HE 300 B	HE 140 B	HE 220 B	865	4640	41263	59944	48	69
8.00	4.00	8.00	0.16	1500	HE 220 B	HE 340 B	HE 240 B	HE 300 B	HE 140 B	HE 220 B	865	4640	41263	59944	48	69
8.00	4.00	8.00	0.16	1500	HE 220 B	HE 340 B	HE 240 B	HE 300 B	HE 160 B	HE 240 B	881	4805	42215	61223	48	70
8.00	4.00	8.00	0.16	1500	HE 220 B	HE 340 B	HE 240 B	HE 300 B	HE 160 B	HE 260 B	890	4884	42740	61951	48	70

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 []	link1 []	diag2 []	diag1 []	pil2 []	pil1 []	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	4.00	8.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	8.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	8.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	8.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	8.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	8.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=4m; H=4m; V_b=2000 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/ Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wal surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
2	4.00	4.00	0.20	2000	D	0.16 g	DCH	4.00	1330	194	24	1922	15360	6.40	32	50322	79019	38	59
2	4.00	4.00	0.20	2000	D	0.16 g	DCM	3.00	997	194	24	1922	15360	6.40	32	39356	60879	39	61
2	4.00	4.00	0.20	2000	D	0.16 g	DCL	1.00	398	194	24	1922	15360	6.40	32	19600	28198	49	71

Database UNICAM (steel bracing system - concentric, 2 diagonals):

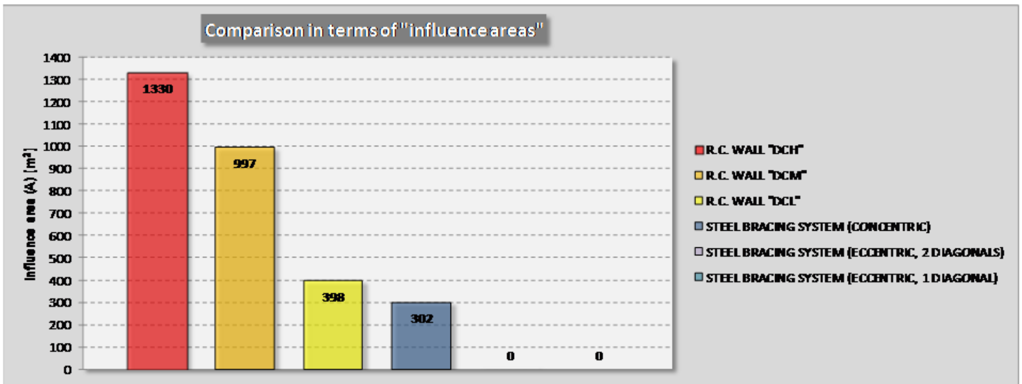
INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	BEAM1 [ ]	DIAG2 [ ]	DIAG1 [ ]	COL2 [ ]	COL1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	4.00	8.00	0.16	2000	HE 180 A	HE 220 A	HE 240 A	HE 300 A	HE 120 A	HE 240 A	302	2315	16304	22822	54	76
4.00	4.00	8.00	0.16	2000	HE 180 A	HE 220 A	HE 240 A	HE 300 A	HE 120 A	HE 240 A	302	2315	16304	22822	54	76
4.00	4.00	8.00	0.16	2000	HE 180 A	HE 220 A	HE 240 A	HE 300 A	HE 120 A	HE 240 A	302	2315	16304	22822	54	76
4.00	4.00	8.00	0.16	2000	HE 180 A	HE 220 A	HE 240 A	HE 300 A	HE 120 A	HE 260 A	302	2378	16477	22995	55	76
4.00	4.00	8.00	0.16	2000	HE 180 A	HE 220 A	HE 240 A	HE 300 A	HE 140 A	HE 260 A	302	2416	16582	23101	55	76
4.00	4.00	8.00	0.16	2000	HE 180 A	HE 220 A	HE 240 A	HE 300 A	HE 140 A	HE 260 A	302	2416	16582	23101	55	76

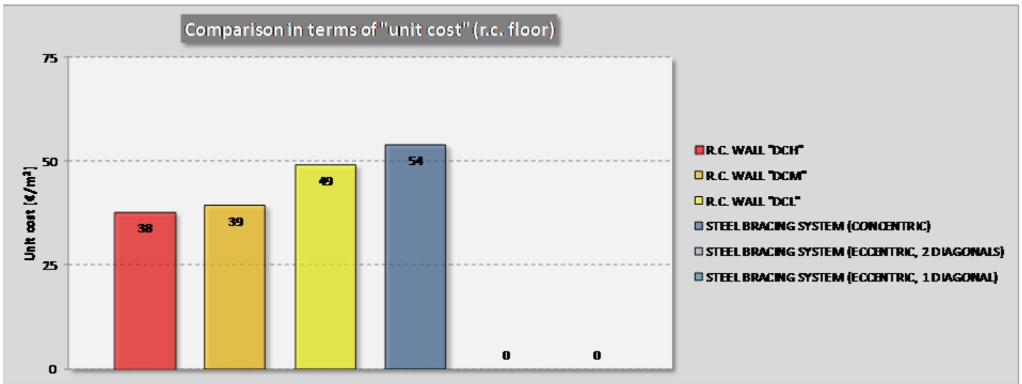
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 []	link1 []	diag2 []	diag1 []	pil2 []	pil1 []	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
8.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
8.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
8.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
8.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
8.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 []	link1 []	diag2 []	diag1 []	pil2 []	pil1 []	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	4.00	5.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=4m; H=6m; V_b=500 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness s [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/ Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wall surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
2	6.00	4.00	0.30	500	D	0.16 g	DCH	4.00	332	73	6	1087	34560	14.40	48	18770	25932	57	78
2	6.00	4.00	0.30	500	D	0.16 g	DCM	3.00	257	73	6	1087	34560	14.40	48	16286	21824	63	85
2	6.00	4.00	0.30	500	D	0.16 g	DCL	1.00	119	73	6	1087	34560	14.40	48	11761	14338	98	120

Database UNICAM (steel bracing system - concentric, 2 diagonals):

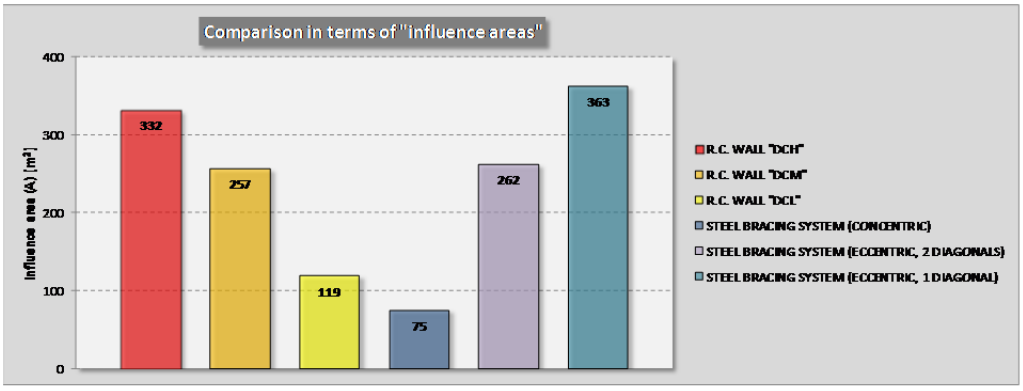
INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	BEAM1 [ ]	DIAG2 [ ]	DIAG1 [ ]	COL2 [ ]	COL1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	6.00	3.00	0.16	500	HE 100 A	HE 120 A	HE 200 A	HE 240 A	HE 160 A	HE 220 A	75	2415	9108	10737	121	142
4.00	6.00	3.00	0.16	500	HE 100 A	HE 120 A	HE 200 A	HE 240 A	HE 160 A	HE 220 A	75	2415	9108	10737	121	142
4.00	6.00	3.00	0.16	500	HE 100 A	HE 120 A	HE 200 A	HE 240 A	HE 160 A	HE 240 A	75	2533	9430	11059	125	146
4.00	6.00	3.00	0.16	500	HE 100 A	HE 120 A	HE 200 A	HE 240 A	HE 160 A	HE 240 A	75	2533	9430	11059	125	146
4.00	6.00	3.00	0.16	500	HE 100 A	HE 120 A	HE 200 A	HE 240 A	HE 160 A	HE 260 A	75	2627	9689	11319	128	150
4.00	6.00	3.00	0.16	500	HE 100 A	HE 120 A	HE 200 A	HE 240 A	HE 180 A	HE 260 A	75	2689	9857	11487	131	152

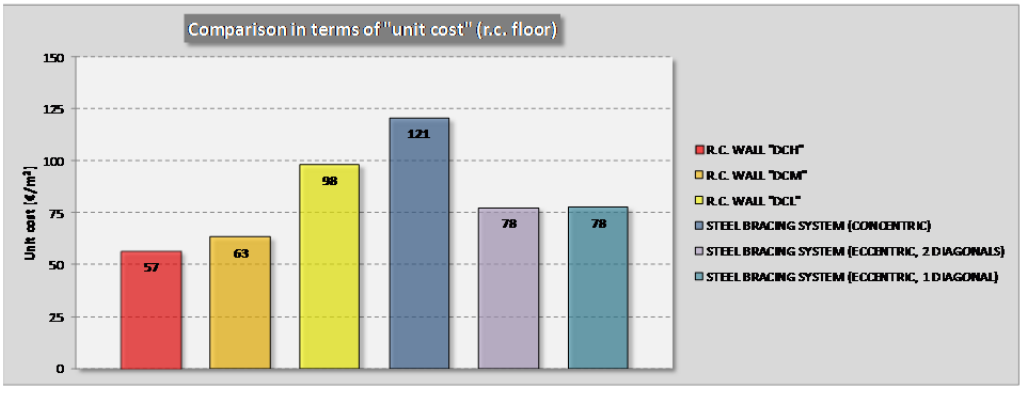
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 [ ]	link1 [ ]	diag2 [ ]	diag1 [ ]	pil2 [ ]	pil1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	6.00	3.00	0.16	500	HE 180 B	HE 220 B	HE 200 B	HE 240 B	HE 140 B	HE 220 B	262	4266	20348	26014	78	99
8.00	6.00	3.00	0.16	500	HE 180 B	HE 220 B	HE 200 B	HE 240 B	HE 160 B	HE 220 B	262	4373	20641	26307	79	100
8.00	6.00	3.00	0.16	500	HE 180 B	HE 220 B	HE 200 B	HE 240 B	HE 160 B	HE 240 B	262	4513	21018	26678	80	102
8.00	6.00	3.00	0.16	500	HE 180 B	HE 220 B	HE 200 B	HE 240 B	HE 180 B	HE 240 B	262	4617	21300	26961	81	103
8.00	6.00	3.00	0.16	500	HE 180 B	HE 220 B	HE 200 B	HE 240 B	HE 180 B	HE 260 B	262	4734	21618	27275	82	104
8.00	6.00	3.00	0.16	500	HE 180 B	HE 220 B	HE 200 B	HE 240 B	HE 200 B	HE 280 B	262	4975	22274	27929	85	107

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 [ ]	link1 [ ]	diag2 [ ]	diag1 [ ]	pil2 [ ]	pil1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	6.00	3.00	0.16	500	HE 220 B	HE 400 A	HE 240 B	HE 300 B	HE 300 B	HE 500 B	346	5799	27297	34762	79	101
4.00	6.00	3.00	0.16	500	HE 220 B	HE 400 A	HE 240 B	HE 300 B	HE 300 B	HE 550 B	363	5945	28272	36112	78	99
4.00	6.00	3.00	0.16	500	HE 220 B	HE 400 A	HE 240 B	HE 300 B	HE 300 B	HE 550 B	363	5945	28272	36112	78	99
4.00	6.00	3.00	0.16	500	HE 220 B	HE 400 A	HE 240 B	HE 300 B	HE 320 B	HE 550 B	365	6060	28632	36503	79	100
4.00	6.00	3.00	0.16	500	HE 220 B	HE 400 A	HE 240 B	HE 300 B	HE 320 B	HE 600 B	381	6210	29579	37800	78	99
4.00	6.00	3.00	0.16	500	HE 220 B	HE 400 A	HE 240 B	HE 300 B	HE 320 B	HE 600 B	381	6210	29579	37800	78	99





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=4m; H=6m; V_b=1000 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness s [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wal surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
2	6.00	4.00	0.30	1000	D	0.16 g	DCH	4.00	665	146	12	2016	34560	14.40	48	31518	45866	47	69
2	6.00	4.00	0.30	1000	D	0.16 g	DCM	3.00	499	146	12	2016	34560	14.40	48	26035	36796	52	74
2	6.00	4.00	0.30	1000	D	0.16 g	DCL	1.00	202	146	12	2016	34560	14.40	48	16237	20588	81	102

Database UNICAM (steel bracing system - concentric, 2 diagonals):

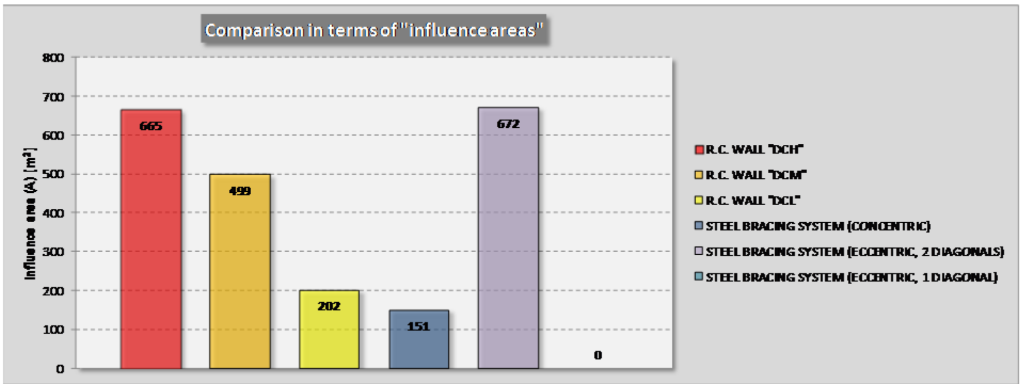
INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	BEAM1 [ ]	DIAG2 [ ]	DIAG1 [ ]	COL2 [ ]	COL1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	6.00	8.00	0.16	1000	HE 140 A	HE 160 A	HE 240 A	HE 300 A	HE 160 A	HE 260 A	151	3283	13977	17236	93	114
4.00	6.00	8.00	0.16	1000	HE 140 A	HE 160 A	HE 240 A	HE 300 A	HE 160 A	HE 260 A	151	3283	13977	17236	93	114
4.00	6.00	8.00	0.16	1000	HE 140 A	HE 160 A	HE 240 A	HE 300 A	HE 160 A	HE 260 A	151	3283	13977	17236	93	114
4.00	6.00	8.00	0.16	1000	HE 140 A	HE 160 A	HE 240 A	HE 300 A	HE 160 A	HE 280 A	151	3382	14247	17506	94	116
4.00	6.00	8.00	0.16	1000	HE 140 A	HE 160 A	HE 240 A	HE 300 A	HE 160 A	HE 280 A	151	3382	14247	17506	94	116
4.00	6.00	8.00	0.16	1000	HE 140 A	HE 160 A	HE 240 A	HE 300 A	HE 180 A	HE 300 A	151	3586	14806	18065	98	120

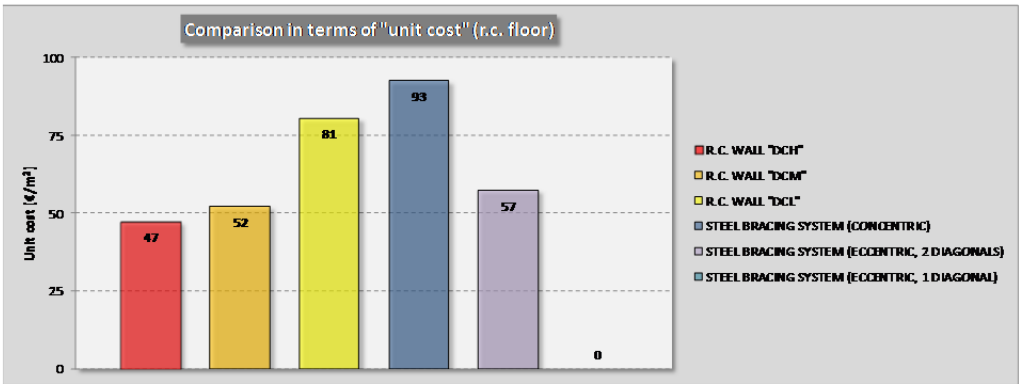
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 []	link1 []	diag2 []	diag1 []	pil2 []	pil1 []	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	6.00	8.00	0.16	1000	HE 220 B	HE 340 B	HE 240 B	HE 300 B	HE 160 B	HE 240 B	672	5955	38473	52971	57	79
8.00	6.00	8.00	0.16	1000	HE 220 B	HE 340 B	HE 240 B	HE 300 B	HE 160 B	HE 240 B	672	5955	38473	52971	57	79
8.00	6.00	8.00	0.16	1000	HE 220 B	HE 340 B	HE 240 B	HE 300 B	HE 160 B	HE 260 B	671	6073	38763	53238	58	79
8.00	6.00	8.00	0.16	1000	HE 220 B	HE 340 B	HE 240 B	HE 300 B	HE 180 B	HE 260 B	671	6176	39045	53521	58	80
8.00	6.00	8.00	0.16	1000	HE 220 B	HE 340 B	HE 240 B	HE 300 B	HE 180 B	HE 280 B	670	6296	39346	53804	59	80
8.00	6.00	8.00	0.16	1000	HE 220 B	HE 340 B	HE 240 B	HE 300 B	HE 200 B	HE 300 B	669	6585	40109	54547	60	82

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 []	link1 []	diag2 []	diag1 []	pil2 []	pil1 []	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	6.00	5.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	5.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	5.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	5.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	5.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	5.00	0.16	1000	-	-	-	-	-	-	-	-	-	-	-	-





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=4m; H=6m; V_b=1500 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness s [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wal surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
2	6.00	4.00	0.30	1500	D	0.16 g	DCH	4.00	997	219	18	2944	34560	14.40	48	44248	65771	44	66
2	6.00	4.00	0.30	1500	D	0.16 g	DCM	3.00	748	219	18	2944	34560	14.40	48	36024	52166	48	70
2	6.00	4.00	0.30	1500	D	0.16 g	DCL	1.00	272	219	18	2944	34560	14.40	48	20339	26219	75	96

Database UNICAM (steel bracing system - concentric, 2 diagonals):

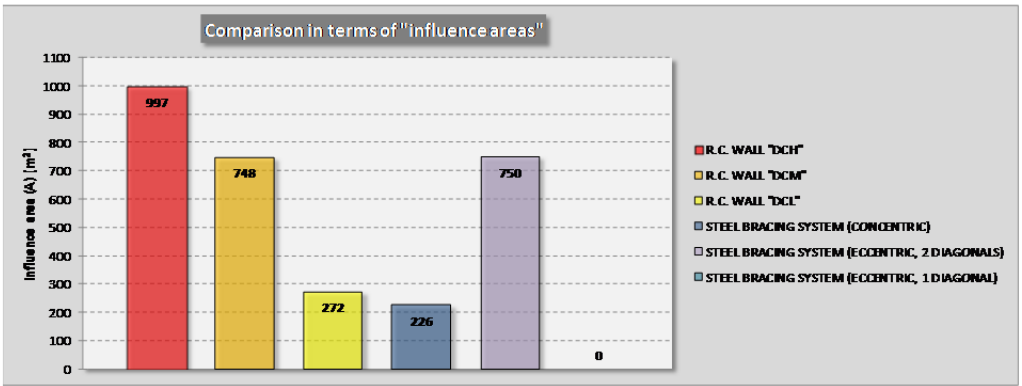
INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	BEAM1 [ ]	DIAG2 [ ]	DIAG1 [ ]	COL2 [ ]	COL1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	6.00	8.00	0.16	1500	HE 160 A	HE 180 A	HE 280 A	HE 400 A	HE 160 A	HE 280 A	226	4093	18685	23574	82	104
4.00	6.00	8.00	0.16	1500	HE 160 A	HE 180 A	HE 280 A	HE 400 A	HE 160 A	HE 280 A	226	4093	18685	23574	82	104
4.00	6.00	8.00	0.16	1500	HE 160 A	HE 180 A	HE 280 A	HE 400 A	HE 160 A	HE 300 A	226	4236	19077	23965	84	106
4.00	6.00	8.00	0.16	1500	HE 160 A	HE 180 A	HE 280 A	HE 400 A	HE 160 A	HE 300 A	226	4236	19077	23965	84	106
4.00	6.00	8.00	0.16	1500	HE 160 A	HE 180 A	HE 280 A	HE 400 A	HE 160 A	HE 300 A	226	4236	19077	23965	84	106
4.00	6.00	8.00	0.16	1500	HE 160 A	HE 180 A	HE 280 A	HE 400 A	HE 180 A	HE 320 A	226	4408	19550	24439	86	108

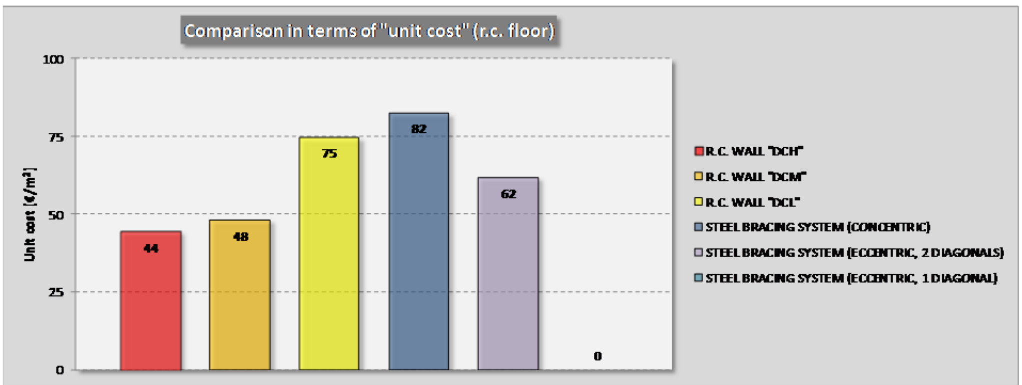
Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 [ ]	link1 [ ]	diag2 [ ]	diag1 [ ]	pil2 [ ]	pil1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	6.00	8.00	0.16	1500	HE 200 M	HE 450B	HE 280 B	HE 500 B	HE 160 B	HE 260 B	750	7878	46333	62527	62	83
8.00	6.00	8.00	0.16	1500	HE 200 M	HE 450B	HE 280 B	HE 500 B	HE 160 B	HE 260 B	750	7878	46333	62527	62	83
8.00	6.00	8.00	0.16	1500	HE 200 M	HE 450B	HE 280 B	HE 500 B	HE 180 B	HE 280 B	766	8101	47450	63974	62	84
8.00	6.00	8.00	0.16	1500	HE 200 M	HE 450B	HE 280 B	HE 500 B	HE 180 B	HE 280 B	766	8101	47450	63974	62	84
8.00	6.00	8.00	0.16	1500	HE 200 M	HE 450B	HE 280 B	HE 500 B	HE 200 B	HE 300 B	782	8390	48799	65687	62	84
8.00	6.00	8.00	0.16	1500	HE 200 M	HE 450B	HE 280 B	HE 500 B	HE 200 B	HE 300 B	782	8390	48799	65687	62	84

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 [ ]	link1 [ ]	diag2 [ ]	diag1 [ ]	pil2 [ ]	pil1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	6.00	8.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	8.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	8.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	8.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	8.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	8.00	0.16	1500	-	-	-	-	-	-	-	-	-	-	-	-





COMPARISON BETWEEN R.C. WALL AND STEEL BRACING SYSTEMS (B=4m; H=6m; V_b=2000 kN)

Database FENO (r.c. wall bracing system):

INPUT									OUTPUT							COST ESTIMATION			
Number of storeys	Storey height H [m]	Width B [m]	Thickness s [m]	Base shear Vb [kN]	Distribution type	Seismic/Wind action	Ductility class	Behaviour factor	Surface/Wall [m²]	Vertical rebars As,bending [cm²]	Horizontal rebars As,shear [cm²/m]	Steel weight [kg]	Concrete weight [kg]	Concrete volume [m³]	Precast DL wal surface [m²]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
2	6.00	4.00	0.30	2000	D	0.16 g	DCH	4.00	1330	291	24	3873	34560	14.40	48	56979	85676	43	64
2	6.00	4.00	0.30	2000	D	0.16 g	DCM	3.00	997	291	24	3873	34560	14.40	48	46013	67536	46	68
2	6.00	4.00	0.30	2000	D	0.16 g	DCL	1.00	337	291	24	3873	34560	14.40	48	24221	31487	72	94

Database UNICAM (steel bracing system - concentric, 2 diagonals):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	BEAM2 [ ]	BEAM1 [ ]	DIAG2 [ ]	DIAG1 [ ]	COL2 [ ]	COL1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	6.00	8.00	0.16	2000	HE 180 A	HE 220 A	HE 300 A	HE 450 B	HE 160 A	HE 300 A	302	5048	23794	30312	79	100
4.00	6.00	8.00	0.16	2000	HE 180 A	HE 220 A	HE 300 A	HE 450 B	HE 160 A	HE 300 A	302	5048	23794	30312	79	100
4.00	6.00	8.00	0.16	2000	HE 180 A	HE 220 A	HE 300 A	HE 450 B	HE 160 A	HE 320 A	302	5160	24100	30618	80	101
4.00	6.00	8.00	0.16	2000	HE 180 A	HE 220 A	HE 300 A	HE 450 B	HE 160 A	HE 320 A	302	5160	24100	30618	80	101
4.00	6.00	8.00	0.16	2000	HE 180 A	HE 220 A	HE 300 A	HE 450 B	HE 160 A	HE 340 A	302	5249	24343	30861	81	102
4.00	6.00	8.00	0.16	2000	HE 180 A	HE 220 A	HE 300 A	HE 450 B	HE 180 A	HE 360 A	302	5394	24741	31259	82	104

Database UNICAM (steel bracing system - eccentric, 2 diagonals):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 [ ]	link1 [ ]	diag2 [ ]	diag1 [ ]	pil2 [ ]	pil1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
8.00	6.00	8.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
8.00	6.00	8.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
8.00	6.00	8.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
8.00	6.00	8.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
8.00	6.00	8.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
8.00	6.00	8.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-

Database UNICAM (steel bracing system - eccentric, 1 diagonal):

INPUT					OUTPUT								COST ESTIMATION			
B [m]	H [m]	Qk1 [kN/m²]	ag/g [ ]	Vb [kN]	link2 [ ]	link1 [ ]	diag2 [ ]	diag1 [ ]	pil2 [ ]	pil1 [ ]	A [m²]	Weight [kg]	Total cost (r.c. floor) [€]	Total cost (s.s. floor) [€]	Unit cost (r.c. floor) [€/m²]	Unit cost (s.s. floor) [€/m²]
4.00	6.00	8.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	8.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	8.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	8.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	8.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-
4.00	6.00	8.00	0.16	2000	-	-	-	-	-	-	-	-	-	-	-	-