



فصلنامه علمی

نشریه علمی - تخصصی چترساره ای دانشجوئی مهندسی عمران

دانشگاه تبریز

سال اول، شماره نخست، اسفند سال ۱۴۰۰

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در این نشریه می خوانید:

بررسی نحوه مدل سازی سگمنت تونل و تاثیر آن بر نشستهای ساختمان های مرتبط

طراحی بهینه قابهای فولادی با اعضای غیرمنشوری با قیود جابجایی و مقاومتی

معرفی روش TOP - DOWN یا سازه معکوس

متن مصاحبه با جناب آقای دکتر امیر زویچی دکترای مهندسی و مدیریت ساخت از دانشگاه Central Florida



در زمینه‌ی علم و فناوری، آن کاری را که ذهن بشر به آن دست نیافته است
آن را وجهه‌ی همت قرار بدهید و دنبال بکنید؛
این طوری است که ما خط مقدم علم را شکسته‌ایم
و یک قدم به جلو برداشته‌ایم.

بیانات مقام معظم رهبری ۱۳۸۵/۰۷/۱۳



دانشگاه تبریز
دانشکده فنی مهندسی مرند



به جهت دریافت اطلاعات مربوط به تماس با دفتر نشریه و ارسال آثار علمی به جهت چاپ در
دومین نسخه از نشریه تکنوسیویل، کیو آر کد فوق را اسکن نمایید



فصلنامه علمی - تخصصی دانشجویی مهندسی عمران

سال اول - شماره اول اسفند ماه سال ۱۴۰۰

شماره مجوز: ۹۱/۴۲۰د

صاحب امتیاز: جناب آقای سالار شاطری وابسته به انجمن علمی مهندسی عمران دانشکده فنی و مهندسی مرنند، دانشگاه تبریز

مدیر مسئول: جناب آقای محمدرضا اختری

سر دبیر: جناب آقای میرشهریار هاشمی زنوزی

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جناب آقای دکتر حسین زنوزی
جناب آقای دکتر جواد غفاری
جناب آقای دکتر کامبیز فلسفیان
جناب آقای محمدرضا اختری
سرکار خانم زهرا رسولپور
جناب آقای سالار شاطری
جناب آقای سید امین طباطبایی
سرکار خانم فاطمه نظرپور
جناب آقای میرشهریار هاشمی زنوزی

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سرکار خانم دکتر حبیبه عباسی
جناب آقای دکتر حسین زنوزی
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جناب آقای دکتر کامبیز فلسفیان
سرکار خانم دکتر لیلا ملکانی
جناب آقای دکتر محسن میرزاجانی

ویراستار، طراح و صفحه آرا:

سرکار خانم فاطمه نظرپور، سرکار خانم زهرا رسولپور، جناب آقای محمدرضا اختری، جناب آقای سالار شاطری، جناب آقای سیدامین طباطبایی
جناب آقای میرشهریار هاشمی زنوزی

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آدرس:

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رئیس هیئت ویراستاری:
سرکار خانم زهرا رسولپور

ترجمه به زبان انگلیسی:
سرکار خانم معصومه اختری



سخن مدیر مسئول:

بنام آن که جان را فکرت آموخت

اگر نمیتوانی اقیانوس باشی، دریا باش، اگر نه رودخانه باش و اگر نه می توانی رودخانه باشی، نهری کوچک باش، اما هیچ گاه مرداب نباش، نهری باش جاری، زلال و مهربان و با جوشش زیست زندگی را به همه بده کن چون وقتی حرکت میکنی هم زنده ای و هم به دیگران زندگی می دهی، سبزه های کنار نهر را دیده ای، چه زیبا چشم ها را نوازش می دهند و آوازی پروانه های لطیف و زیبا هستند، این ها به خاطر سخاوت و مهربانی نهر کوچک اما جاری است، پس تو هم با الهام از این رود کوچک جاری شو و بدان خدا در همه حال با تو است.

با سلام و احترام خدمت تمامی مخاطبین و مطالعه کنندگان نشریه علمی تخصصی تکنوسیویل

با عنایت و تلاش مستمر اساتید و دانشجویان و هیئت تحریر و هیئت ویراستاری، نخستین شماره از نشریه علمی تخصصی چند رسانه ای مهندسی عمران دانشگاه تبریز را به اتمام رسانیدم و سعی کردیم در این نشریه مقالاتی از موضوعات بروز در مهندسی عمران را نشر دهیم تا بتوانیم در افزایش سطح معلومات عمومی و تخصصی دانشجویان مهندسی عمران نقش داشته باشیم.

در انتها بر خود وظیفه میدانم که از اساتید محترم گروه مهندسی عمران دانشگاه تبریز، اساتید محترم دانشکده فنی و مهندسی مرند، دانشجویان رشته مهندسی عمران و تمامی دست اندرکاران که ما را در راستای به سرانجام رساندن این نشریه یاری کردند قدردانی نمایم.

و تشکر ویژه داریم از ریاست محترم دانشکده فنی و مهندسی مرند، جناب آقای دکتر شهامت که امکانات لازم را برای تیم نشریه فراهم کردند تا بتوانیم قدمی هرچند کوچک را در اعتلای نشریات دانشجویی دانشگاه تبریز برداشته باشیم.

محمدرضا اختری

مدیر مسئول نشریه علمی-تخصصی تکنوسیویل



سخن سردبیر:

به نام آنکه هستی نام از او یافت
فلک جنبش، زمین آرام از او یافت

سلام و عرض ادب خدمت مخاطبین گرانقدر نشریه تکنوسیویل

با عنایت و اهتمام به پیشرفت روزافزون علم و فناوری، ضرورت ارائه نتایج حاصل از تحقیقات و پژوهش ها برای استفاده محققان دو چندان شده است. بدین سبب سعی شده است قدمی هر چند کوچک در این راستا برداشته شود.

این نشریه ثمره ی تحقیقات و پژوهش های اساتید و دانشجویان توانمند دانشگاه تبریز و ... می باشد. در واقع هدف از انتشار این نشریه علمی – تخصصی ، ارتقای دانش و سطح علمی دانشجویان و محققان در زمینه های مختلف ، گسترش فعالیت های پژوهشی بین مراکز صنعتی و علمی و پژوهشی و ایجاد بستری مناسب برای توسعه ارتباط میان پژوهشگران، اساتید صاحب تجربه ، دانشجویان می باشد. تلاش کلیه عوامل نشریه بر این بوده است که با سر لوحه قرار دادن این اهداف، برگ سبزی در خور نام بلندآوازه دانشگاه تبریز ارائه نماییم.

این شماره از نشریه ، نخستین چاپ نشریه تکنوسیویل می باشد، که در آن به موضوعات متنوعی در زمینه های تخصصی مهندسی عمران پرداخته شده است. امید است مطالب ذکر شده مورد توجه مخاطبان گرامی قرار گرفته باشد.

نهایتا بر خود لازم می دانم از تمام اساتید و همکارانم در تیم نشریه تکنوسیویل کمال سپاس و قدردانی را بجا آورم. همچنین، خواهشمند است با نظرات و انتقادات سازنده خویش ما را در جهت غنای هرچه بیشتر این نشریه یاری فرمائید.

میر شهریار هاشمی زنوزی

سردبیر نشریه علمی – تخصصی تکنوسیویل

دانشگاه تبریز



دانشکده فنی و مهندسی مرنند

دانشگاه تبریز به عنوان دومین دانشگاه قدیمی کشور فعالیت علمی خود را از سال 1326 با ایجاد دو دانشکده ادبیات و پزشکی آغاز نموده است. این دانشگاه بزرگ نقش بسیار برجسته ای در تحولات علمی، فرهنگی و سیاسی هفتاد سال اخیر کشور داشته و در حال حاضر با داشتن 21 دانشکده، 10 پژوهشکده، 5 قطب علمی، بیش از 800 نفر عضو هیئت علمی، 24000 نفر دانشجو و 1000 نفر پرسنل اداری در 4 رشته کاردانی، 164 رشته کارشناسی، 322 رشته کارشناسی ارشد و 209 رشته دکتری تخصصی به تربیت نیروی انسانی ماهر و متخصص اهتمام دارد. این دانشگاه با برخورداری از امکانات منحصر به فرد علمی در شمالغرب کشور و با آزمایشگاه های بسیار مجهز در حوزه های مختلف بیش از 300 هزار عنوان کتاب، 7 هزار کاربر فعال شبکه و 25 نشریه علمی پژوهشی و اشتراک مجلات معتبر الکترونیکی و چاپی دنیا در خدمت پژوهشگران بوده و تا کنون سه نفر از پژوهشگران بوده و تا کنون سه نفر از اساتید دانشگاه به عنوان چهره ماندگار کشور بیش از 20 نفر استاد و پژوهشگر نمونه کشوری و پنج نفر به عنوان دانشمند جهان اسلام معرفی شده است و تعداد زیادی از فارغ التحصیلان آن هماکنون در بالاترین پست های سیاسی و اجرایی کشور عهده دار مسئولیت می باشند.

دانشگاه تبریز علاوه بر فعالیت های آموزشی و پژوهشی در امر گسترش آموزش عالی در منطقه شمالغرب کشور نیز نقش برجسته و ارزنده ای داشته و دانشگاه های محقق اردبیلی، مراغه و بناب از آن منشعب شده است و هم اکنون در شهرهای مرنند، اهر و میانه دارای دانشکده ی اقماری بوده و در منطقه آزاد تجاری ارس نیز یک پردیس بین المللی دارد.

بخش بعدی :

مصاحبه



متن مصاحبه با

جناب آقای دکتر امیر زویچی (دکتری مهندسی و مدیریت ساخت از دانشگاه آمریکا)

موضوع: بررسی راه های مهاجرت تحصیلی و موفقیت در این مسیر



با عرض سلام و ادب و وقت بخیر خدمت شما آقای دکتر، از این که وقتتان را در اختیار ما قرار دادید نهایت قدردانی را داریم

در ابتدا اگر موافق باشید از شما دعوت میکنیم که یک معرفی داشته باشید جناب دکتر و بعد سوال ها را خدمتتان مطرح کنیم

در ابتدای کار سلام و وقت بخیر میگم خدمت تمامی دانشجوها...

بله من یک معرفی میکنم که در واقع سرگذشتم را میگویم برای اینکه فکر میکنم افرادی که در حال خواندن این مصاحبه هستند اکثرا دانشجو هستند که میتوانیم با هم ارتباط برقرار کنیم تا شاید موارد مشابهی در سرگذشت من پیدا کنیم و بتواند نقطه عطفی در زندگی و تغییر مسیر زندگی آن ها باشد.

من لیسانس را در سال 1381 در رشته مهندسی عمران دانشگاه فردوسی مشهد بوم و البته یک ترم را نیز در دانشگاه تبریز گزرانده ام و مقطع ارشد را در دانشگاه امیرکبیر و در رشته مدیریت ساخت ادامه تحصیل دادم بعد از اتمام دوره فوق لیسانس در یک بازه زمانی وارد بازار کار شدم و حتی در آن زمان تدریس هم داشتم و شروع کردم به انجام دادن کارهای مربوط به اپلای و از دانشگاه Central Florida در جنوب شرقی آمریکا پذیرش گرفتم و دوره دکتری را در مدت 3 سال و 2 ماه به اتمام رساندم و بعد مهاجرت کردم به ایالت کالیفرنیا که شروع کنم به کارآموزی و الان در ایالت کالیفرنیا مشغول کار هستم.

خیلی ممنونیم آقای دکتر، اگر اجازه بدهید از دوره لیسانس شروع کنیم و چندتا سوال را با جنابعالی مطرح کنیم.

در دوره لیسانس چه فاکتورهایی و مواردی که باعث موفقیتتان چه در ایران و چه در بحث اهلای و چه در موقعیت اجتماعی که الان دارید شده است را لطفاً بفرمایید و همچنین چه کارهایی را که دوست داشتید انجام بدهید که انجام ندادید و سوالات مربوط به اینکه معدلتون چند بوده و یا کدام کلاس هارو شرکت کردید را لطفاً بفرمایید آقای دکتر.

بله پس من تمرکز میکنم بر روی مقطع لیسانس و چیزهایی که میگم و اتفاقاتی که برای من افتاده لزوماً همه اش اتفاق های خوب و درستی نبوده اند میگویم تا شما دچار این اتفاقات نشوید و فرصت هایی را از دست ندهید.

دوران لیسانس اکثر زمان من و دوستانم در دانشگاه سپری می شد و دروس بسیار سنگین بود و اساتید هم سخت میگرفتند و ما فرصت آنچنانی برای فعالیت های جانبی نداشتیم و من این را یک نقطه ضعف می دانم و بچه ها میتوانند کارهای مختلفی را در دوران لیسانس انجام دهند.

دوران لیسانس با وجود اینکه خیلی فشار تحصیلی از طرف دانشگاه زیاد است یکی از او دورانی هست که شما در آن زمان خیلی زمان های آزاد هم دارید و من یادم هست که اون زمان میتوانستیم کتاب های مختلفی بخوانیم، رمان بخوانیم، فیلم نگاه کنیم و ...

خیلی از شخصیت ما در اون زمان ساخته میشد، دوستانی که انتخاب میکردیم و وقت های که باهاشون میگذروندیم در آینده ما تاثیر داشت و هدف های ما متناسب با افرادی که باهاشون دوست بودیم تعیین می شد.

به عنوان مثال برای فعالیت های جانبی میتوانید کار های آزمایشگاهی انجام دهید و با اساتید بیشتر کار کنید و از استاد بخواهید که برایتان کار بیشتر و اضافی انجام دهد و آن دانشجویی باشید که علاقه خودتون رو بتونید نشون بدید و مهم این هست که به واسطه برخوردهایی که داری علاقه خودتون رو واسه آینده پیدا کنید، اما در دوره لیسانس تمرکز ما بیشتر روی درس بود و معدل من در حدود 16 بود و جزء 10 یا 15 نفر اول بودم در واقع پر تلاش بودیم.

یک سوال دیگر اینکه آقای دکتر لطفاً بفرمایید که در دوران لیسانستون چه کارهای جانبی انجام میدادید یا مثلاً کارآموزی را جای خاصی میرفتید و سوال دوم اینکه کارهایی که در دوران لیسانس انجام میدادید چه مقدار تاثیر گذار بود در پروسه اپلایتون و اهمیت داشت تجربیاتی که به دست آورده بودید و اگر توضیح بدهید خیلی ممنون میشویم و سپس بریم سراغ دوره فوق لیسانس.

بله در خصوص کارآموزی این را بگویم که من کارآموزی دوران لیسانس را که به صورت 3 واحد بود و پدر من در مشهد کار مهندسی عمران میکرد، پدرم منو پیش یکی از دوستاش که در اطراف اردبیل کار راهسازی را انجام میدادند، فرستادند و اینطوری بود که من، یک جوان 22 ساله، در مدت سه ماه حضور در آن جا یک تجربه کارگاهی ارزشمندی را چه خواه و چه ناخواه به دست آوردم و دعوت میکنم که شما هم در دوران لیسانس کارآموزی رو مهم بگیرید چون تجربیات ارزشمندی را در اختیار یک دانشجویی که دروس را به صورت تئوری خوانده، قرار می دهد.

ببینید ما درس نمیخوانیم که درس خوانده باشیم، در ایران اینجوری بود که بتوانیم مهندس بشویم، دکتر بشویم و یک جایگاه اجتماعی مناسبی پیدا کنیم، اما باید تفکراتمون را یک مقدار عوض کنیم، ما درس را میخوانیم که یه کاری را بتوانیم انجام دهیم و اگر در دوران لیسانس به جایی رسیدید که مثلاً فکر کنید که آیا از استاتیک که میخوانید آیا از آن کاری در می آید یا خیر، اون برد شماست و در کارآموزی فرصت دارید که بتوانید این هارا تجربه کنید که بسیار کمک کننده است.

تجربه ای که من به شخصه آن را نداشتم ولی دوست داشتم که تجربه اش کنم کارهای آزمایشگاهی بود، الان اکثر دانشگاه ها تجهیزات آزمایشگاهی دارند، چون الان بسیاری از دانشجویها غرق در کتاب و قلم می شوند سمت کارهای آزمایشگاهی نمی روند ولی بسیاری از اتفاقات خوب مهندسی در آزمایشگاه ها اتفاق می افتد. توصیه من این هست که حتما تجربه کار آزمایشگاهی را داشته باشید.

خب اگر موافق باشید برویم سراغ مقطع ارشد و اینکه چرا دانشگاه امیرکبیر را برای ادامه تحصیل انتخاب کردید؟

من نمیخواستم خود را بعد از مقطع لیسانس محدود ببینیم و در آن زمان یک رشته جدید اومده بود به اسم مدیریت ساخت... مدیریت ساخت یعنی اینکه شما باید از لحاظ مدیریتی به کلیه فعالیت هایی که انجام میشه تسلط داشته باشی و این چیزی بود که من میخواستم، چون که من دوست داشتم بعد از مقطع کارشناسی، هنوز چیزهای زیادی را راجب مهندسی عمران یاد بگیرم. به این صورت شد که چون رشته مدیریت ساخت تازه وارد دانشگاه های ایران شده بود و با توجه به اینکه رشته های جدید یعنی کلا چیزهای جدید ذاتا جذابیت دارند ولی خب همه چیزهای جذاب قطعا درست نیستند و باید تحقیق کرد راجبشون، من هم در آن زمان بهترین دانشگاه ها را رده بندی کردم و بهترینش که امیرکبیر بود رو انتخاب کردم و همکلاسی من رتبه یک نیز بود و این نشون میداد که تصمیمم درست در انتخاب رشته مدیریت ساخت درست بوده.

میشه یک مقدار در زمینه اپلای در مقطع کارشناسی و ورود به کارشناسی ارشد و همینطور سربازی و مشکلاتی که در این راه برای دانشجویهای مقطع کارشناسی وجود دارد بفرمایید.

خب در زمان ما زیاد موضوع مهاجرت مطرح نبود و به صورت یک آپشن به موضوع مهاجرت نگاه می شد اما من دوست داشتم که مهاجرت کنم و با خودم تصمیم میگرفتم که یک سال تلاش کنم تا از مقطع کارشناسی مهاجرت کنم یا ارشد بخونم و برای دکتری اپلای کنم چون در اون زمان باتوجه به شرایط مالی زندگی در خارج از کشور حداقل 30 هزار دلار لازم داشتم و تصمیم گرفتم کارشناسی ارشد رو در ایران بخونم و به هر حال 30 هزار دلار صرفه جویی کنم.

و طبیعتا هم از میخواستم سربازی را عقب بندازم پس اینجوری شد که من تصمیم گرفتم که ارشد بخونم و بعد اپلای کنم

در مورد اینکه لیسانس بهتر هست برای اپلای یا ارشد اینطوری میتونم بگم که حالا با توجه به شرایط کنونی و اینکه اگر شرایط کشورمون بهتر بشه همه ما دوست داریم به کشورمون برگردیم و در این حال از کسانی که تو ایران کار کردن شاید 10 سال عقبتر باشیم، حالا مهاجرت سختی های خودش رو دارد که دوری از خانواده یکی از اوناست و هرچقدر سن بالاتر میره مهاجرت سخت تر میشه و یک جوان بیست ساله هم اصلا به مهاجرت فکر نمیکنه ولی در کل به نظر من اگر شرایط مالی و خانوادگیتون اجازه اپلای و مهاجرت میده، اگر الان مهاجرت کنید از 3 سال دیگه بهتر هست.

در کل دنیا از یک دانشجوی لیسانس انتظارات زیادی نمیره که مثلا مقالات درجه بالایی داشته باشه ولی برای مقطع ارشد خب لازمه که مقاله داشته باشه و نمره زبان عالی داشته باشه و بلد باشه کارهای تحقیقاتی انجام بده، من در هر حال توصیه میکنم اگر قصد مهاجرت دارید بهتر هست که در کارشناسی این کار رو انجام دهید.

چه توصیه هایی میکنید برای بچه ها که چیکار کنند تا رزومه شون قوی بشه و بتونن رزومشون رو بهتر بکنند؟

پروسه ای که باعث شد من به فکر اقدام برای اپلای بکنم یکی از دوستانم بود که همکلاسی من در دانشگاه امیرکبیر بود و در حین سربازی داشت کار های مهاجرتش رو انجام میداد، یه روزی به من گفت که امیر میتوانم بیایم به خانه شما چون که با یه استاد خارجی مصاحبه دارم (در اون زمان من اینترنت داشتم) گفتم آره چرا که حتما بیا ...

و بعد اون من هم تونستم در همان دانشگاه پذیرش بگیرم و باهم بتونیم بیایم آمریکا برای ادامه تحصیلات...

نکته اخلاقی این قضیه دوست خوب هست یعنی ما داریم تیم های دوستانه ای که در عین دوستی رقابت هم دارند و این عالیه.

یکی از قسمت های مهم در زمینه اپلای یادگیری زبان هست یک قسمت نمره است و یک قسمت یادگیری هست، چه بسا افرادی نمره بالا گرفتند ولی هنوز نمی توانند به صورت صریح انگلیسی حرف بزنند، هرچقدر زبانتان قوی تر باشد، نزدیک تر هستید به هدفتان برای اپلای.

کارهای آزمایشگاهی، کارآموزی این ها مهم هستند برای مقطع کارشناسی اما برای مقطع کارشناسی ارشد خودتون رو درگیری کار مقاله نویسی بکنید مهم نیست خیلی عجیب و غریب باشه مهم اینه که شما بتونید یک صفحه به انگلیسی بنویسید و در یک جایی چاپ کنید.

برای ادامه مصاحبه میتوانید Qr code کد فوق را اسکن کنید و فایل صوتی کامل مصاحبه را دانلود کنید.



در نهایت صمیمانه و خیلی زیاد سپاسگذاریم از آقای دکتر امیر زویچی که وقت خود را در اختیار ما قرار دادند که بتوانیم از تجربیات گرانبهایشان استفاده کنیم تا با نشر مطالب قدمی در پیشرفت دانشجوهای این مرز و بوم داشته باشیم.

به عنوان پیشنهاد حتما توصیه می شود که فایل صوتی را دانلود و گوش کنید نکات مهم زیاد دیگری را آقای دکتر زویچی در فایل صوتی مطرح کرده اند.

بخش بعدی:

مقالات

“طراحی بهینه قابهای فولادی با اعضای غیر منشوری با قيود جابجایی و مقاومتی”



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خلاصه

معمولاً فرآیند بهینه‌سازی قابهای فولادی با اینرسی متغیر با در نظر گرفتن اثر ترکیبی مقاومت محوری و خمشی، تا حدی پیچیده و زمان بر می‌باشد. در این پژوهش، ابتدا روابط دقیق ماتریس سختی المان‌ها با استفاده از روش‌های انرژی استخراج و در آنالیز سازه به کار برده شده است. سپس روش معیارهای بهینگی (O.C) برای بهینه‌سازی وزن سازه مورد استفاده قرار گرفته است. این روش از روش‌های جبری- عددی چندمتغیره و مقید بصورت گریزانی بوده و سرعت بالایی نسبت به روش‌های جستجویی دارد. قيود طراحی نیز بصورت محدودیت جابجایی، ظرفیت مجاز باربری در اثر ترکیب نیروهای محوری و خمشی و قيود ابعادی اعمال گردیده است. در این تحقیق عمق مقاطع در گره‌ها بعنوان متغیر طراحی در نظر گرفته شده است و عرض و ضخامت بال و جان ثابت فرض شده است. در ضمن در طراحی ضوابط آیین‌نامه LRDF لحاظ گردیده است. در نهایت نرم افزاری با نام Optimum برای طرح بهینه انواع قابهای فولادی تهیه شده است.

کلمات کلیدی: بهینه سازی، قاب‌های فولادی، مقاطع غیر منشوری، معیارهای بهینگی

1. مقدمه

امروزه استفاده از تیرهای با ارتفاع متغیر یا غیر منشوری در صنعت ساختمان گسترش بسیاری پیدا کرده است. این نوع تیرها بخصوص در ساختمان‌های صنعتی با قابهای صلب که در آنها احتیاج به دهانه‌های بزرگ داریم رونق فراوانی دارد. در این تیرها ارتفاع حداکثر تیر با توجه به لنگر خمشی حداکثر بدست می‌آید و این ارتفاع همگام با کم شدن مقدار لنگر خمشی، کوچکتر می‌شود. تحلیل قابهایی که دارای چنین اعضای هستند تقریباً حل شده است، با این وجود طراحی قابهای غیر منشوری معمولاً به سهولت تحلیل آنها نمی‌باشد و در آیین‌نامه‌های طراحی معمولاً از روشهای تقریبی استفاده می‌گردد. در نتیجه طراحی بهینه این نوع قابهای فولادی مسئله‌ای است که حائز اهمیت می‌باشد.

اکثر طراحان معتقدند که طرح بهینه یک سازه بایستی تامین کننده قیدهای طراحی و نیز حداقل وزن یا هزینه آن باشد. بنابراین در فرآیند طراحی بهینه سازه، ابتدا بایستی از روی نتایج تحلیلی، تابع هزینه و قیدهای طراحی را تعیین کرده، سپس برای بدست آوردن حداقل تابع هزینه، از روشهای بهینه سازی استفاده شود، بطوریکه قیدهای طراحی را نیز ارضاء نماید و در نهایت نتایج از لحاظ عملی بودن بررسی گردند [3].

روش‌های طراحی بهینه سازه‌ها را می‌توان به دو گروه کلی روش‌های جبری و عددی تقسیم نمود. روشهای جبری معمولاً براساس تئوریهای ریاضی استوار بوده و برای طراحی بهینه المان‌های سازه‌ای ساده مانند تیرها و ستون‌ها و صفحات مورد استفاده قرار می‌گیرند و نمی‌توان آنها را در سیستم‌های سازه‌ای بزرگ و سازه‌های اسکلتی با مقاطع غیر منشوری مورد استفاده قرار داد. اما روش‌های عددی با توجه به پیشرفتهای برنامه نویسی کامپیوتری طی یک سری فرآیندهای تکراری و خودکار بدست می‌آید. در این روش‌ها پس از اینکه یک طرح اولیه برای شروع جستجوی طرح بهینه معرفی شد، برنامه طی یک سری اصول خاص، بمرور به طرح بهینه نزدیک می‌گردد. جستجو زمانی متوقف می‌گردد که یک سری معیارهای خاص ارضاء

گردند و در این حالت است که طرح بدست آمده به طرح بهینه مطلق بسیار نزدیک شده است. در این مقاله برای طراحی کمترین وزن سازه های اسکلتی با مقاطع غیر منشوری، از روشهای طراحی تمام تنشی¹ (FSD)، طراحی برای قید مقاومت ترکیبی مقاطع و طراحی برای قید جابجایی استفاده شده است.

2. متغیرهای طراحی، تابع هدف، قیدها

در فرآیند طراحی بهینه سازه، برخی از کمیت ها مقادیر ثابتی دارند و برخی تغییر می نمایند تا اینکه حالت بهینه بدست آید. پارامترهایی که در فرآیند بهینه سازی ثابت هستند، پارامترهای از پیش تعیین شده بوده و سایر متغیرها، متغیرهای طراحی نامیده می شوند. از نقطه نظر فیزیکی، متغیرهای طراحی، ممکن است بیان کننده برخی از خواص سازه از قبیل خواص مکانیکی یا فیزیکی مواد، توپولوژی سازه (نحوه اتصالات اعضاء و یا تعداد المان ها در سازه)، ساختار یا شکل هندسی سازه و یا سطح مقطع یا ابعاد عضو باشند [4]. در این پژوهش عمق مقاطع I شکل در گره ها به عنوان متغیر طراحی در نظر گرفته شده است.

معمولاً در مسائل بهینه سازی تعداد طرح های مطلوب بسیار زیاد می باشد از اینرو برای انتخاب بهترین طرح لازم است تا تابعی از متغیرهای طراحی تعریف شود تا اینکه بتوان طرح های مطلوب را با هم مقایسه کرد. این تابع، تابع هدف بوده و در این پژوهش وزن به عنوان تابع هدف در نظر گرفته می شود و داریم:

$$W = \rho V$$

$$W = \sum_{r=1}^{nm} \rho_r v_r = \rho \sum_{r=1}^{nm} v_r \quad (1)$$

در رابطه فوق، ρ وزن مخصوص اعضاء و v_r حجم عضو r ام است.

قیدها عبارتند از محدودیتها و نیازهایی که یک طرح بایستی دارا باشد تا اینکه به یک طرح مطلوب تبدیل گردد. در این پژوهش قیدهای جابجایی و قیدهای مقاومتی به عنوان شرایط قیدی مسئله بهینه سازی در نظر گرفته می شوند.

قیدهای جابجایی

با فرض اینکه به تعداد p عدد قید جابجایی در سازه داشته باشیم، قید n ام جابجایی بصورت زیر قابل بیان است:

$$g_{dn}(D_k) = \delta_j - \delta_j^U \leq 0 \quad (2)$$

در رابطه فوق δ_j ، جابجایی گرهی می باشد. معمولاً جابجایی در یک گره، مستقل از متغیرهای عمق سایر گره ها نمی باشد. δ_j^U نیز حد بالای جابجایی و یا جابجایی مجاز گرهی می باشد. مقدار جابجایی مجاز بایستی طوری انتخاب گردد که به شرایط بهره برداری سازه مورد نظر آسیبی وارد نسازد.

قیدهای مقاومتی

برای عضو I ام از یک سازه اسکلتی، که تحت اثر نیروهای محوری و خمشی قرار دارد، قید مقاومت ترکیبی، بر اساس آئین نامه LRFD بصورت زیر بیان شده است:

$$\begin{cases} \frac{P_u}{\phi P_n} \geq 0.2 \Rightarrow \frac{P_u}{\phi P_n} + \frac{8}{9} \frac{M_{ux}}{\phi_b M_{nx}} \leq 1.0 \\ \frac{P_u}{\phi P_n} < 0.2 \Rightarrow \frac{P_u}{2\phi P_n} + \frac{M_{ux}}{\phi_b M_{nx}} \leq 1.0 \end{cases} \quad (3)$$

که در این روابط P_u و M_u ، نیروی محوری و لنگر خمشی ناشی از بارهای ضریب دار بوده و P_n و M_n مقاومت اسمی مقطع مورد نظر در برابر نیروی محوری و خمشی می باشد که از طریق آیین نامه تعیین می گردند. ضرایب تقلیل مقاومت ϕ نیز برای فشار، کشش و خمش بترتیب برابر است با 0/85، 0/9 و 0/9. در برخی حالات، مانند طراحی بهینه به روش تمام تنشی FSD، بجای پیدا کردن مقاومت ترکیبی مقطع در برابر نیروی محوری و خمش، می توان تنش

¹ Fully Stressed Design

را بعنوان تنش مجاز مقاطع تعریف نمود و آنرا معیار بهینگی اعضاء در فرآیندهای تکراری بهینه‌یابی در نظر گرفت. در تعیین تنش مجاز σ^U می‌توان از آئین‌نامه‌های مختلف استفاده کرد و نیز سلیقه‌های شخصی را نیز در آن اعمال نمود. در اینصورت قید تنش عبارت خواهد بود:

$$g_s = \frac{\sigma}{\sigma^U} \leq 1.0 \quad (4)$$

با توجه به روابط (3) می‌توان قید مقاومت ترکیبی را بصورت زیر نوشت:

$$g_{sr}(D_i, D_j) = \frac{a_1}{P_n} + \frac{a_2}{M_{nx}} \quad (5)$$

D_i و D_j متغیرهای طراحی عمق و پارامترهای a_1 و a_2 مقادیر ثابتی هستند که بصورت زیر تعریف می‌شوند:

$$\begin{cases} \frac{P_u}{\phi P_n} \geq 0.2 \Rightarrow a_1 = \frac{P_u}{0.85} a_2 = \frac{8M_u}{8.1} \\ \frac{P_u}{\phi P_n} < 0.2 \Rightarrow a_1 = \frac{P_u}{1.7} a_2 = \frac{M_u}{0.9} \end{cases} \quad (6)$$

با توجه به اینکه قیدهای مقاومت ترکیبی اعضاء براساس مقاومت اسمی آنها برای نیروی محوری و خمشی بیان می‌گردد، براساس آئین‌نامه LRFD، برای اعضای غیرمنشوری این مقادیر را می‌توان برحسب متغیرهای طراحی بصورت خلاصه زیر بیان کرد [5]:

جدول 1- مقاومت اسمی مقاطع تحت شرایط مختلف طبق آیین نامه LRFD

$P_n = F_y A_g$ $A_g = D_i t_w - 2T$ $T = t_w t_f - b_f t_f$	مقاومت اسمی در برابر کشش
$\lambda_{eff} = \sqrt{C_1 DT}$ $C_1 = 6F_y (Kl)^2 / (E t_f b_f^3)$ $DT = D_i t_w - 2T$ $\begin{cases} \lambda_{eff} \leq 1.5 \Rightarrow P_n = 0.658^{C_1 DT} F_y DT \\ \lambda_{eff} > 1.5 \Rightarrow P_n = 0.877 F_y / C_1 \end{cases}$	مقاومت اسمی در برابر فشار
$M_n = (5/3) S_x F_{b\gamma}$	مقاومت اسمی در برابر خمش

حال با در دست داشتن مقاومت اسمی اعضاء با اینرسی متغیر در برابر کشش، فشار و خمش، می‌توان رابطه قید مقاومتی (5) را برحسب متغیرهای طراحی و نیز ثابت‌های مسئله بدست می‌آورد. در بخش‌های آتی، حالت‌های مختلف بهینه‌سازی در مسائل مورد بررسی قرار می‌گیرد. حالت‌های بررسی شده همگی از روش معیارهای بهینگی^۲ (O.C.) تبعیت می‌کنند [6].

3. طراحی به روش FSD

کاربرد روش FSD به این صورت است که در اولین مرحله، سازه با توجه به ابعاد اولیه انتخابی، که طراح در نظر گرفته است، آنالیز می‌شود و نتایج نیروهای المان در مقاطع مختلف محاسبه می‌گردد. سپس حجم کل سازه و در نتیجه وزن آن بدست می‌آید. اختلاف وزن سازه در دو سیکل متوالی، ملاک سنجش همگرایی لازم در فرآیندهای تکراری بهینه‌یابی می‌باشد. این دقت، توسط طراح به برنامه معرفی می‌شود و برای مثال می‌توان آنرا 0/1 گرم انتخاب نمود. پس از محاسبه وزن سازه، بایستی به محاسبه تنش‌های موجود در مقاطع مختلف سازه پرداخت. این تنش‌ها بصورت مجزا، برای تمامی اعضاء، در گره‌ها تعیین می‌شود و برای مقایسه با تنش مجاز بکار می‌روند. پس از محاسبه تنش‌های σ_i نوبت به طراحی مجدد سازه و بدست آوردن متغیرهای طراحی جدید می‌رسد. برای این کار از رابطه بازگشتی درجه صفر زیر استفاده می‌کنیم:

² Optimum Criteria Method

$$D_i^{(k+1)} = D_i^{(k)} \left(\frac{\delta_i^{(k)}}{\delta_i^U} \right)^v \quad (7)$$

در این رابطه D_i متغیر طراحی عمق بوده و v جهت افزایش سرعت همگرایی به نقطه بهینه لحاظ شده و برای اکثر مسائل مقدار 0/8 مقدار مناسبی می باشد. پس از بدست آوردن متغیرهای طراحی جدید، عمق حداقل مقاطع مختلف در سازه کنترل می گردد و اگر از حد پایین عمق که توسط طراح معرفی می گردد کمتر باشد برابر عمق حداقل در نظر گرفته می شود:

$$D_i \triangleleft D_i^L \Rightarrow D_i = D_i^L \quad (8)$$

پس از کنترل عمق حداقل نوبت به اعمال گروه بندی های داده شده توسط طراح بر روی متغیرهای عمق و نیز اعمال شرایط تقارنی موجود بر روی متغیرهای طراحی می باشد. اعمال گروه بندی در گره های سازه باعث محدود شدن تابع هدف شده و باعث می شود که فرایندهای تکراری به طرح بهینه همگرا گردد. در تعریف گروه بندی می توان علاوه بر تغییرات خطی برای عمق ها به راحتی تغییرات سهمی و یا درجات بالاتر را در نظر گرفت.

4. طراحی با محدودیت جابجایی

در این حالت صورت مسئله بهینه سازی بصورت زیر تعریف می شود:

$$\begin{aligned} W &= \sum_{r=1}^{nm} \rho_r v_r \rightarrow \text{Min} \\ g_{dn}(D_i) &= \delta_i - \delta_i^U \leq 0 \\ D_i - D_i^U &\geq 0 \end{aligned} \quad (9)$$

در این روش جابجایی گره های خاصی از سازه را در یک جهت معین به مقدار مشخصی محدود می سازیم. معمولاً در یک قاب گرهی که دارای حداکثر جابجایی باشد توسط طراح قابل تشخیص می باشد و طراح می تواند محدودیت جابجایی را برای همان گره تعریف نماید.

در این روش، ابتدا سازه براساس ابعاد اولیه آنالیز شده و نیروهای داخلی و جابجایی های گرهی سازه تعیین می گردند. سپس حجم و وزن سازه محاسبه شده و طبق یک سری محاسبات عددی، مشتق حجم سازه نسبت به تک تک متغیرهای طراحی D_k محاسبه می شود. این مقادیر دقیقاً با مقادیر حاصله از مشتق جبری حجم سازه، برابر می باشند و هیچ تقریبی در آنها وارد نشده است. لازم به ذکر است که در محاسبه مشتق حجم سازه نسبت به یک متغیر طراحی، مانند D_k ، تنها اعضای از سازه در نظر گرفته می شوند که منتهی به گره k باشند. سایر اعضای سازه مستقل از D_k بوده و مشتق آنها صفر خواهد بود. پس از محاسبه مشتق حجم سازه نسبت به متغیر طراحی D_k ، نوبت به محاسبه مشتق قید جابجایی، نسبت به متغیر طراحی D_k می رسد:

$$g_{dn} = \delta_i - \delta_i^U \Rightarrow \left(\frac{\partial g_{dn}}{\partial D_k} \right) = \frac{\partial(\delta_i)}{\partial D_k} \quad (10)$$

از آنجائیکه بیان عبارت S_i برحسب متغیرهای طراحی D_k ، کاری بسیار دشوار بوده و غیر ممکن می نماید، برای محاسبه مشتق قید جابجایی نسبت به متغیر طراحی D_k ، از روش های عددی استفاده شده است.

با توجه به اینکه در این پژوهش از روش معیارهای بهینگی جهت طراحی بهینه سازه، استفاده شده است، برای تبدیل قیدهای نامساوی به تساوی، از لاگرانژین تابع هدف استفاده خواهیم نمود:

$$L(D_k, \lambda_{dn}) = \sum_{r=1}^{nm} \rho_r v_r - \sum_{n=1}^p \lambda_{dn} g_{dn}(D_k) \quad (11)$$

شرایط لازم Kuhan-Tucker در این مسئله عبارت خواهد بود از:

$$\begin{cases} \frac{\partial L}{\partial D_k} = 0 \\ \frac{\partial L}{\partial \lambda_{dn}} = 0 \end{cases} \Rightarrow \begin{cases} \sum_{r=1}^{nm} \rho_r \frac{\partial v_r}{\partial D_k} - \sum_{n=1}^p \lambda_{dn} \frac{\partial g_{dn}(D_k)}{\partial D_k} = 0 \\ \lambda_{dn} g_{dn} = 0, \lambda_{dn} \geq 0 \end{cases} \quad (12)$$

و در نهایت رابطه بازگشتی زیر برای یافتن متغیرهای عمق در فرایندهای تکراری بهینه سازی بکار گرفته می شوند:

$$D_k^{(v+1)} = D_k^{(v)} \left[\frac{\sum_{n=1}^p \lambda_{dn} \frac{\partial g_{dn}(D_k)}{\partial D_k}}{\sum_{r=1}^{nm} \rho_r \frac{\partial v_r}{\partial D_k}} \right]^c \quad (13)$$

در این رابطه v و $v+1$ ، سیکل‌های بهینه‌یابی را مشخص می‌کنند و c معرف اندازه گام می‌باشد که برای سازه‌های ساده، با عضوهای کم حدود 0/1 و برای سازه‌های پیچیده‌تر مقادیر نزدیک به 0/01 انتخاب شده است. برای یافتن مقادیر جدید ضریب لاگرانژ در هر سیکل نیز خواهیم داشت:

$$\lambda_{dn}^{(v+1)} = \lambda_{dn}^{(v)} \left(\frac{\delta_j}{\delta_j^U} \right)^m \quad (14)$$

که در این رابطه m ضریب ترمیم بوده و معمولاً 0/8 در نظر گرفته می‌شود. پس از محاسبه متغیرهای جدید طراحی و نیز ضرایب لاگرانژ، گروه بندی و شرایط تقارنی در مسئله وارد شده و سپس وزن سازه را بدست می‌آوریم و تفاضل بین وزن بدست آمده و مقدار سیکل قبلی ملاک رسیدن به همگرایی قرار می‌گیرد.

5. طراحی با قید مقاومت ترکیبی

این حالت، نوع خاصی از روش FSD می‌باشد، با این توضیح که در این حالت بجای معرفی یک تنش نهایی خاص مانند σ_i^U برای اعضای مختلف، مقاومت هر مقطع که ترکیبی از مقاومت خمشی و محوری آن است بدست آمده و ملاک طراحی مجدد سازه در فرآیندهای تکراری بهینه‌یابی قرار می‌گیرد. در این روش، پس از اینکه از طریق آنالیز، حداکثر مقدار P_u و M_u تعیین شدند مقادیر مقاومت اسمی مقطع (P_n و M_n) را از طریق معادلات جدول (1) بدست می‌آوریم و نهایتاً قید مقاومتی بصورت رابطه (5) بدست می‌آید. اگر قید مقاومتی $g_{sr}(D_i, D_j)$ برای عضو r ام بزرگتر از 1 باشد، بایستی مقطع مورد نظر را قویتر نماییم و در غیر اینصورت، مقطع باید کوچکتر گردد. (بین گره i و j از عضو r ام، حداکثر مقدار g_{sr} محاسبه شده، در نظر گرفته می‌شود) پس از بدست آوردن $g_{sr}(D_i, D_j)$ برای عضو r ام، برای تصحیح متغیرهای عمق از رابطه بازگشتی زیر استفاده خواهیم نمود:

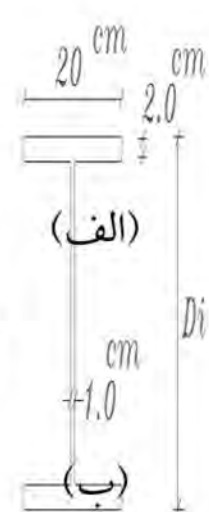
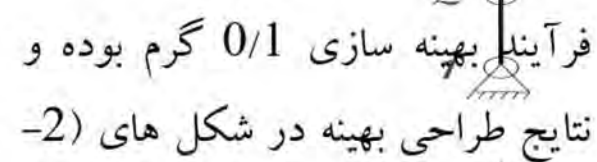
$$D_k^{(v+1)} = D_k^{(v)} (g_{sr(\max)})^m \quad (15)$$

در این رابطه نیز، ضریب m بمنظور افزایش سرعت همگرایی بکار رفته است و مقدار 0/8، که در حالت FSD وجود داشت، برای اینحالت نیز جوابهای خوبی داشته است و همگرایی مناسبی را بدست می‌دهد. پس از تصحیح متغیرهای عمق و اعمال گروه‌بندی و تقارن در آنها، وزن سازه محاسبه شده و با وزن بدست آمده در مرحله قبلی مقایسه می‌گردد و این عملیات تا زمان رسیدن به همگرایی مورد نظر ادامه می‌یابد. معمولاً تعداد تکرار لازم برای اینکار در حالت‌های FSD، کمتر از حالت قید جابجایی می‌باشد.

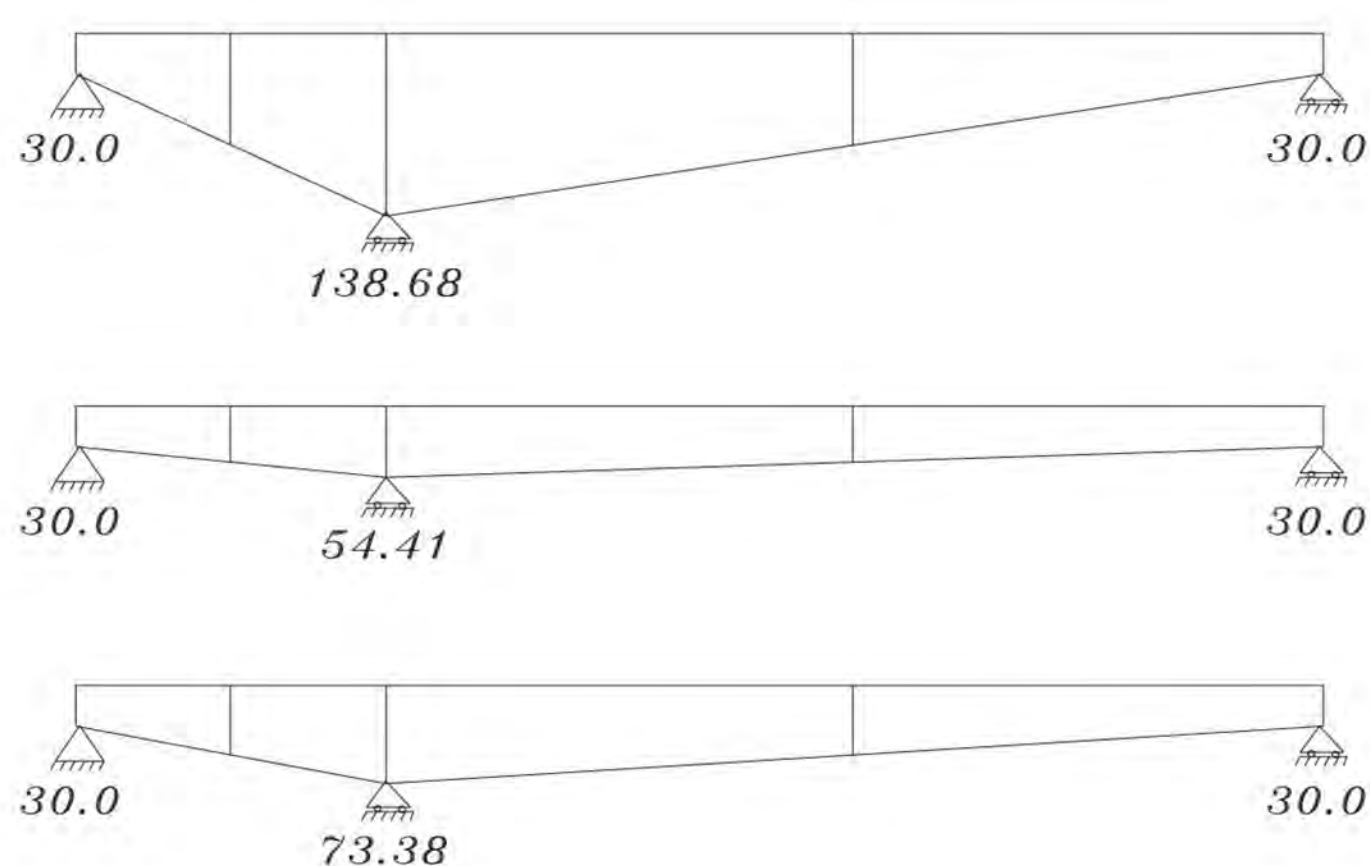
6. نتایج تحلیل‌های عددی

در این بخش مثالهایی را بررسی کرده و طی آن همگرایی روش‌های مختلف مورد بحث را مطالعه می‌کنیم. پس از اینکه در فرآیندهای بهینه سازی به همگرایی مورد نظر رسیدیم، ابعاد نهایی سازه و همچنین وزن بهینه آن بدست می‌آید. به عنوان مثال اول، تیر دو دهانه شکل (1) را با مقطع متغیر در نظر می‌گیریم. مشخصات فولاد مورد استفاده به قرار زیر است که آنها را در طی عملیات پارامتر ثابت فرض می‌کنیم [7]:

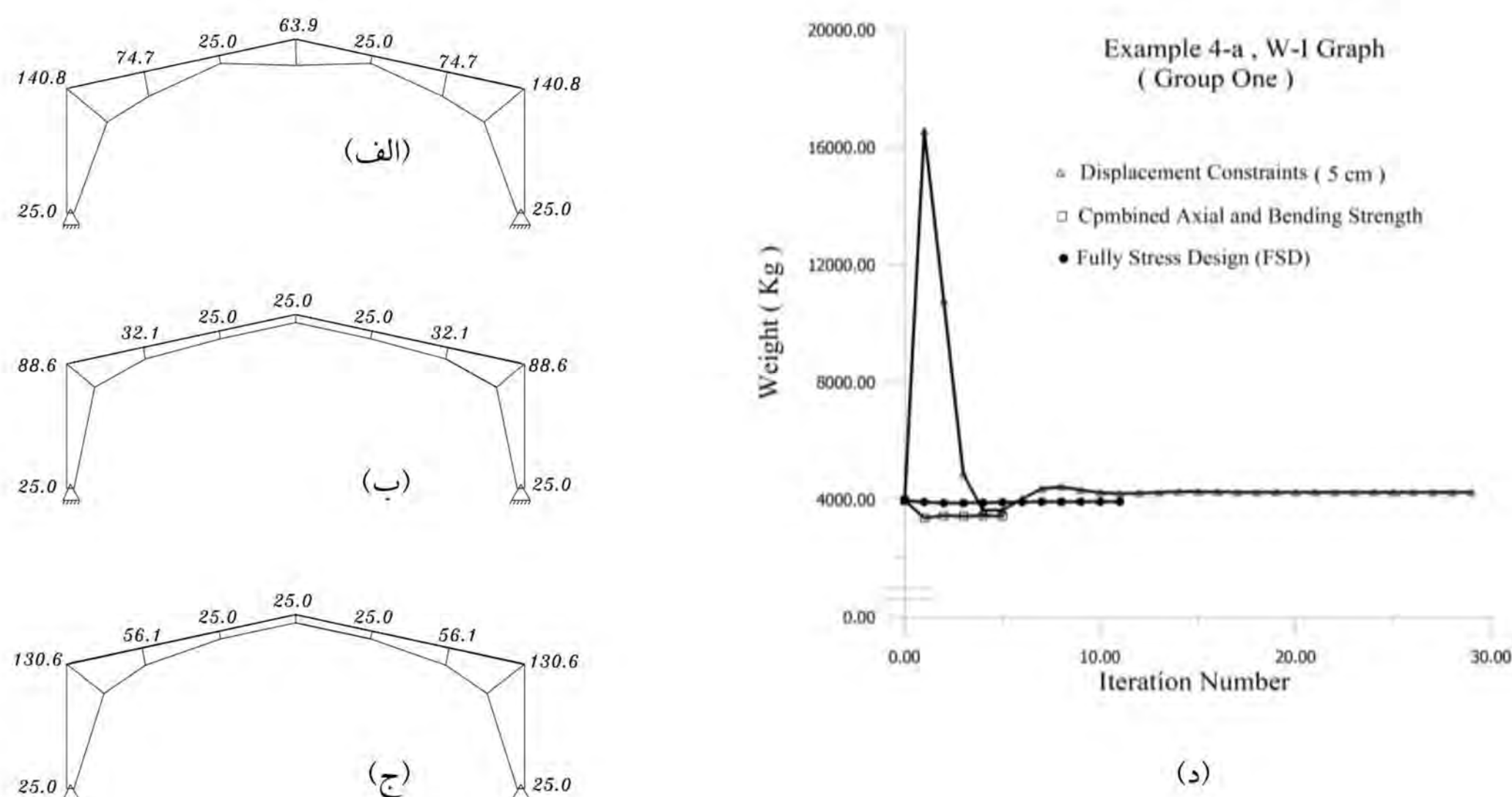
$$\gamma = 7.85 \times 10^{-3} \text{ kg/cm}^3$$



در مثال دوم یک قاب شیبدار یک دهانه را مطابق شکل (3) مورد بررسی قرار می دهیم. دقت همگرایی در این مثال نیز 0/1 گرم و عمق حداقل 30 سانتیمتر می باشد. در شکل (4-الف تا د) نتایج طراحی بهینه سازی ارایه شده است.



شکل 3- هندسه قاب مثال شماره 2



شکل 4- مثال شماره 2; (الف) طرح بهینه با قید جابجایی 5 سانتی متر (ب) طرح بهینه با قید مقاومت ترکیبی (ج) طرح بهینه تمام تنشی (د) فرآیند همگرایی به طرح بهینه با انواع قیدها.

7. نتیجه گیری

همانطوریکه از نتایج تحلیلهای عددی حاصل می شود، روش معیار بهینگی (O.C) که در حل مسایل بکار گرفته شده است، روشی کاملاً مؤثر و قوی بوده و از آن میتوان برای مسائل غیرخطی از درجات بالا و با تعداد متغیرهای زیاد استفاده نمود. ضمناً همگرایی این روش خوب بوده و تعداد تکرارهای لازم جهت رسیدن به طرح اولیه کم می باشد. با اینحال نحوه انتخاب متغیرهای عمق اولیه نقش مهمی در تعداد تکرارهای لازم جهت رسیدن به طرح بهینه دارد. هرچقدر طرح اولیه از طرح بهینه دورتر انتخاب گردد، تعداد تکرارهای لازم افزایش خواهد یافت. در مسائل طراحی بهینه سازه ها، طراح می تواند با استفاده از گروه بندی های متنوع و معرفی تقارن در مسائل و نیز تعریف عمق حداقل برای مقاطع سازه، به طرح بهینه مورد نظر خود برسد.

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برای دانلود این مقاله کیوآر کد مقابل را اسکن کرده و بر روی لینک موجود کلیک کنید:



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2- کارشناس ارشد ژئوتکنیک

خلاصه

به خاطر پیشرفت تکنولوژی قطارهای شهری رویکرد استفاده از مترو در شهرهای پرجمعیت و بخصوص مراکز استانها بیشتر شده و ضروری به نظر می رسد. اجرای پروژه قطار شهری در شهرهای با تراکم جمعیت زیاد بایستی بالاجبار در مناطق پر جمعیت شهری از اولویت بالایی برخوردار است و مسیر تونلهای مترو به ناچار از زیر و یا از جوار ساختمانهای موجود عبور می کنند در صورتی که حفاری تونل با کنترل و پیش بینی های لازم انجام نگیرد باعث ایجاد جابجاییها و تغییر شکلهایی در سطح زمین شده و آسیبهای سازه ای بر ساختمانهای اطراف وارد می کند. در این تحقیق تاثیر نحوه مدلسازی سگمنت تونل خط 2 متروی تبریز بر ساختمان بیمارستان امیر المومنین بررسی شده است. پس از بررسی نشست ساختمان بعد از احداث تونل مترو و نحوه مدلسازی سگمنت با استفاده از روش تحلیل عددی و محاسبه میزان جابجاییها ناشی از نشست و آسیب های احتمالی مورد مطالعه قرار گرفته است. برای انجام تحلیلهای عددی از نرم افزار PLAXIS 3D TUNNEL استفاده شده است. نتایج حاصل از مدل سازی عددی نرم افزار نشان می دهد که در اثر حفاری تونل، ماکزیمم نشست سطح زمین در بالای تونل به میزان 31/06 میلیمتر می باشند که با توجه به موقعیت قرارگیری ساختمان بیمارستان نسبت به محل تونل، تاثیر قابل ملاحظه ای بر نشستهای ساختمان نخواهد داشت.

کلمات کلیدی: حفاری تونل مترو، سگمنت، نشست سطحی، Plaxis 3D Tunnel، متروی تبریز

1. مقدمه

با توجه به رشد روز افزون جمعیت و افزایش آلایندهای هوا و تسهیل در رفت و آمد درون شهری و بیرون شهری و همسوس شدن با پیشرفت تکنولوژی ناوگان حمل و نقل مسافری و باری، تمامی مسئولین کشوری و مدیریتی را ملزم به استفاده از تکنولوژی و ایجاد بسترهای لازم برای زندگی شهرنشینی کرده است که در کنار این برنامه های راهبردی و مدیریت کلانشهرها، کاهش آلودگی و روانسازی حمل و نقل بین شهری، مطالعه و اجرای احداث مترو و قطارهای شهری در کلانشهرها جزء سرفصل های مهم می باشد و تبریز یکی از کلانشهرهای مهم و پرجمعیت کشور می باشد [1]. روش های عددی با توجه به استفاده از نرم افزار و روان بودن قضیه و راحت تر به نتیجه رسیدن و همچنین زیاد بودن سرعت روشهای محاسبه، اثر بخشی بیشتری دارند. روش بررسی و تحلیل اجزا محدود (FEM) به عنوان یکی از بررسیهای عددی، این امکان را به ما می دهند که پارامترها و عوامل مختلفی را در حفاری تونل که هیچ کدام از روش های تجربی و تحلیلی آن ها را در نظر نمی گیرند، بکار بگیریم. روش های عددی همچنین امکان تحلیل بررسی تاثیر متقابل حفاری تونل بر روی سازه های سطحی و زیرسطحی را برای تحلیلگر مهیا می سازد. برای تحلیل عددی در این تحقیق از مدل سازی سه بعدی با نرم افزار PLAXIS 3D TUNNEL استفاده شده است که بر اساس روش اجزا محدود بررسی می کند.

کاراکوس و فُول (2003) با در دست داشتن نشست های بر جای مشاهده شده در ایستگاه هیثرو واقع در لندن اثر حالت های مختلف حفاری تونل را بر نشست های سطحی زمین در حالت کرنش سطح (دو بعدی) با نرم افزار ABAQUS مورد مطالعه قرار دادند. ایشان تاثیر روند سخت شدن لاینینگ بر نشست های سطحی زمین را ارزیابی نموده و نتایج را با نتایج عملی مقایسه کردند [4].

حسنلو، (۱۳۹۲)، بررسی عددی تاثیر اجرای شمع های نگهبان در کاهش نشست های ناشی از حفاری تونل های متروی شهری تحقیقی انجام داده اند و مهمترین مشکل در این زمینه، تأثیر حفاری روی پی سازه های مجاور است. بر اساس نتایج این تحقیق برای کاهش نشست ساختمان های مجاور تونل از شمع های نگهبان استفاده شده است. در این روش شمع ها قبل از حفاری تونل و بین ساختمان های مجاور تونل و تونل اجرا می شوند. این تحقیق با استفاده از روش عددی اجزاء محدود و با استفاده از نرم افزار PLAXIS 3D TUNNEL با در نظر گرفتن رفتار غیر خطی موهر کلمب برای خاک ، انجام شده است [5].

قره داش و برزگر (1392) بررسی عددی تاثیر اندرکنش تونل - سازه ی سطحی بر نشست سطح زمین مورد تحقیق قرار داده اند و همچنین ضمن بررسی نمودارهای تغییرات فاصله ی جانبی بین تونل و ساختمان، مهم ترین نکته این است که افزایش فاصله ی جانبی، ابتدا افزایش نشست سطح زمین و سپس تاج تونل را به دنبال داشته و مکانیسم تغییر شکل تونل و تغییرات تنش قائم، با فاصله گرفتن از ساختمان، بر روند تغییرات موثر است. همچنین اثر لحاظ کردن این عوامل بر تغییر شکل نقاط متفاوت ساختمان و مقایسه ی آن با نتایج تحلیل های زمین بکر نیز ارائه شده است [6].

بررسی های تجربی و تحلیلی پیش بینی مدل سازی سگمنت (پوشش) تونلها در متروهای در حال احداث و یا احداث شده و بررسی نشست ها در سطح زمین مربوط به تحلیل نشست زمین دست نخورده می باشند. هرچند که در تحلیل های مهندسی، مسائل اغلب شامل اندرکنش بین ساخت حفاری تونل و دیگر سازه ها است. این قبیل شرایط شامل نوع پوشش تونل یا سگمنت و مصالح استفاده شده در سگمنت برای ساختمان های سطحی موجود، سازه های زیرسطحی موجود (همانند کانال ها مخابراتی، لوله کشیهای شهری) یا ساخت سازه های زیرزمینی پیچیده از قبیل ایستگاه های زیرزمینی مترو می باشند. واضح و نمایان است که بررسیهای تجربی و تحلیلی که ارائه شده در این گونه موارد دارای محدودیت هایی نیز هست. مدل سازی عددی امکان و بررسی تطبیق دادن اجزا مختلف مسائل تنش و کرنش در یک محیط تحلیل را فراهم می آورند. روش های عددی مختلفی بر اساس نظریه های محیط پیوسته و ناپیوسته ارائه گردیده اند. از آنجایی که منطقه مورد مطالعه در این تحقیق به صورت خاکی و ریزشی است محیط به صورت پیوسته فرض شده است؛ بنابراین روش عددی مورد استفاده روش اجزا محدود (FEM) است. Plaxis 3D Tunnel یک نرم افزاری قوی و اجزا محدود بوده و منحصراً به منظور تجزیه و تحلیل و محاسبه نشست و تغییر شکل و پایداری در پروژه های مهندسی ژئوتکنیک استفاده می شود. با توجه به امکان مدل سازی سگمنت به شکلهای مختلف (المان حجمی و المان صفحه ای)، تاثیر این مدل سازی بر نشست های سطح زمین و همچنین ساختمانهای مجاور بررسی شده است.

2. معرفی پروژه خط دو متروی تبریز

خط 2 قطار شهری از منطقه قراملک در غرب تبریز شروع شده و بعد از گذشتن از خیابانهای قدس، قره آغاج، جمهوری، میدان دانشسرا، خیابان عباسی به شهرک باغمیشه می رسد. در ادامه به سمت شرق امتداد یافته و بعد از عبور از شهرک مرزداران در حوالی نمایشگاه بین المللی تبریز خاتمه می یابد. طول کلی این خط 26.6 کیلومتر است [6].

در مطالعات ژئوتکنیک تکمیلی، در محل هر ایستگاه یک یا دو گمانه دیگر نیز حفاری شده و نمونه های لازم برداشته شده است. به منظور مطالعات ژئوتکنیک تکمیلی خط 2 قطار شهری تبریز، تعداد 92 گمانه و 3 چاهک حفاری شده است. در محل هر ایستگاه با احتساب گمانه مطالعات اول، به طور متوسط 3 گمانه حفاری شده است. در این مقاله حد فاصل ایستگاه D2 واقع در خیابان قدس یا قره آغاج، ابتدای خیابان علامه امینی به طول 60 متر از ایستگاه به طرف چهارراه قدس که نزدیک بیمارستان است انتخاب شده است. تراز تونل در عمق 26/6 متری قرار دارد. بر اساس نتایج مطالعات ژئوتکنیکی تراز آب زیرزمینی در 8 متری سطح زمین قرار گرفته است.

3. مدل سازی عددی مراحل حفاری

3. 1. محدوده مدلسازی شده

محدوده مدل سازی شده به طول 36 متر از تونل متروی خط 2 تبریز که این مقطع انتخاب شده در حوالی ایستگاه D2 علامه امینی (قدس) قرار دارد. شکل 1 موقعیت ساختمان بیمارستان امیر المومنین در ایستگاه D2 را نشان می دهد.



شکل 1: موقعیت ساختمان بیمارستان نسبت به تونل مترو

ساختمان بیمارستان امیرالمومنین تبریز در ضلع شمالی خط دو متروی تبریز و مجاور ایستگاه D2 (علامه امینی) واقع است و فاصله ضلع جنوبی ساختمان از تاج تونل حدودا 70 متر است و عرض ساختمان 24 متر موازی با تونل مترو است و طول آن 50 متر می باشد و در 5 طبقه با مصالح بتن آرمه احداث شده است. مشخصات آن در جدول (1) و (2) آورده شده است.

جدول 1- مشخصات ساختمان امیرالمومنین

ساختمان	مساحت مقطع پی (m ²)	تعداد طبقه	کمینه فاصله بین محور تونل و ساختمان (m)	عمق تاج تونل از سطح زمین (m)
بیمارستان امیرالمومنین	1200	5	70	20

جدول 2- خواص بتن پی ساختمان بیمارستان

پارامتر	واحد	نماد	مقادیر
شناسه	-	-	بتن
مدل مصالح	-	مدل	Linear-elastic
نوع مصالح	-	نوع	Non-porous
سختی محوری	kN/m ³	γ_{unsat}	$3/9 \times 10^7$
سختی خمشی	kN/m ²	E_{ref}	$7/312 \times 10^6$
ضخامت	m	d	1/5
جرم حجمی	kN/m	w	37/5
ضریب پواسون	-	v	0/15

3. 2 خصوصیات لایه های خاک منطقه

با توجه به انطباق خوب نتایج مدل رفتاری سخت شونده با رفتار خاک، برای مدلسازی خاک از مدل سخت شونده استفاده شده است. پارامترهای ژئوتکنیکی لایه های خاک منطقه برای مدل فوق، در جدول (3) ارائه شده است.

جدول 3- مشخصات مصالح لایه های خاک

مقادیر				واحد	پارامتر
لایه 6-0 متر	لایه 6-14	لایه 14-20	لایه < 20		
Hardening (SC)	Hardening (SM)	Hardening (SM. ML. CL)	Hardening (ML. CL)	-	مدل مصالح
Drained	Drained	Drained	Drained	-	نوع رفتار مصالح
17/5	16/8	17/3	17	kN/m ³	وزن مخصوص غیر اشباع
20	19	19	20	kN/m ³	وزن مخصوص اشباع
70000	100000	80000	90000	kN/m ²	E _{ur}
35000	50000	40000	45000	kN/m ²	E ₅₀
35000	50000	40000	45000	KN/m ²	E _{oed}
0/32	0/31	0/36	0/37	-	نسبت پواسون
0	0	0	0	deg	زاویه اتساع
15	25	25	40	kN/m ²	چسبندگی
27	29	27	27	deg	زاویه اصطکاک

3. 3 خصوصیات سپر دستگاه و سگمنت های مدل سازی شده

برای مدلسازی سپر دستگاه از المان صفحه ای استفاده شده است که پارامترهای آن در جدول (4) آورده شده است. برای مدلسازی سگمنت تونل حفاری شده معمولاً دو نوع المان قابل استفاده است: یکی المان حجمی و دیگری المان صفحه ای. با توجه به متفاوت بودن نتایج این دو نوع المان، برای بررسی تاثیر آن در میزان نشستها، از هر دو نوع مدل برای مدلسازی سگمنت استفاده شده است. پارامترهای مدلسازی سگمنت برای هر دو مدل مطابق جداول 5 و 6 است.

جدول 4- مشخصات سپر TBM

پارامتر	واحد	مقدار
EA	kN/m^2	2/ 1E+07
EI	$\text{kN/m}^2/\text{m}$	1/75E+04
ضخامت نگهدارنده دستگاه (متر)	m	0/1
V	----	0/15
وزن نگهدارنده	$\text{kN/m}^2/\text{m}$	8/5
Materil Type	Elastic	-----

جدول 5- مشخصات سگمنت نوع 1 (المان حجمی)

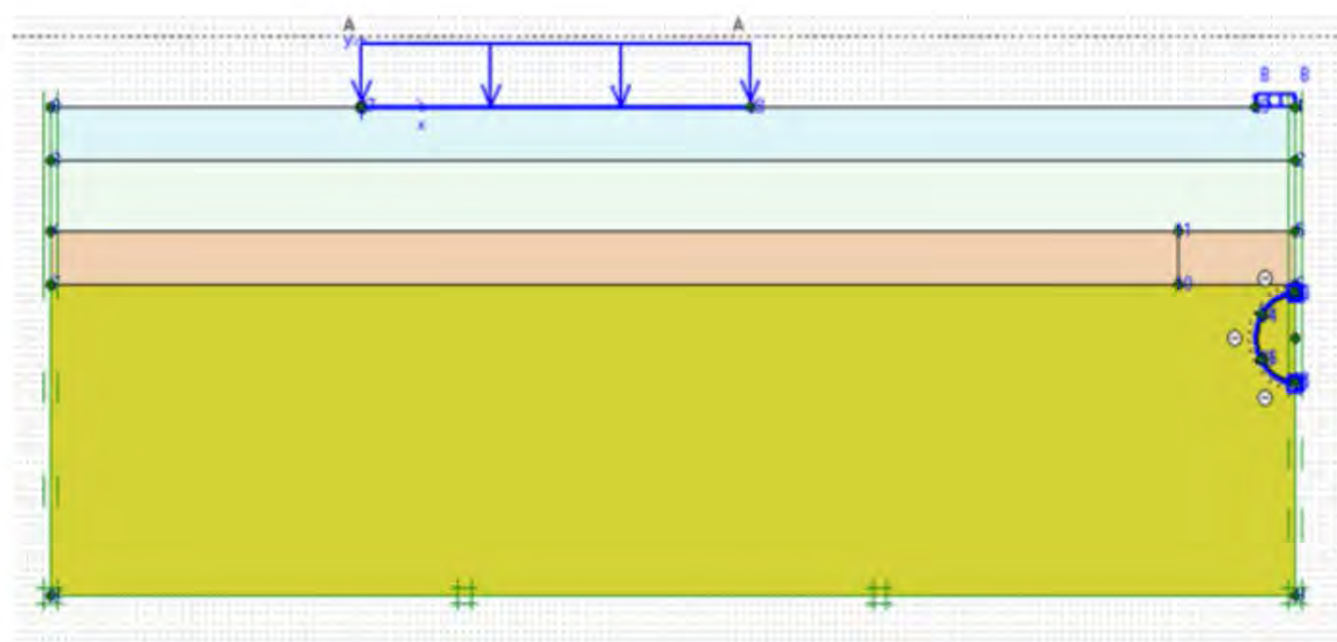
پارامتر	واحد	مقدار
E_{oed}	kN/m^2	3/5E+07
E_{ref}	kN/m^2	3/5E+07
V_{nu}	----	0/2
γ_{unsat}	kN/m^3	24
Mateial model	Linear elastic	-----
Materil Type	Non -- Porous	-----

جدول 6- مشخصات سگمنت نوع 2 (المان صفحه)

پارامتر	واحد	مقدار
EA	kN/m^2	1/103E+07
EI	$\text{kN/m}^2/\text{m}$	1/125E+05
ضخامت (متر)	m	0/35
V	----	0/2
وزن	$\text{kN/m}^2/\text{m}$	8/5
Materil Type	Elastic	-----

3.4 ایجاد هندسه مدل و ابعاد آن

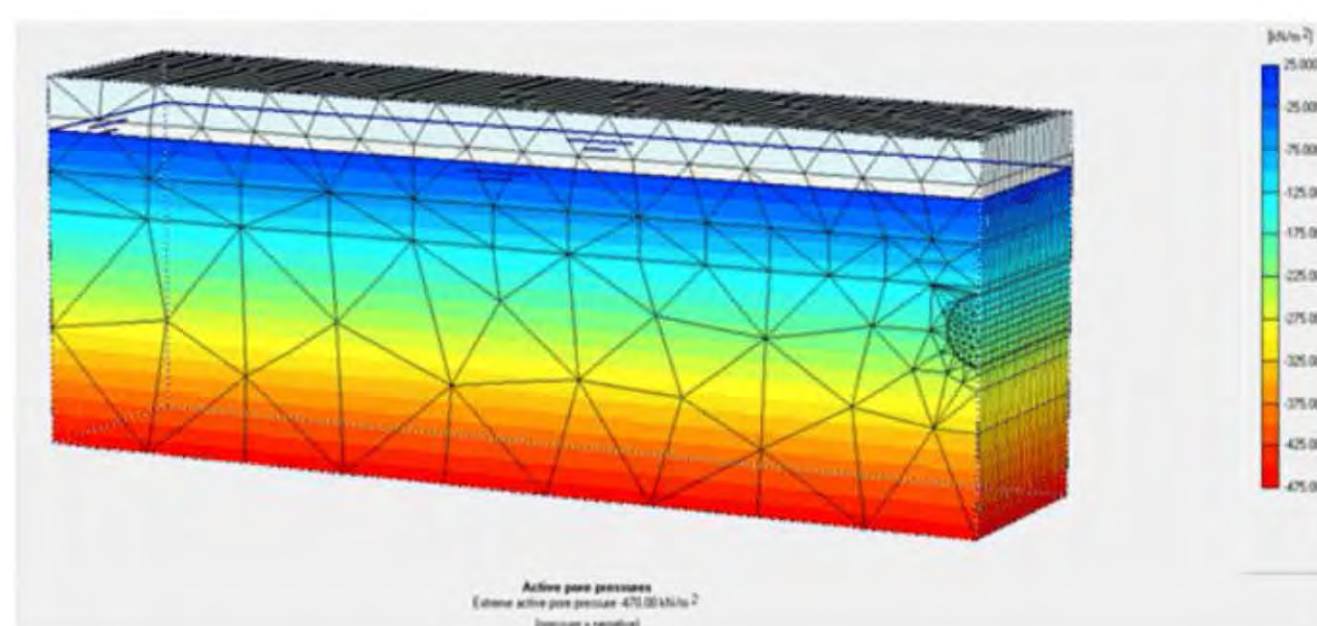
المان 15 گرهی ایزو پارامتریک مورد استفاده برای ساخت مدل، شامل 6 گره مثلی در صفحه XY و 9 گره در جهت Z است که قابلیت های بالایی در شبیه سازی پاسخ محیط های خاکی در مقابل تغییرات تنش دارد. المان های دیگر مورد استفاده در مدل، المان صفحه ای است که برای مدل کردن سپر دستگاه حفاری از آن استفاده شده است. مدل ساخته شده در شکل 2 نشان داده شده است.



شکل 2- مدل سازی اولیه و شرایط مرزی اعمال شده و اعمال نیروهای وارده از ساختمان و بار ترافیک

ابعاد مدل: ارتفاع 55 متر و طول 160 متر و عرض 36 متر و طول تونل حفاری شده 36 متر

ابعاد ساختمان: طول 50 متر و عرض 24 متر و 5 طبقه و یک طبقه زیر زمین با بار معادل 50 کیلونیوتن بر متر مربع بار زنده در خیابان بالای تونل (خیابان قدس): 10 کیلونیوتن بر مترمربع
با توجه به اینکه تراز آب زیر زمین در این منطقه با توجه به مطالعات مهندسی مشاور و نتایج آزمایشات از گمانه‌ها در 8 متر از سطح زمین قرار دارد. لذا در شکل 3 موقعیت تراز آب نشان داده شده است.



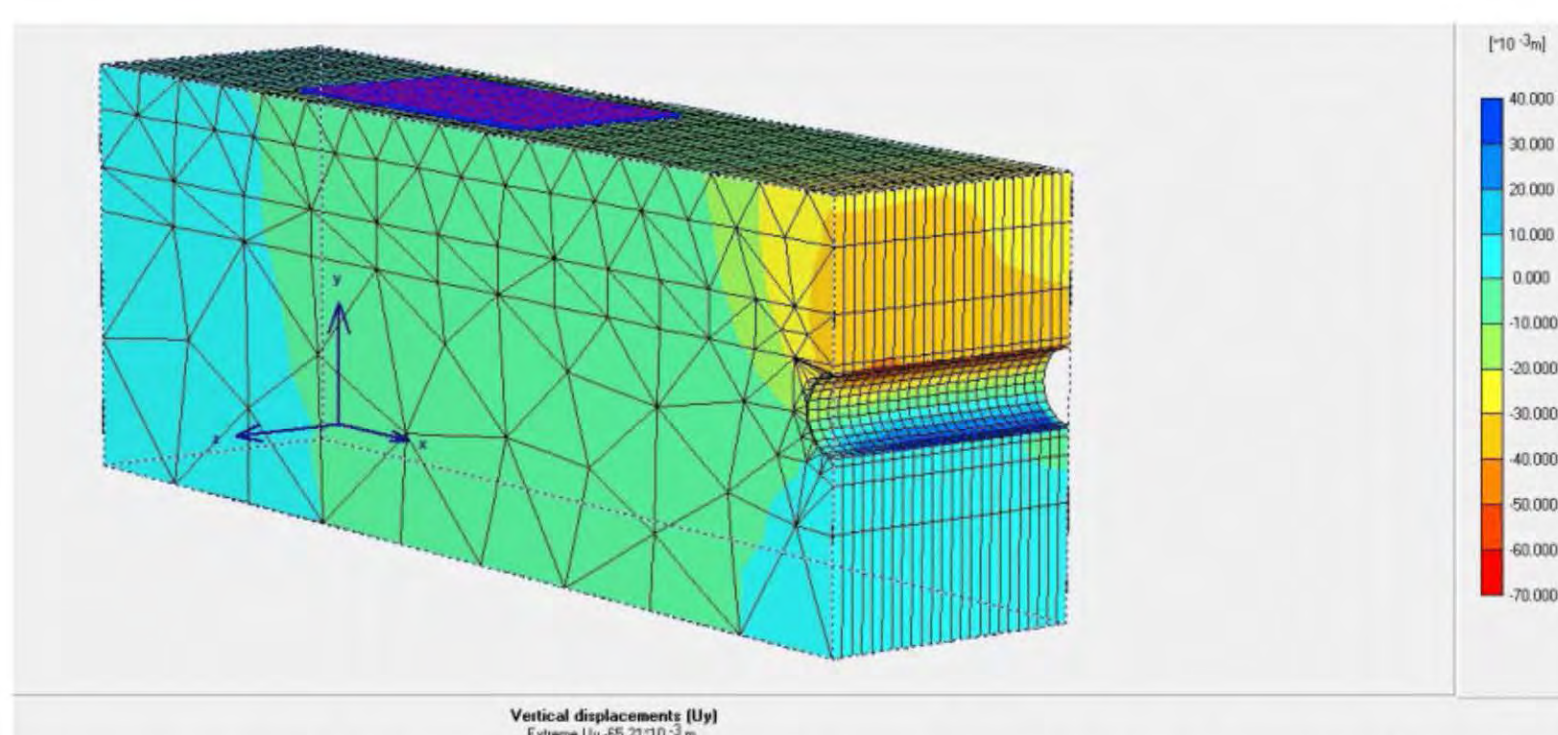
شکل 3- مرحله اعمال تراز آب

بعد از اعمال تراز آب مرحله محاسبات مدل شروع می شود. در این قسمت مدل مورد نظر از 26 فاز تشکیل شده است که طول فاز ها به غیر از فاز دوم، 1/5 متر (معادل با عرض هر سگمنت) می باشد. طول فاز دوم 9 متر (6 اسلایس) که برای جاگیری هد دستگاه می باشد در نظر گرفته شده است. محاسبات فاز اول مربوط به نشست ساختمان قبل از حفاری است و از فاز دوم تا فاز 26 نشست ها بعد از حفاری را نشان می دهد و در تمامی فازها نیروی فشار جبهه کار 240 کیلونیوتن بر مترمربع و پارامتر انقباض 0/5 درصد در نظر گرفته شده است.

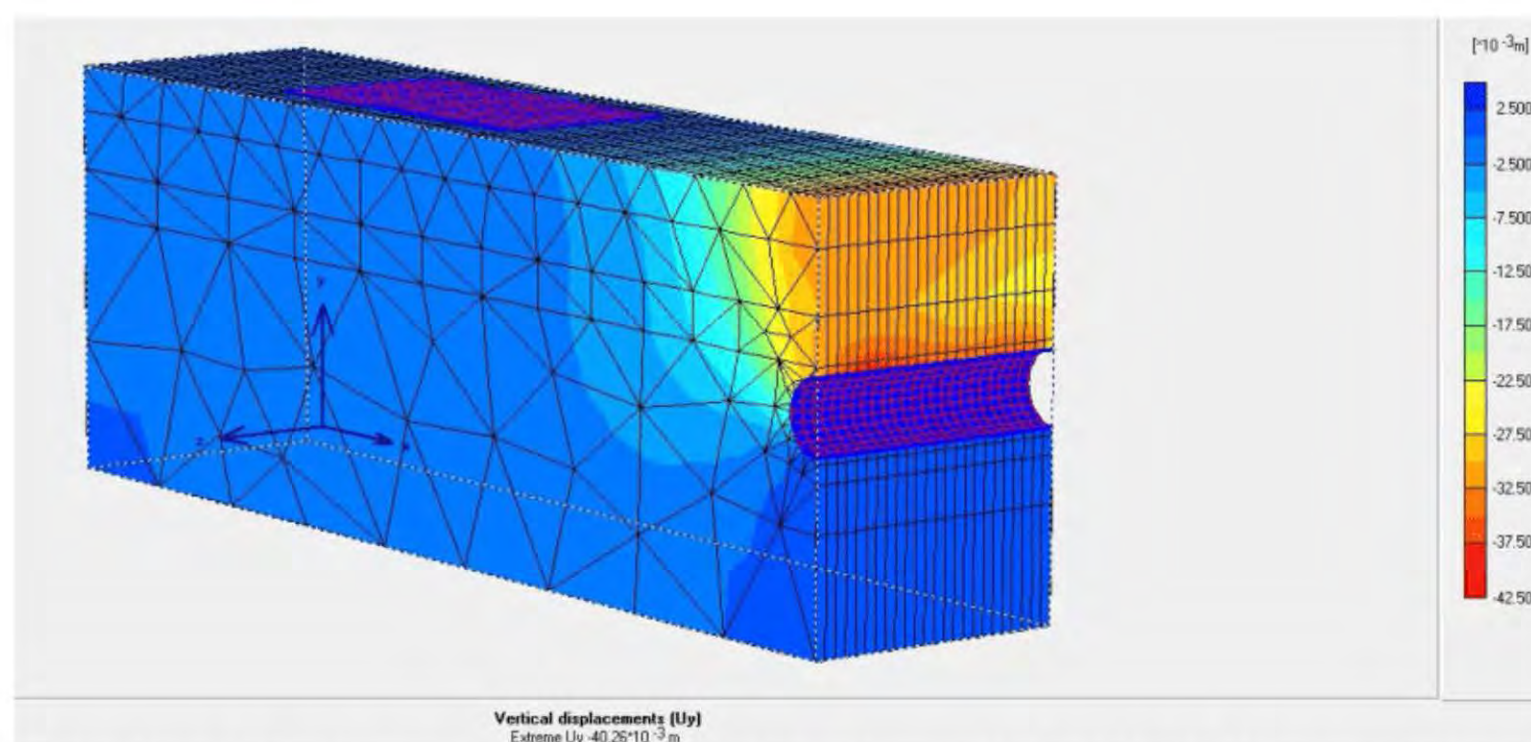
4. تحلیل نشست سطح زمین

در بررسی نشست سطحی زمین در دو مدل سازی انجام شده برای سگمنت به روشهای حجمی و صفحه ای نتایج نشان می دهند میزان جابجایی سطحی زمین در مدل سازی سگمنت با المان صفحه ای بیشتر از مدل سازی المان حجمی می باشد.

شکل 4 و 5 کانتور جابجایی قائم بعد از اتمام حفاری به ترتیب برای مدل کردن سگمنت به روش المان حجمی و المان صفحه ای را نشان می دهد. همانطور که در شکل 4 مشاهده می شود مقدار بیشترین جابجایی قائم در تاج تونل و برابر 65/21 میلیمتر و مقدار نشست قائم سطح زمین برابر 29/92 میلیمتر است. در شکل 5 نیز مقدار بیشترین جابجایی قائم در تاج تونل و برابر 40/26 میلیمتر و مقدار نشست قائم سطح زمین برابر 31/06 میلیمتر نشان داده شده است.

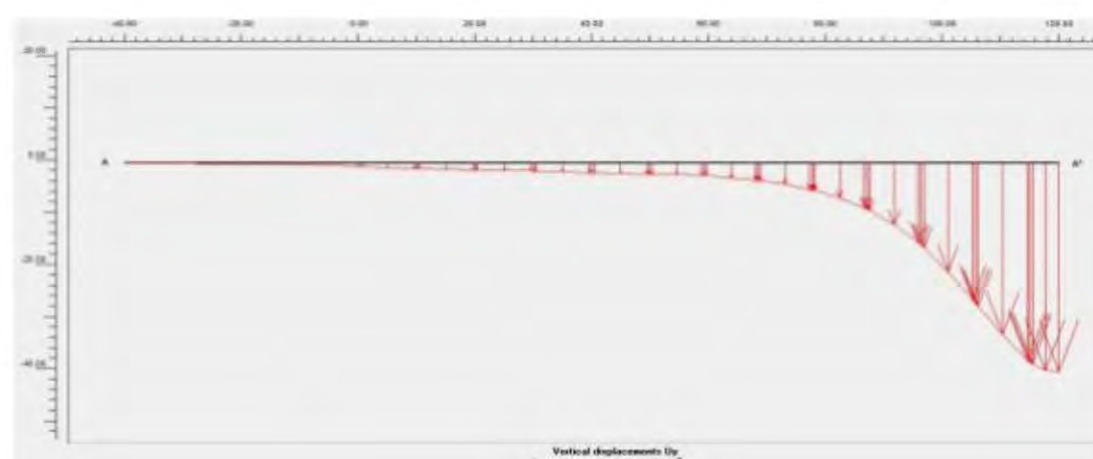


شکل 4- کانتور جابجایی قائم در انتهای حفاری با مدل کردن سگمنت به روش المان حجمی

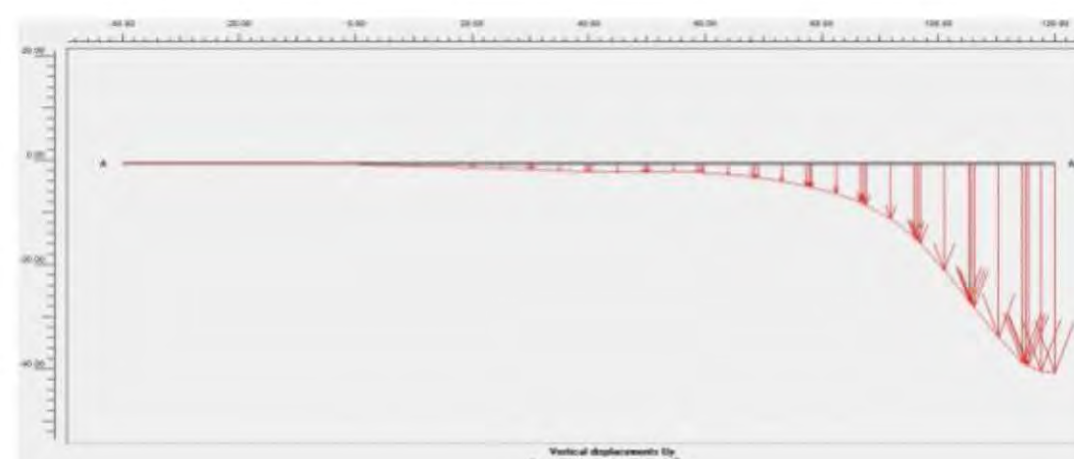


شکل 5- کانتور جابجایی قائم در انتهای حفاری با مدل کردن سگمنت به روش المان صفحه ای

در شکل 6 پروفیل نشست عرضی سطح زمین برای مقطع حفاری شده در حضور سربارهای ناشی از ساختمان بیمارستان و ترافیک خیابان در دو روش مدل سازی سگمنت نشان داده شده است. مقادیر بیشترین نشست سطح زمین در بالای تونل و برای حالت های مدل سازی سگمنت از نوع المان حجمی و المان صفحه ای به ترتیب برابر 29/92 و 31/06 میلیمتر است.



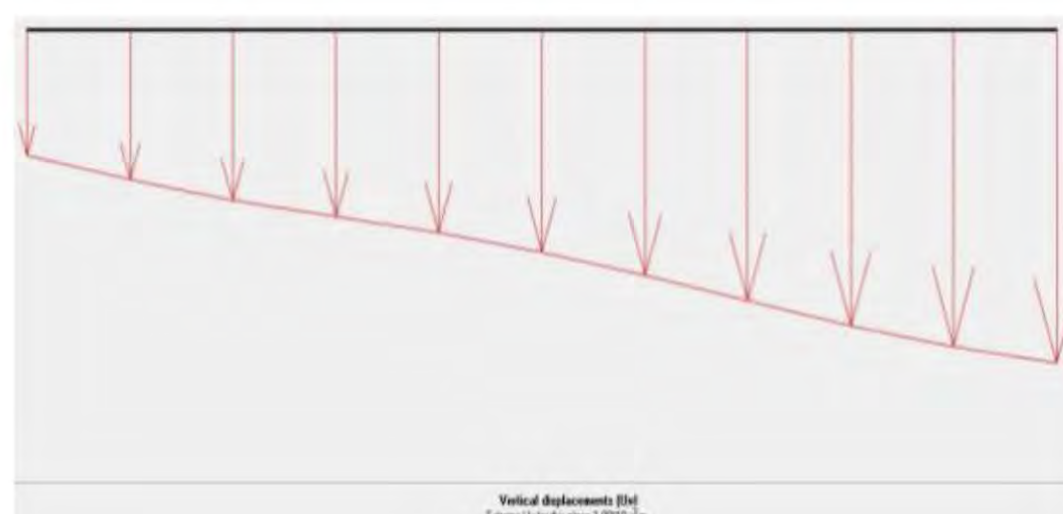
(ب)



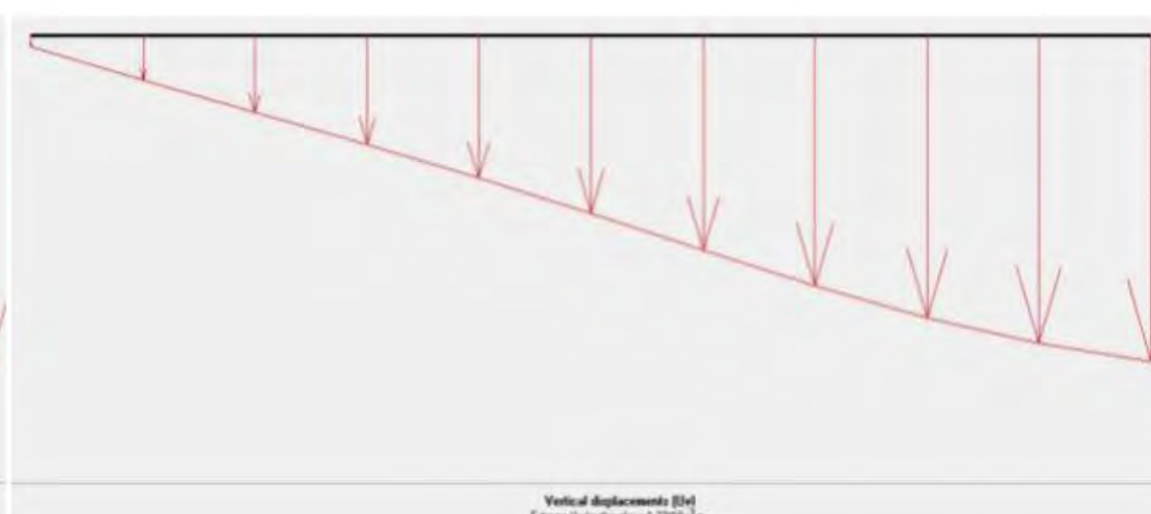
(الف)

شکل 6- نمودار نشست عرضی سطح زمین برای مقطع حفاری شده در حضور ساختمان بیمارستان، الف) مدل سگمنت به روش المان حجمی، ب) مدل سگمنت به روش المان صفحه ای

در شکل 7 نشست قائم پی ساختمان بیمارستان بعد از حفاری کامل تونل برای دو حالت مدل سازی سگمنت نشان داده شده است. همانطور که در شکل 7 مشاهده می شود نقاطی از پی ساختمان که نزدیک به حفاری تونل هستند بیشترین نشست را نشان می دهند. مقادیر بیشترین نشست پی ساختمان برای حالت های مدل سازی سگمنت از نوع المان حجمی و المان صفحه ای به ترتیب برابر 1/22 و 1/89 میلیمتر است.



(ب)



(الف)

شکل 7- نمودار نشست پی ساختمان بیمارستان بعد از حفاری، الف) مدل سگمنت به روش المان حجمی، ب) مدل سگمنت به روش المان صفحه ای

5. نتیجه گیری

تونل‌های حمل و نقل شهری در مجاورت سازه‌های دیگر احداث و حفاری می‌شوند. عبور از کنار پی ساختمان‌های خیلی بزرگ، و سایر تاسیسات شهری، نشست‌های سطح زمین ناشی از حفاری، برخی از مشکلاتی است که در راستای احداث یک تونل شهری می‌تواند وجود داشته باشد؛ بنابراین ایمنی خود تونل و سایر سازه‌های مرتبط با آن از عوامل مهم در موفقیت طرح یک تونل شهری می‌باشد. امروزه نیز روش‌های عددی به لحاظ مدل‌سازی شرایط زمین و تونل‌سازی، از جمله روش‌های مناسب برای بررسی و مطالعه تاثیر حفاری تونل‌ها می‌باشند، در این تحقیق با استفاده از مدل‌سازی عددی سه بعدی Plaxis 3D Tunnel به بررسی عددی تاثیر حفاری تونل بر ساختمان بیمارستان امیرالمومنین پرداخته شده است. در مدل‌سازی خاک از مدل رفتاری سخت شونده استفاده شده است و برای مدل‌سازی سگمنت از دو روش المان حجمی و المان صفحه‌ای استفاده شده است. با توجه به تحلیل‌های صورت گرفته، اهم نتایج به شرح ذیل می‌باشند:

- بر اساس بررسی و تحلیل مدل در آخرین فاز محاسباتی (اتمام حفاری تونل) ماکزیمم نشست سطح زمین در بالای تونل برای مدل‌سازی سگمنت به روش المان حجمی 29/92 میلیمتر و در روش المان صفحه‌ای 31/06 میلیمتر می‌باشد.
- نشست پی ساختمان در اثر حفاری تونل بصورت غیر یکنواخت بوده به طوریکه نقاط نزدیک به حفاری بیشترین نشست را نشان می‌دهد. مقادیر بیشترین نشست پی ساختمان برای حالت‌های مدل‌سازی سگمنت از نوع المان حجمی و المان صفحه‌ای به ترتیب برابر 1/22 و 1/89 میلیمتر است.
- با توجه به نتایج به دست آمده از تحلیل‌ها، مدل‌سازی سگمنت به روش‌های المان حجمی و المان صفحه‌ای اختلاف قابل ملاحظه‌ای در مقدار نشست‌های قائم ندارد هر چند که مدل‌سازی سگمنت با روش المان حجمی مقادیر نشست کمتری نسبت به روش المان صفحه‌ای نشان می‌دهد.
- با توجه به نتایج نشست‌های مدل‌سازی عددی حفاری تونل، برای ساختمان بیمارستان امیرالمومنین آسیب جدی وارد نمی‌شود.

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برای دانلود این مقاله کیوآر کد مقابل را اسکن کرده و بر روی لینک موجود کلیک کنید:



مقاله بعدی :

تأثیر سازه مقاوم در برابر زلزله و روش نوین در ساخت سازه ضد زلزله

نوشته مهندس سیده لیلا حسینی

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“تأثیر سازه مقاوم در برابر زلزله و روش نوین در ساخت سازه ضد زلزله”



نویسنده: سیده لیلا سید حسینی

دانشجویی مقطع کارشناسی عمران اجرایی دانشگاه تبریز

ایمیل: Leylahoseini225@gmail.com

خلاصه:

زلزله پدیده‌ای است که در بسیاری از کشورهای دنیا شاهد آن بوده‌ایم که هر کشور در تلاش برای کم‌تر کردن خسارات مالی و جانی و ایجاد ایمنی برای زندگی هستند. از نظر اهمیت حفظ جان در اولویت اول و بعد حفظ اموال مردم و در آخر اقتصادی بودن سازه مهم است. این امر باعث شده تا توجه به خصوصی به سازه و نوع ساخت و بالا بردن ایمنی آن شود. عوامل زیر از علتهای تخریب زلزله هستند که ما به جز ایجاد سازه‌های مقاوم در هیچ یک از آنها نمیتوان تغییر یا تأثیری داشته باشیم.

۱. بزرگی، شدت و مدت زلزله

۲. شرایط زمین‌شناسی منطقه

۳. حداکثر توان لرزه زایی گسل‌ها

۴. نوع گسل‌ها

۵. فاصله از چشمه‌های لرزه زایی

۶. وضعیت سازه‌های از نظر مقاومت

با توجه به قرار گیری ایران در کمربند لرزه خیز آلپ- هیمالیا ایران را یکی از زلزله خیزترین کشورها هست. حدود ۸ درصد از زمین لرزه‌های دنیا و حدود ۱۷ درصد از زلزله‌های بزرگ دنیا در فلات ایران رخ می‌دهد. این امر سبب میشود تا ما به اصل طراحی و ساخت ایمن سازه دقت کنیم و این در مهندسی یک امر مهم و اساسی محسوب شود. البته از آنجایی که ژاپن بیشترین تعداد زلزله‌ها را دارد و ساخت سازه ایمن و مقاوم در برابر زلزله‌ها مهم است و کشور ژاپن پیشرفت خوبی در این زمینه را در طی سال‌های کسب کرده است، بنابراین با بررسی تکنولوژی‌های کارآمد این کشور و بررسی امکان اجرای آنها در ایران با توجه به منابع مالی و فناوری موجود در کشور می‌توان به چشم انداز و

راهنمایی برای طراحیهای ضد زلزله در آینده دست پیدا کنیم. طبقه نتایج بدست آمده از پژوهش حاضر سیستم های خانه های گنبدی و فریم های گهواره های دارای بالاترین امکان اجرا را داراست .

کلید واژه ها: زلزله، سازه مقاوم ، شیوه های نوین

مقدمه:

زلزله: عبارت از حرکات و ارتعاشات ناگهانی سطح زمین ناشی از شکسته شدن سنگهایی در پوسته زمین و رها شدن انرژی ذخیره شده در آنها است که در صورت شدت زیاد در مراکز انسانی موجب خسارت ها و زیانهای فراوان می شود. زلزله از یک طرف موجب شکسته شدن و جابجائی بین توده های سنگی پوسته زمین می شود و از طرف دیگر همین جابجائی و شکسته شدن منجر به ایجاد امواج و انتشار در درون زمین می شود، مانند انداختن قطعه سنگی در حوض یا دریاچه که منجر به ایجاد امواجی می شود.

سازه های دینامیکی همواره در برابر بارهای دینامیکی طبیعی مثل زلزله قرار دارند، اما این بارگذاری ها را می توان با محاسبه مصالح مناسب و رعایت مقررات و استانداردهای کنترل و پیشگیری کرد . از آن جایی که امروزه روشهای جدید برای پیشگیری و مقاوم سازی ساختمان در برابر زلزله وجود دارد و ایران از نظر ساختمانی منازل مسکونی فرسوده در شهرها و بافت فرسوده خشتی در روستاها زیاد به چشم میخورد پس چه بهتر میشود تا این بناهای فرسوده تا حد

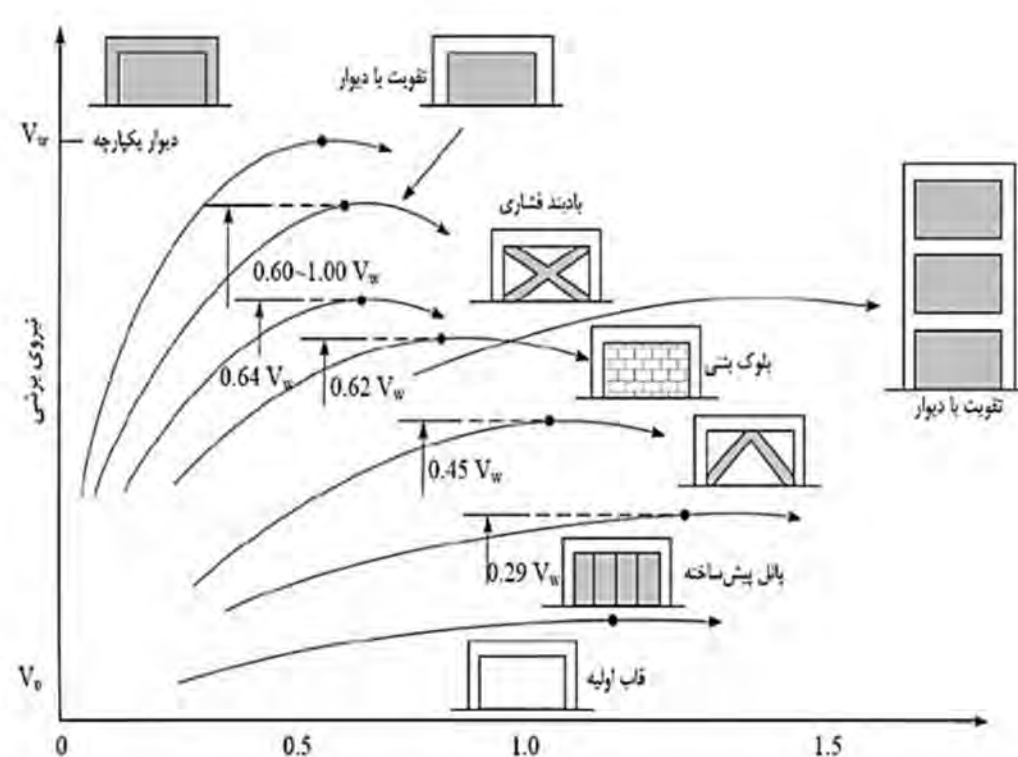
امکان با روشهای نوین بازسازی یا نوسازی شوند در نتیجه اهمیت این پروژه در اینجا روشن می شود.

مقاوم سازی:

فرآیند ارتقاء سیستم ساختاری یک ساختمان که به منظور بهبود عملکرد آن تحت بارهای موجود و یا برای افزایش قدرت حمل بارهای اضافی بر روی ساختمان توصیف می شود، مقاوم سازی ساختمان نامیده می شود. به طور خلاصه مقاومت در برابر نیروهای وارده بر سازه را مقاومت میگوییم . مقاومت سازی نوع ساختمان (فولادی، بتنی و...) متفاوت است . مقاوم سازی میتواند دو روش انجام داد.

اضافه کردن سیستم سازه ای جدید:

از جمله سیستم های سازه ای می توان به استفاده از بادبند های فولادی، استفاده از دیوارهای برشی فولادی بتنی و نیز پرکننده، افزودن روش های کنترل غیر فعال مثل جداسازی تکیه گاه ها، استفاده از میراگرها مهاربند ها و اشاره کرد .



کارایی دیوارهای سازه ای و مهاربند ها

تقویت اعضای سازه ای موجود:

از جمله راه های تقویت اعضای سازه افزایش ابعاد و ظرفیت باربری اعضای سازه می باشد. روش های که به کار میرود استفاده از پوشش های بتنی ستونها و اتصالات ساختمان های بتنی، محصور کردن ستونهای بتن مسلح توسط پوشش های فلزی و مقاوم سازی اعضای بتن مسلح سازه ای با استفاده از چسباندن ورق های الیاف پلاستیکی میباشد.

مقاوم سازی با استفاده از FRP:

روش جدید در مقاوم سازی سازه به شمار میرود. پلیمرهای مسطح فیبری FRP از ترکیب رزین و الیاف (میباشند) FRP (اف آر پی) بدلیل خواص فیزیکی جایگزین مناسبی برای سایر روش های سنتی در مقاوم سازی ساختمان میباشد. مقاوم سازی ساختمان با FRP بدلیل نسبت بالای مقاومت به وزن این محصول یکی از روش های کاربردی در تقویت سازه های بتنی می باشد.

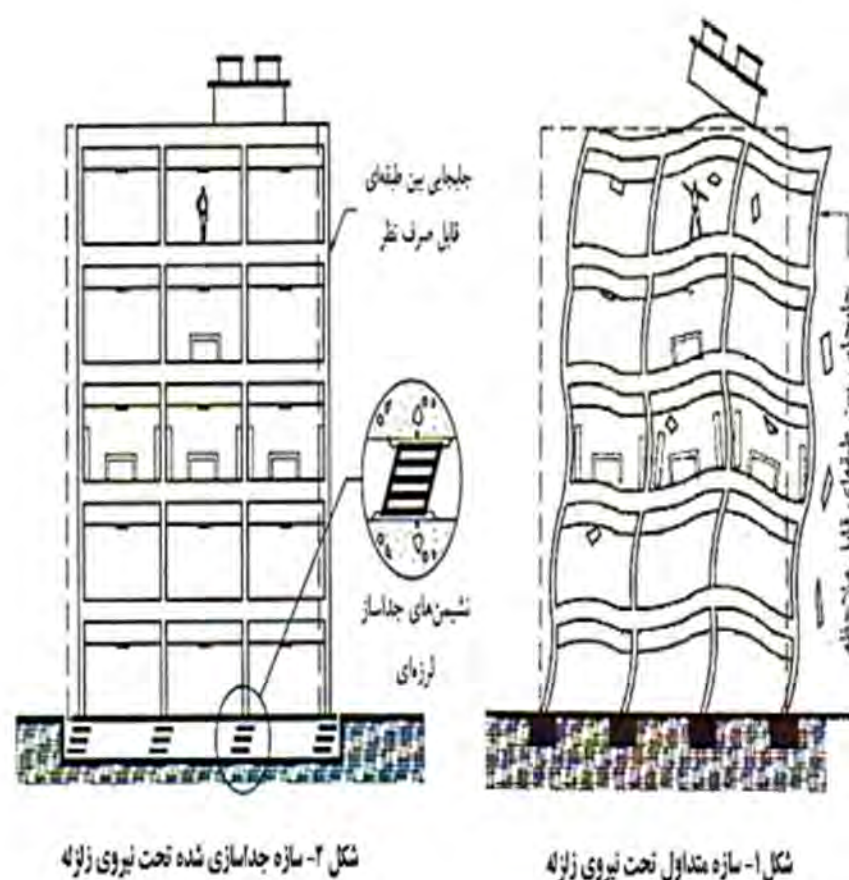
مقاومت کششی، مقاومت مغناطیسی، مدول الاستیسیته ی مناسب و عدم بروز گسیختگی ناشی از پدیده ی خزش از ویژگی های مهم مصالح FRP می باشند که مقاوم سازی ساختمان با FRP را تبدیل به روشی نوین نسبت به سایر روش های مقاوم سازی کرده است. محصولات FRP اف آر پی دارای چسبندگی بالایی به سطوح بتنی هستند که

فرآیند افزایش مقاومت بتن به این روش را آسان تر می کند.

مقاوم سازی با استفاده از جداسازی های

لرزه ای:

جداسازه لرزه ای به فناوری اطلاق میشود که اثر زمین لرزه بر ساختمان را کاهش و مانع از بروز آسیب در سازه میشود. در حقیقت این فناوری با کاهش جابه جایی جانبی سازه به واسطه تغییر دوره و شتاب اعمال شده از زلزله به سازه میباشد.



مقاوم سازی با استفاده از ژاکتهای فولادی و

بتنی:

با استفاده از ژاکتهای فولادی و بتنی میتوان اجزای سازه را به صورت موضعی مقاوم سازی کرد.

ژاکت های فولادی:

استفاده از ژاکتهای فولادی روشی برای مقاومسازی سازه های بتنی است که نحوه ی اجرای آن بر حسب نیاز به سه روش دورپیچ، نواری یا موضعی انجام میگیرد. ژاکت فولادی ضمن عدم افزایش وزن قابل توجه بر روی سازه، سبب افزایش شکلپذیری و مقاومت سازه میگردد. مورد دیگری که در آن ژاکت فولادی مورد استفاده قرار میگیرد، ستونهای ضعیف سازه میباشد که فاقد آرماتورهای کافی هستند، که در این موارد به کارگیری ژاکتهای فولادی ضمن افزایش مقاومت برشی و خمشی ستونها با ایجاد محصور شدگی، مقاومت فشاری بتن را نیز افزایش میدهد و از کماتش آرماتورهای طولی نیز جلوگیری می کند.



مهاربند ها:

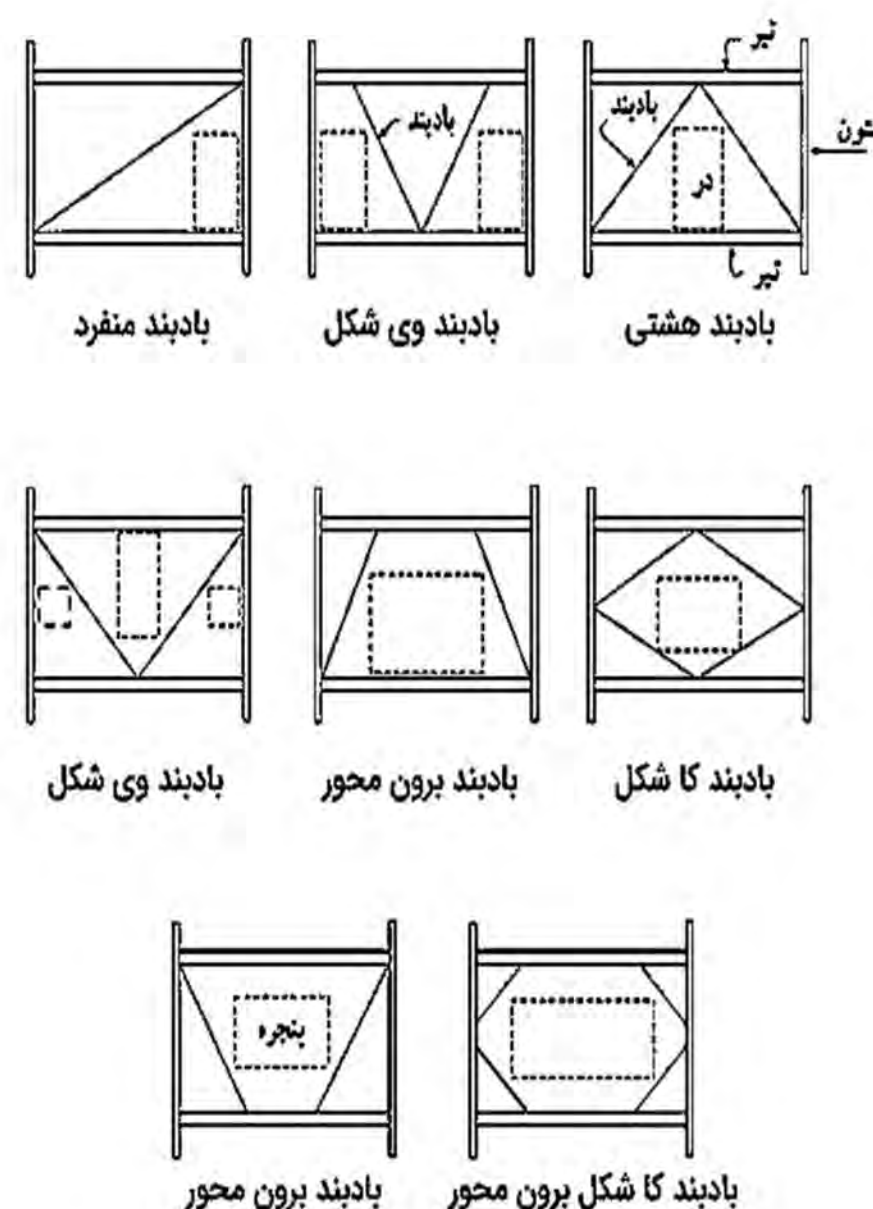
یکی از سیستم های مقاوم در برابر بارهای جانبی، قاب های مهاربندی شده می باشد. قاب مهاربندی شده سیستمی به شکل خرپای قائم است که بیشتر در ساختمان های فولادی برای ایجاد مقاومت در برابر نیروهای جانبی استفاده می شود. مهاربند یک عضو سخت کننده سازه در برابر نیروهای جانبی همانند نیروی باد نیروی زلزله می باشد که به دلیل اجرای سریع نسبت به دیوار برشی عمومیت خاصی بین عامه پیدا کرده است. در افزایش مقاومت سازه با نصب و اجرای دیوارهای برشی یا بادبندها، مقاومت سازه افزایش استفاده از بادبندها از اهمیت ویژه ای در ساختمانهای اسکلت بتنی



ژاکت های بتنی:

یکی از روشهای مقاومسازی است که نحوه ی عملکرد آن مشابه ژاکت فولادی است ولی کاربرد کمتری دارد. عمده

برخوردار است. افزایش انعطافپذیری در معماری، وزن کم سیستم، آسانی و سرعت ساخت و قابلیت انتخاب چندین سیستم را میتوان از اصلترین مزیت‌های بادبند فلزی دانست.



دیوارهای برشی و بهسازی آنها:

دیوارهای برشی فولادی صفحه فولادی نوعی سیستم جدید مقاوم در برابر بارهای جانبی بوده که نسبت سایر سیستم‌های مقاوم در برابر بار جانبی دارای عملکرد بهتری است. در این سیستم نیروهای جانبی توسط دیافراگم‌های کف طبقات به صورت افقی به صفحه، تیر و ستون‌های این نوع دیوار منتقل می‌شود. قاب فولادی محیطی هر صفحه ممکن است دارای اتصال تیر به ستون به صورت ساده

(مفصلی) یا ممان گیر (گیردار) باشد. همچنین صفحه می‌تواند با سخت کننده‌یابدون آن باشد. علاوه بر این، صفحه ممکن است توسط پیچ و یا جوش به قاب محیطی‌اش متصل شود.

سبک سازی :

در دهه های اخیر ساخت و ساز در کشور ایران از لحاظ کمیت رشد وسیع و قابل ملاحظه ای را داشته است ساختمانهای مذکور در مقایسه با ساختمان های قدیمی تر دارای سیستم های سازه ای مناسب در برابر بارهای وارد می باشند اما مسئله قابل توجه در این ساختمان ها استفاده از مصالح سازه ای و جزئیات معماری سنتی در ساخت و ساز آنها میباشد مصالح سنتی در مقایسه با مصالح جدیدتر دارای وزن سنگین تری می باشند و باعث می شوند که وزن سازه بسیار زیاد و سنگین باشد و از آنجایی که نیروی زلزله با وزن سازه رابطه ای مستقیم دارد هر چقدر وزن سازه بیشتر باشد اثرات ناشی از زلزله بر سازه نیز بیشتر خواهد شد بنابراین یکی از روش های مقاوم سازی ساختمان ها در برابر زلزله کم کردن وزن سازه یا سبک سازی می باشد.

روش های سبک سازی ساختمان به دو دسته تقسیم می گردند:

✓ سبک کردن اجزای غیر باربر ساختمان

✓ سبک کردن اجزای باربر ساختمان

سبک سازی اجزای غیر باربر در سه جزء زیر انجام می گردد:

- ✓ سبک سازی در جداگرهای داخلی ساختمان
- ✓ سبک سازی در جداگرهای خارجی ساختمان
- ✓ سبک سازی در سقف سازه های بتنی

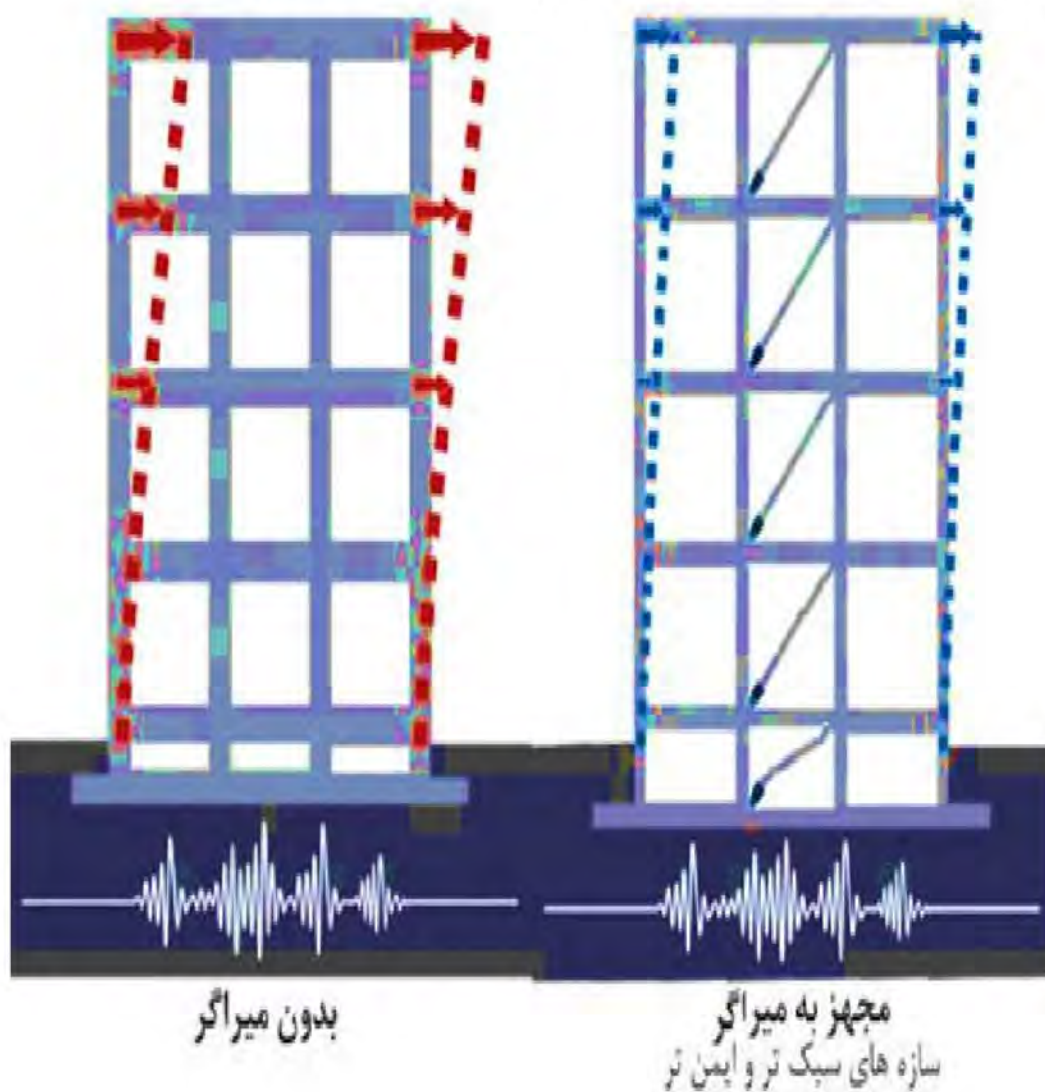
میراگرها:

بحث جدیدی که سالهای اخیر میان دانشمندان علوم ژئوتکنیک و مهندسين طراح سازه ها مطرح است طراحی نوع جدیدی از ساختمانها است که شامل یک سیستم مهاربند زلزله ای باشند که فقط در مقابل ارتعاشات مختلف ناشی از زلزله عمل نموده و در تحمل بارهای استاتیکی هیچ نقشی نداشته باشند که این مسئله باعث ساده سازی پیش بینی رفتار سازه تحت بارگذاری لرزه ای می شود.

هدف اصلی این روش ها جلوگیری از انتقال مستقیم نیروی زلزله از پی به سازه میباشد. این روش اگر درست اجرا شوند میتوانند نتایج قابل قبولی داشته باشند. مزیت اصلی این روش این است که بقیه روشها در صلب کردن بیشتر سازه در تلاشند اما این روش نه.

به طور کلی میراگرها به منظور کاستن پاسخ دینامیکی سازه در برابر بارگذاری باد و زلزله استفاده می شوند. مکانیزم عملکرد اینگونه وسایل به گونه ای است که با انجام تغییر

شکل های ویژه و اعمال مکانیکی خاصی، مقدار زیادی از انرژی ورودی به سازه بر اثر بارگذاری دینامیکی از جذب و مستهلک میسازند. عملکرد این گونه وسایل موجب می شود که انرژی دریافتی سایر اعضای سازه ها کاهش یافته و در نتیجه تغییر شکل زیادی در آنها ایجاد نمی شود.



میراگرها به انواع مختلف فلزی تسلیم، اصطکاکی و آلیاژی و... به وجود می آیند.





نتیجه گیری:

در اینجا روشهای متعددی برای ساخت یک سازه ایمنی نام برده شد که هر یک از این روشها نسبت به محل و نوع استفاده از سازه و عوامل دیگر بستگی دارد.

نهایتا باید توجه کرد که ایران به دلیل زلزله خیز بودن ایمنی سازه باید یک اولویت مهم شناخته شده و بهترین روش نسبت به موقعیت بررسی و پیاده سازی شود. البته اقتصادی بود یک پروژه هم باینکه اولویت سوم و بعد از جان و مال انسان قرار دارد مدنظر گرفته شود.

طبق مطالعات انجام شده این نتیجه حاصل میشود که در بخش سازه های بتنی برای تقویت سازه در برابر لرزه باید از دیوار برشی و طبق روش های اراعه شده به تقویت دیوار برشی پرداخته شود. همین طور در مورد تقویت ستون ها میتوان به روش استفاده از ژاکت بتنی و فلزی اشاره کرد که به دلیل مقاومت زیاد از بهترین روش ها محسوب می شود .

منابع:

1. مرتضی نقی پور ، امید حاتم، کاهش جرم ساختمان و نقش آن در اقتصادی بودن طرح در مقابل زلزله ، مجموعه مقالات اولین کنگره مهندس عمران ، دانشگاه صنعتی شریف
2. دکتر محسن ایزدی نیا استاد یار دانشگاه نجف آباد ، بررسی اثرات سبک سازی بر رفتار لرزه‌های سازه های بتنی
3. کنفرانس بهسازی لرزه ای
4. احمد باقرزاده خلخالی ، صبا خاقانی ، فاطمه جعفری ، روشهای مقاوم سازی سازه در برابر زلزله ، ششمین کنفرانس بین المللی ملی پژوهش های کاربردی در مهندسی عمران ، معماری و مدیریت شهری
5. محمود محمد زمانی ، بررسی انواع روشهای رایج مقاوم سازی سازه ها در برابر زلزله
6. کماسی، مهدی و یاراحمدی، مبین و فرجی، حدیث، 1393، روش های مقاوم سازی سازه ها در برابر زلزله، سومین کنفرانس ملی مصالح و سازه های نوین در مهندسی عمران، سمنان.
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برای دانلود این مقاله به زبان انگلیسی کیوآر کد
مقابل را اسکن کرده و بر روی لینک موجود کلیک
کنید:

A vintage white and yellow van is driving away on a winding asphalt road that curves through a dense forest of tall evergreen trees. The road has double yellow lines and a white edge line. The scene is captured from a low angle, looking down the road.

Next Article

Techno Civil
Civil Engineering Student Journal

"The Impact of Creating Roadways in Forests and Its Impact on Human Life and Its Quality"



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Vegetation, pastures, forests, and green space in every city, region, and country are among the assets and wealth of that community and the protection of this valuable treasure plays an important role in the development and prosperity of the country.

"Forests, green spaces, and vegetation play an important role in the health of the human body and soul, and research has shown that those who live in green and wooded areas or natural environments are more likely than others to live in nature," said one

agricultural expert. "They live in a more polluted and denser urban environment and are healthier."

she gives an example in this regard and says: "Most hospitals and medical centers, especially centers that treat mental illness are located on the outskirts of cities and forest environments and green and wooded areas because of the healthy climate, abundant vegetation and "Pleasure has a great effect on blood pressure, heart rate, stress, and mental stress."

Also, with a little care and attention, you can see the effect of climate, forests, and green pastures on the mood of people in different regions. In the northern provinces of the country, which are green and full of various trees and plants, you are a lush people. On the contrary, in some mountainous areas with fewer trees, people find it a little harder to trust each other, and this only shows the impact of nature and the climate of the area. Because the nature of human beings is good and flexible in itself, and this is an important external factor (living in nature or not living

in nature) that causes extensive changes in the mind and even in the behavior of different human beings.

Research by some researchers has shown that presence in green environments and forests will reduce the effects of ADHD in children. In this study, 17 children with ADHD were placed in three different positions in nature and forest parks. They walked for 20 minutes.

Children were able to concentrate more with this method and their hyperactive effects were less visible.

Even a cursory glance reveals that families who grow several plants in their homes are more mentally refreshed and laugh and have a milder mood because they receive a lot of energy from the plants. No more than the balcony area of an apartment.

Unfortunately, today stress and mental illness

have increased in society and the nature of urban life and noise pollution and air pollution is an effective reason for the emergence of various physical and mental illnesses. For this reason, health experts believe that going to forests and parks and green spaces is effective to increase relaxation and reduce stress and prevent many diseases.

And growing a few small pots at home is one way to bring the forest to our homes and workplaces.

Researchers at an international congress in the South Korean capital, Seoul, claim that sitting in the shade of a tree helps to alleviate some of the human stress, as greenery and nature have amazing healing effects on the body and mind.

However, we know that roads play an important role in our daily lives. Roads are used to communicate between cities. People go to work through the roads. Children and adolescents use roads to communicate. They go to school and study. Every day, food is delivered to many cities of origin to their

destination cities. And all our daily work is related to the road and our connection with the world outside the home. Every year, many exports and imports, from food products to clothing, etc., through land roads and road connections. Therefore, there is no denying the necessity of the road. As a result, their existence is inevitable.

But in addition to the positive effects of roads on the daily performance of humans and the economy and other situations in the country, it has devastating effects on the health of the human body and soul and even wildlife. A range that may cause their extinction and it will not be possible for them to grow anywhere else.

For the construction of roads, forests and pastures are destroyed to a great extent, which may destroy the unique vegetation of an area.

And of course, we know that by destroying rare vegetation we are destroying a part of the national capital.

Also, if we leave out the discussion of national assets, the loss of vegetation can cause irreparable damage in the long run. Soil erosion is one of these important issues. Now, after cutting down the big trees and plants, with just a light rain, the whole area will be bigger and more damaged than ever.

Vegetation of the soil surface in any case increases the permeability of the soil and reduces the flow of surface runoff. Vegetation, in addition to helping direct raindrops to the soil surface and separating surface soil particles, reduces the speed of water flow on the soil surface and thus increases the time required for water to penetrate the soil.

Recent studies show that with increasing tree felling to create roads, soil erosion has increased proportionately, and the floods of recent years are also due to this. You may think that work is over and there is no way to compensate, but to prevent the Irregular felling of trees, sowing and cultivation of

medicinal plants and rangeland species and implementation of watershed management and aquifer management plans are among the effective ways to reduce the phenomenon of soil erosion ...

With another example, I will explain the importance of forests to you.

Scientists believe that tropical forests provide more than 50 percent of the earth's oxygen, which is why it is so important for the earth's health. Tropical forests have also been the primary source of many fruits, such as bananas, mangoes, and coconuts.

Today, many pharmaceuticals and industrial raw materials such as coffee, cocoa, oils, cosmetics, and perfumes, rubber, rubber, and toothpaste are sourced from tropical forests. But today, for this reason, as well as the mining of gold, aluminum, and bauxite, has caused more deforestation in the tropics.

Therefore, creating roads in the forests is necessary to use the said cases. Wood resources, healthy recreation, and reduction of diseases are other benefits of forests. But we must create a balance. This means that we have roads in the heart of the forest with a minimum and low density. Use the heart of the forests and do not harm the huge and rich wildlife of different communities.

Another important point is that taking medicine after Sohrab's death is also useless. According to the Mehr correspondent, on Monday evening, in the presence of law enforcement and judicial agents and some agencies in charge, 12 residential units out of 14 residential units in a residential complex in Surkhani village, Chabaksar section of Rudsar city were destroyed by a court order. The prosecutor of Rudsar, pointing out that the matter stated: the builders of this town have built 14 residential units in the area of Surkhani Chabaksar village of Rudsar by forging documents, which were destroyed today by a court order.

Janat Rostami stated that the process of demolition of residential units and commercial places that have been built illegally continues.

He continued: these violators will be sentenced to one to three years in prison and pay a fine.

But the point is why, after the destruction of the green pastures and after many years, the officials have just realized that this area is part of the agricultural jihad and is not land that is suitable for construction.

Not only will this demolition not bring back the national capital, that is, the same trees that were cut down to build this town, but only the construction capital and its team will be wasted.

Therefore, it is better to monitor the implementation of buildings more strictly and not to allow natural resources to be sacrificed for the personal interests of some. Meanwhile, it is not clear exactly how many thousands of meters of the forest will be destroyed to build roads leading to the aristocratic villas. Not only are they beautiful, but many farmers make money from them every year. It is unfortunate and invites us all to think deeply. And enforce it, and also wants the people to have authority over their interests and the money they receive from the sale of their lands, which of course is very small compared to the real value of the lands, and not to sell their lands, and to think before themselves. May the future of this land and our beloved homeland. This great land needs large trees for the future that have oxygen and fruit, and wood for large industrial works, to create employment and, of course, the welfare and comfort of the people present in society.

Trees are the lifeblood of humans and animals and, in fact, the breath of the earth. Arboriculture and agriculture attach great importance to the Muslims and advise them to protect the trees and not to destroy the forests, because the destruction of the forests

will cause the extinction of the human and animal generations.

Many of our infallible prophets and imams (AS) were farmers and gardeners and planted and harvested garden products with their own hands. Imam Mohammad Baqir (AS) did not fail to plant trees and cultivate them even in the heat of summer. The Holy Prophet of Islam (PBUH) in addition to livestock and trade, cultivated trees and agriculture: and in preserving the trees, even in war with the enemies and occupying their land, he emphasized the soldiers of Islam.

resources. Iran's forest area has decreased by about 11 percent over the past 40 years.

Therefore, the definite number of trees and the creation of roads in forests should have a special law and rule, and a comprehensive plan should be put in place to replace them.

This has led some Arab countries, despite the lack of fertile soil, to plant hectares of land to develop and build a clean and green future in their desert country, in order to create a clean and beautiful landscape for the future. And this is a much easier task in our country,



طبقه بندی اقلیمی	بارش سالانه (mm)	پوشش گیاهی
مرطوب تمام	800-2000	جنگل های کوهستانی و پست دریای خزر
مرطوب	600-1000	جنگل های نیمه مرطوب مخلوط بلوط و راش
نیمه مرطوب	500-750	جنگل های بلوط زاگرس
نیمه مرطوب	500-750	جنگل های بلوط - عرعر (سر و کوهی)
نیمه مرطوب	500-750	جنگل های بلوط - سوزنی برگ (کاج)
نیمه خشک	300-500	جنگل های عرعر (سر و کوهی)
نیمه خشک	300-50	استپ های درختی پسته، بادام کوهی و افرا
خشک	150-300	درخت زارهای بادام کوهی و پسته
نیمه خشک	400	درخت و بوته زارهای گرمسیر
خشک	150-300	درخت و بوته زارهای گرمسیر

The importance of the tree and tree planting is narrated in a narration quoted by one of the Infallible (AS): "Even if you saw the Day of Judgment and you were planting a tree, do not give up this good deed of yours."

In Iran, the level of forest cover is about 7.5 percent, and considering the per capita forest in the world, which is 0.8 hectares, and in Iran, 0.2 hectares, therefore, Iran is one of the countries that is very poor in terms of forest

which has a lot of good and good soil, and it only needs a precise and scientific plan.

Also, by establishing suitable centers for endangered species from which we have taken their safe environment, we will provide a suitable environment for growth and reproduction so that we do not lose the blessings of their existence.

conclusion:

we must know that before us there were forests and mountains and plains, and it is we who want to use them. So, if we want this use to be permanent, we must create a balance.

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NEXT ARTICAL IS:

“Diagrid Structural System and Earthquake Effect on them”

Written by En. Fatemeh Nazarpour

Techno Civil

Civil Engineering Student Journal

“Diagrid Structural System and Earthquake Effect on them”



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Introduction:

All over the world, tall buildings are being revived. Where sustainability plays a key role throughout their design, design and construction. Because the environmental costs of structural systems become significant over time, there is an urgent need to use innovative solutions that can reduce and optimize the investment of structural materials. Recently, several high-rise buildings have used structural systems consisting of large perimeter steel frames arranged in triangular modules (diagrids). Low consumption of structural materials makes diagrid systems part of ambitious sustainable projects that have achieved great international recognition.

Diagrid systems do not have column members so that the diagonal system supports both vertical and lateral loading, despite the advantages provided by diagrids in terms of the combination of aesthetic expression, adaptability, structural efficiency and stability of their use under sufficient Lateral seismic requirements have not been studied. Execution of diagrids in seismic hazard areas requires not only the determination of lateral strength (under a conventional design

approach), but also the explicit consideration of the lateral deformation target in terms of lateral stiffness required. Unlike a structural system formed by frames and braces, in which the lateral deformations resulting from general shear and flexural (bending) actions are controlled primarily by members of different structures (braces and their supporting columns, respectively), in a diagrid system, each the two deformation components are controlled by diagonal members. In a diagrid, the placement of structural members in the form of peripheral triangles leads to structural behavior that is dominated by stresses and axial deformations. The study on the lateral response of diagrids was initially limited to the case of wind. Interesting observations were made about their optimal structural configuration. Indicates that in tall buildings, the angle of inclination of the diagonals to the floor system plan should be in a narrow range with an axis of about 70 degrees. Mellah et al observed that the geometry of real diagrid systems shows the angles that fall within this range. Some studies have identified a relationship between the optimal diameter angle and the aspect ratio of the structure.

The larger the aspect ratio of the structure, the larger the optimal angle of the diagonal column.

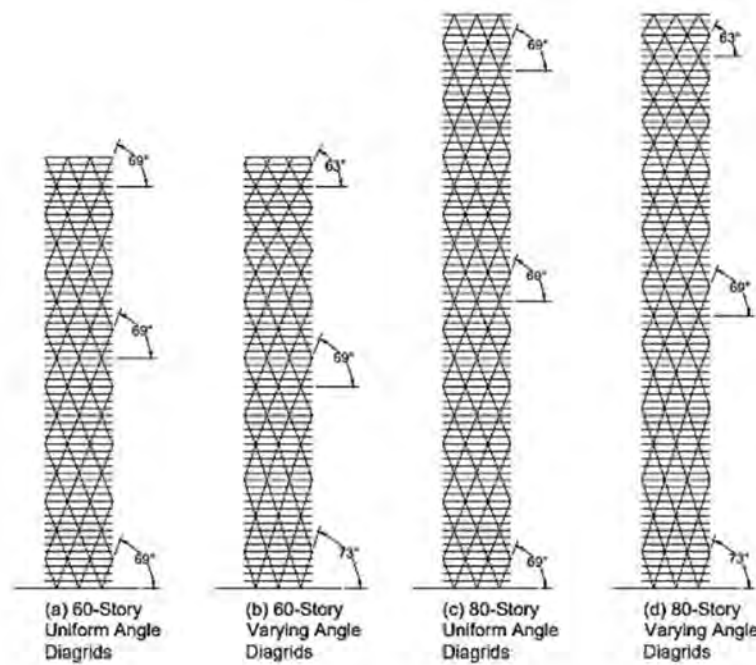


Figure 1

Structural concepts:

A key idea for a better understanding of the structural behavior of a tall, slender building is to think of the building as a ground floor pillar. They are created by the motion of the earth; They tend to break the building (cut) in which case the building should not break and the building should not have additional deformation of the cut (as shown in Figure 2) or push forward (bending) in which case the columns should not be in tensile pressure. Should be destroyed and the bending deformation should not exceed the allowable value. (As shown in Figure 3).

Therefore, the building must have a system that in addition to shear strength is also resistant to bending, and in general, the building should not have strains beyond the elastic limit.

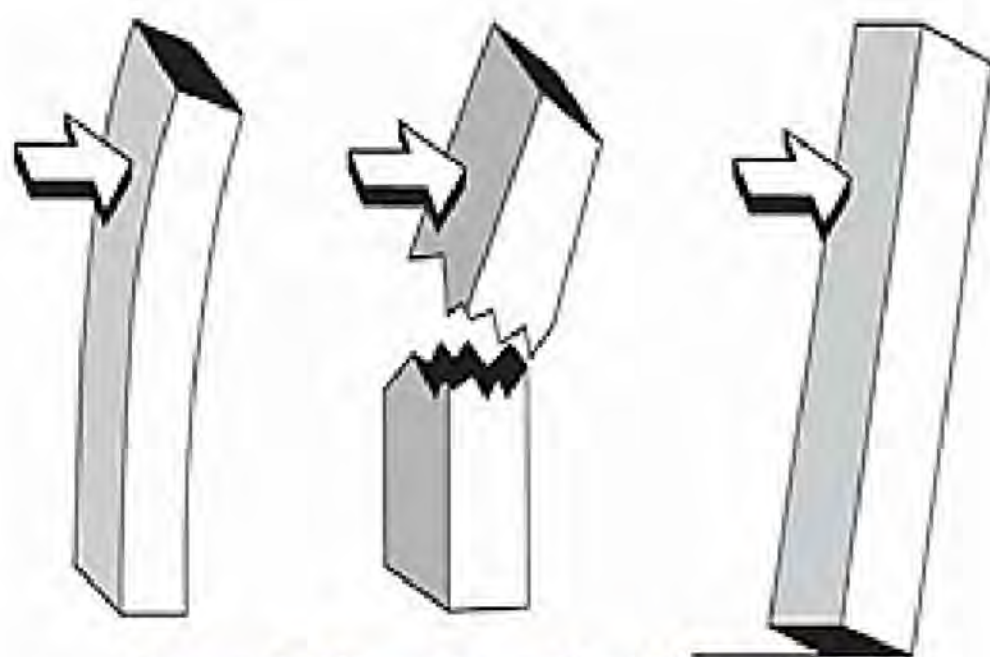


Figure 2- Shear strength of the building

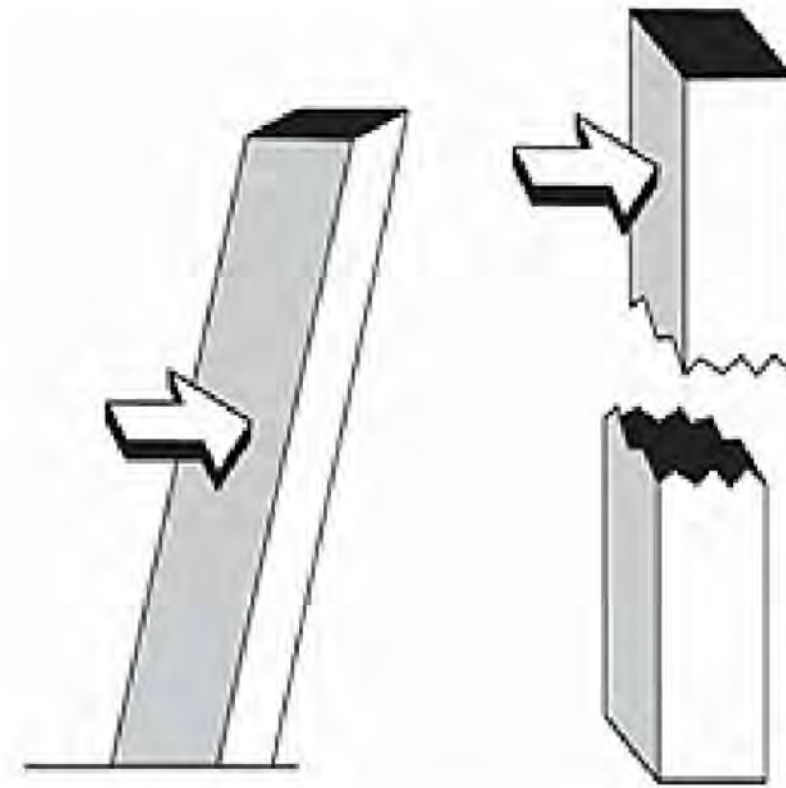


Figure 3 - Flexural strength of the building

Introduction of Diagrid structure:

Diagrid structures can be considered as a subset of contract pipe structures, with the difference that in conventional pipe buildings, the pipes are placed vertically and frame-shaped, and act against lateral forces, especially shear forces, such as rear beams. But in the diagrid structure, all the pipes are connected diagonally and by connecting to each other, it creates an integrated system that acts in unison against lateral forces. In simpler language, like the braces of a simple steel frame building, with the feature that they cover the whole structure, and high-rise buildings can be designed and executed with this method. The Diagrid structure was first used in the construction of tall buildings and skyscrapers in the early twentieth century. The first example of these skyscrapers is the John Hankaki Tower in Chicago, which was built with a pipe system, and the first signs of diagonal pipes for greater strength of the building can be seen in the view of this tower.

The emergence of the Qatari network in high-rise buildings today began around the 1960s. At that time, due to complex connections and lack of technological advancement, few people used this system. One of the oldest examples of the use of such a system is the 13-storey

building in St. Petersburg, Russia, which was completed in 2017.

Introduction of tubular structural system:

The piping system is a system for building the skeleton of a building, developed by two engineers named Milestone and Fazlur Khan, which is seen in most high-rise buildings today. This system of pipes is actually a combination of columns that are close to each other, which are connected by deep internal beams and surround the skeleton of the building. The torsional strength of this system and its lateral stiffness are high, but a general drawback is the uneven distribution of force on the wing columns, which leads to cutting lameness. This in itself limits the maximum use of the strength capacity and stiffness of the structure. To solve this problem, a system of grouped pipes is used, which consists of groups of pipes that are located at a very short distance from each other and are connected by a beam.

The most prominent feature of this system is the short distance of the surrounding columns, which are connected to each other with deep beams and a very large vertical plane resists the overturning anchor. The distance between the columns is usually 2 to 4 meters and the depth of the beams is 0.6 to 1.3 meters

In general, the piped structural system is the most economical method for constructing high-rise structures above forty floors. In addition, this system can be used in steel, concrete structures or a combination of both. In this way, in steel structures, the perimeter frames are made in the form of plates and large parts in the factory and are transported to the place of manufacture and the instrument. In concrete structures, sliding molds are used to increase the speed of construction. Therefore, it is worth noting that the piping system is the best option for high-rise buildings if implemented with all the criteria in mind. Because it reduces the weight

of materials used in the building and thus increases the number of floors is possible.

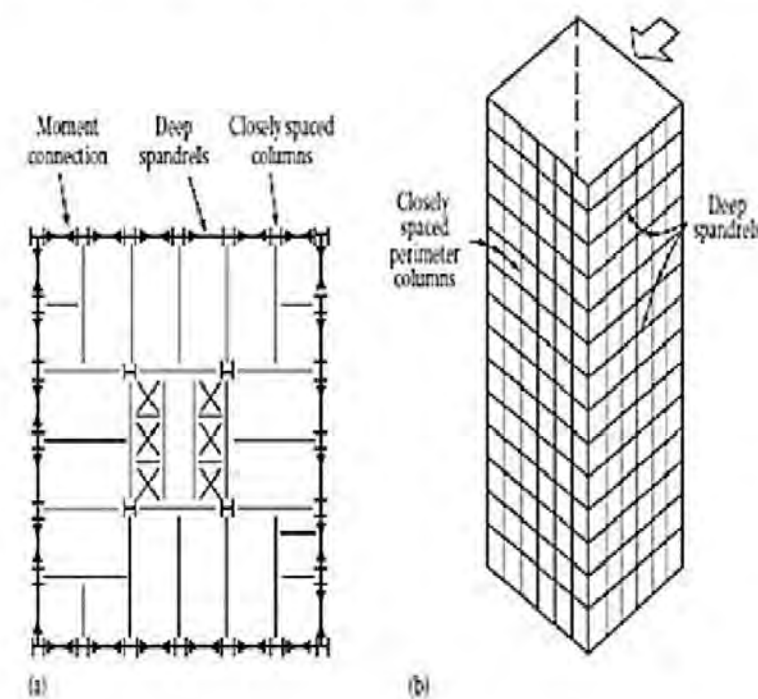
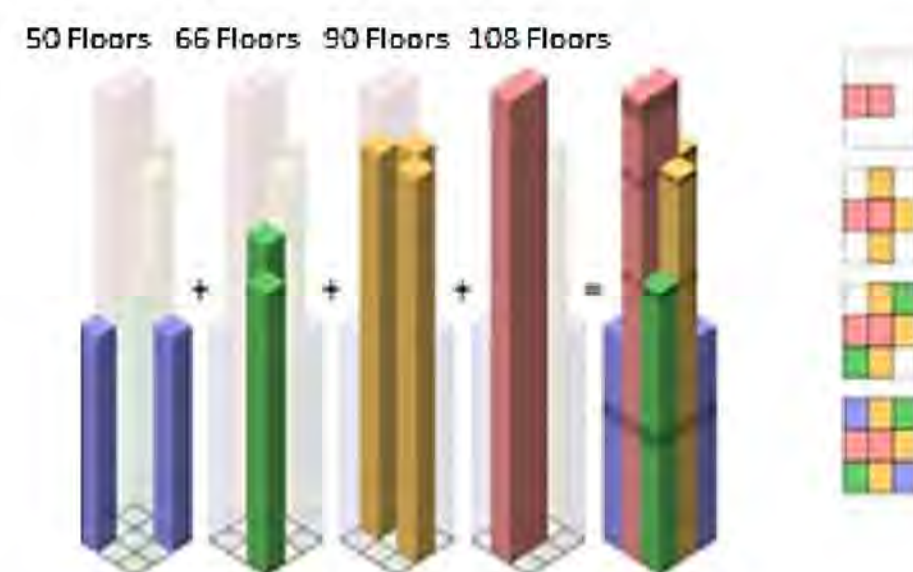


Figure 4

Applications of pipe structure system:

The most common use of the pipe structure system is in the construction of forty-story buildings, one of the most prominent examples of which is the Willis Tower in Chicago, USA. The tower held the record for the tallest tower in the world for 22 years. The plan of this tower includes two 50-story pipes, two 66-storey pipes, three 90-storey pipes and two 108-storey pipes, each of which is placed separately next to each other and creates the final shape of the building. This trick in using a pipe system is the best way to deal with wind forces and is suitable for cities and areas that are windy. Another application of this system is to use pipes to build buildings that have large openings in the outer frame in their design.



9 pipes, each composed of one column close to each other, are made at different heights

Although the structural system of the perimeter frame has a tubular shape, its behavior against lateral loads is much more complex than that of a tube. Unlike a rigid pipe, the peripheral frames are exposed to cutting lameness. Which increases the axial stresses of the corner columns and at the same time reduces the axial stresses of the inner columns of the wing and the life panel.

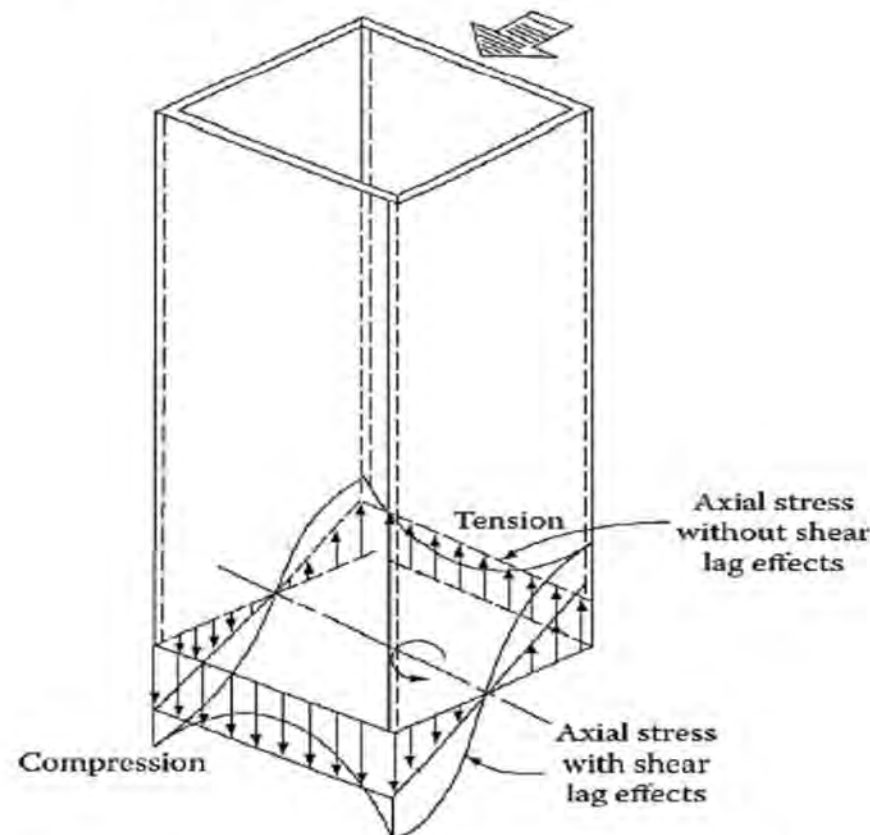


Figure 6. Cutting limp in the tubular system

Braced pipe system:

In this type of pipe system, diagonal braces, also called trusses, are used to increase the stiffness and efficiency of pipe frames. Due to the presence of these diagonal braces, the distances between the perimeter columns increase and the dimensions of the beams and columns decrease, in which case it is possible to create and design large openings. This piping system can collect gravitational loads from the floor in an oblique manner. Also, due to stiffness and lateral stiffness, the shear lameness phenomenon is reduced.

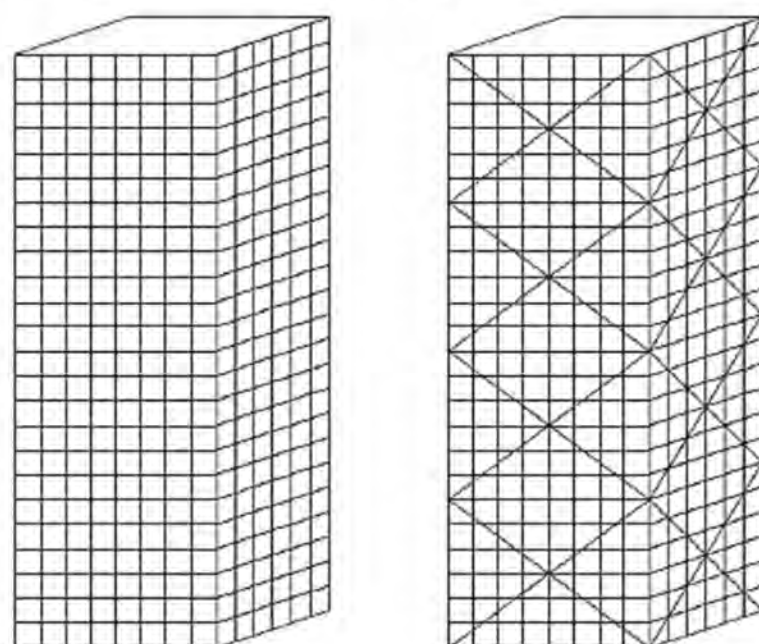


Figure 7. Ordinary and restrained pipe system with general bracing

Research method:

The pipe system is generally a combination of close columns and deep beams that are located in the perimeter of the building. Under the effect of lateral loads, such as bending, it is a hollow plane, as a result of which the strands on the opposite side of the lateral forces are shortened and the strands on the side of the lateral force are lengthened. On the other hand, insufficient rigidity of the gate beams and their flexural deformation due to the incision made in the members during the application of lateral forces cause the inclination of the incision. In other words, the flexibility effects of the gate beams will cause a non-linear distribution of pressure and tension along the columns. In this case, the shear deformations that make up most of the lateral displacement of the building will be very important. The building will increase and decrease in the middle columns. In the near field, horizontal maps perpendicular to the fault has pulses with long periods, so that such maps have more effects on structures than distant maps of the fault. Near-field earthquakes in which the velocity pulse velocity is more intense or whose pulse duration is longer increase the response of the structure further, so however, structures that are closer to the seismic source should have more ductility. To be able to reduce the response of the structure. Increasing the ratio of ground motion pulse to natural period of the structure and also increasing the ratio of ground acceleration to yield strength of the structure increases the nonlinear response and damage to the structure and because the close effects of the fault are greater in the high period range, increasing the softness and main period of the structure. Increases the near-fault effects so that high-frequency structures (low periodicity) that are in the linear range; Under nearby earthquakes.

Faults with short frequency content (long period) do not have a large response, but if these structures enter the nonlinear region, their frequency will decrease and their period will increase, and in this case, they will be vulnerable to earthquakes near the fault.

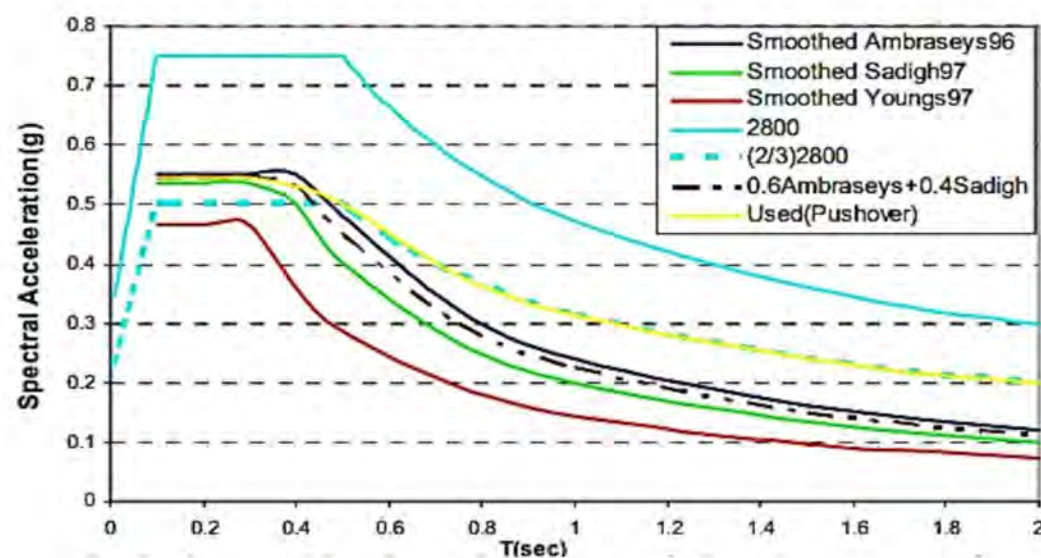


Figure 8 - Earthquake acceleration spectra away from faults

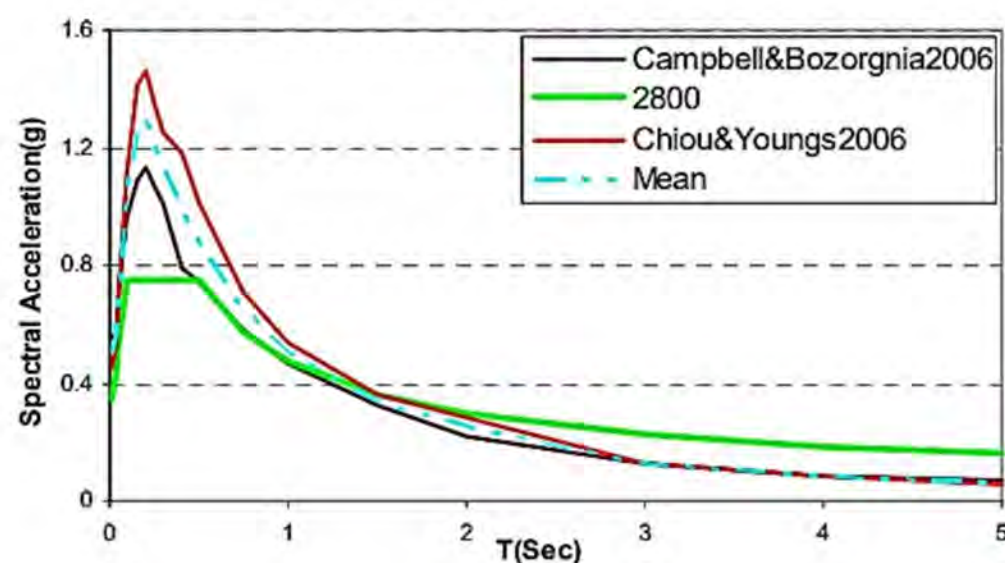


Figure 9 - Earthquake acceleration spectra near faults

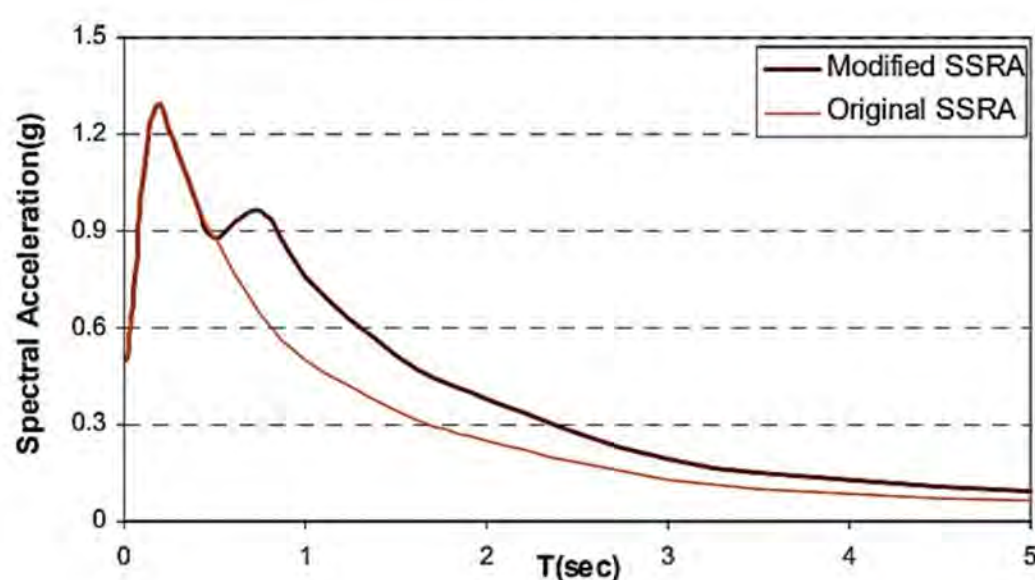


Figure 10 - The standard design spectrum of 2800 and the mean spectrum of near-scale

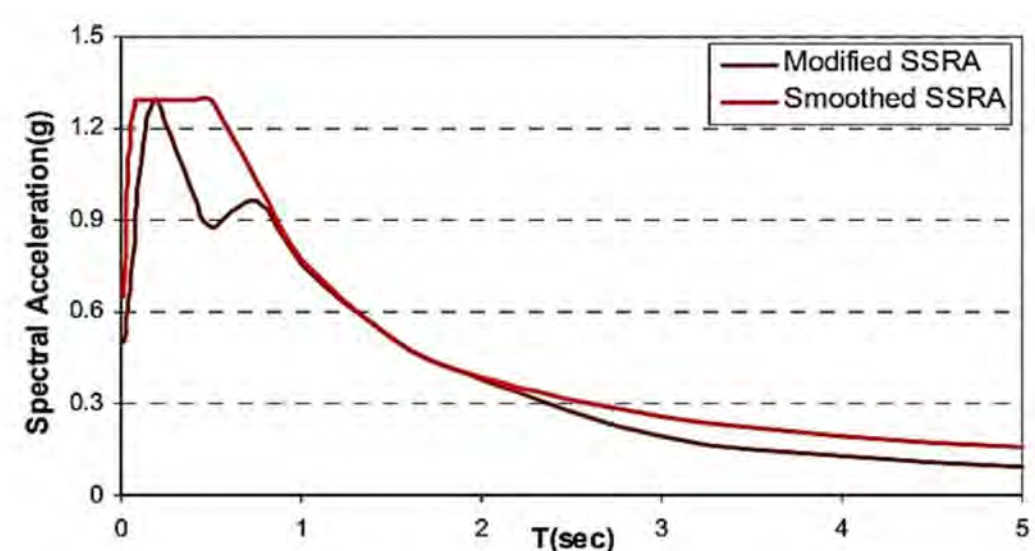


Figure 11- The standard design spectrum of 2800 and the average spectral range of distant scaled records using the square root squared method.

Seismic hazard analysis on two near and far faults:

In this section, based on linear seismic springs (active faults in the region) and using seismic parameters obtained from the relationship between Gutenberg-Richter and Kikoi method, in SEISRISKIII software, the probability of exceeding the horizontal spectral accelerations in different periods is estimated. May be. Now, if for each given seismic hazard level, the corresponding horizontal periods and accelerations are plotted in a graph, the same hazard spectrum is obtained. After reviewing the existing reduction models and relationships, for the station away from the fault of three priestly relationships Ambraseys, Simpson and Boomer (1996), Younges (1997) and Siddique (1997)

In **Figure (8)** the spectra related to the selected reduction relations are smoothed in the manner presented in FEMA356. The residues are combined in a 3: 2 ratios for Ambraseys96 and Sadigh97, respectively. Because Regulation 2800 does not allow the use of values less than two-thirds of the standard design spectrum, the same value is used at least for parts of the composite spectrum (0.6 Ambraseys + 0.4Sadigh) that fall below the

minimum value. Used is shown in the figure. Also, for the station far from the fault, two reduction relations of Chiu and Youngs (2006) and Campbell and Bozorgnia (2006) have been used. In **Figure (9)**, the spectra obtained from the two selected reduction relations for the site close to the fault, along with the standard design spectrum of Regulation 2800, are compared with each other and combined in equal proportions, in other words, averaged.

Considering the joints formed in **Figure 12** for a regular and irregular 10-story structure in the plan under the close record of the Northridge fault, it can be concluded that with the irregularity in the plan, the performance level

of the building with the piping system changes. 10 levels have changed from the level of safety performance.

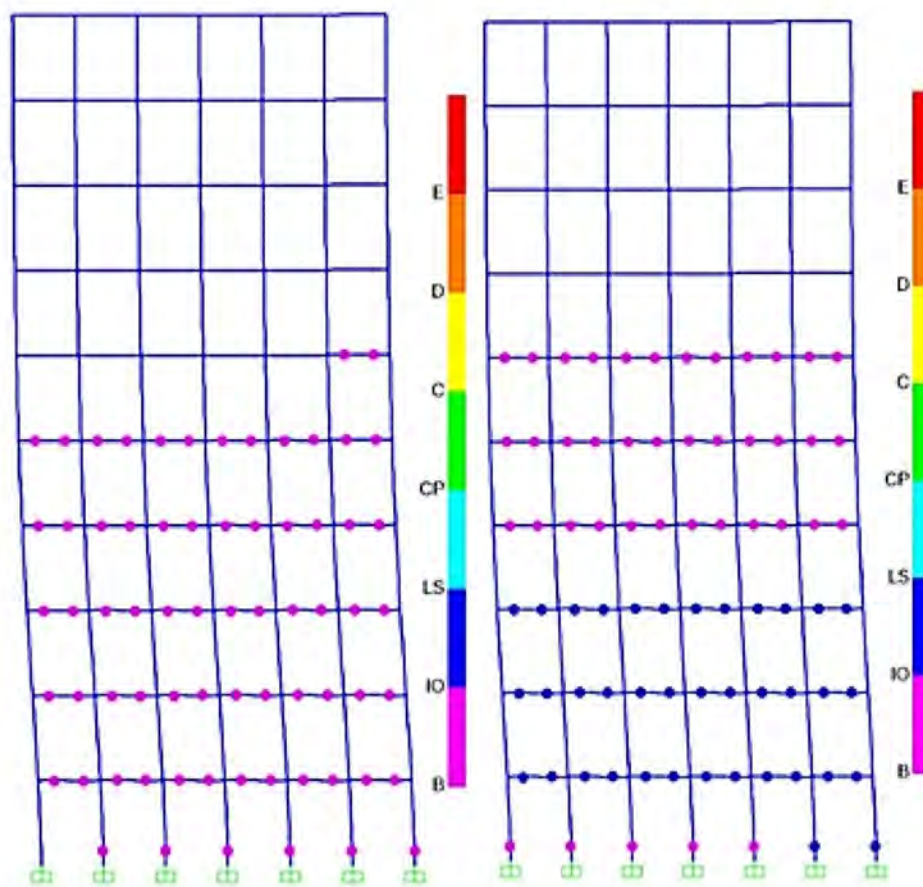


Figure 12 - Forming plastic joints for regular and irregular 10-story structures under the Northridge Earthquake near the area

Considering the joints formed in **Figure 8** for a regular and irregular 10-storey structure in the plan under the record far from the Manjil fault, it can be concluded that with an irregularity in the plan, the performance level of the building with a pipe system change. The level of uninterrupted use performance has changed to the level of life safety performance.

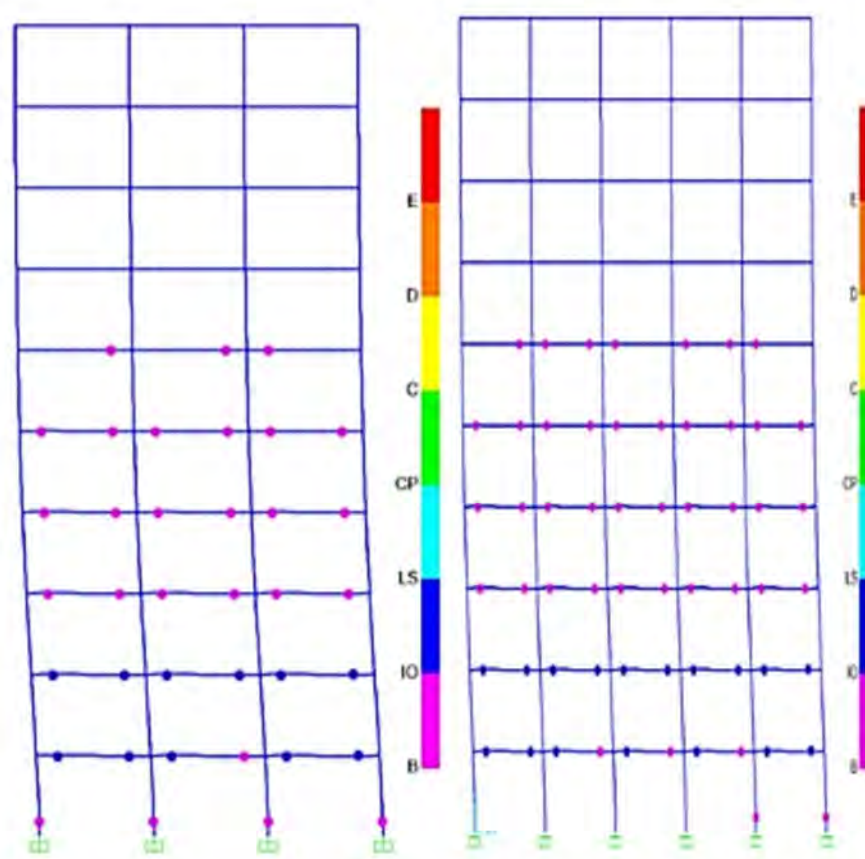


Figure 13- irregular structures under the Manjil Earthquake

Considering the joints formed in the figure for regular and irregular 30-storey structure in the plan, it can be concluded that with irregularity in the plan, the performance level of the building with pipe system has changed, in other words, the 30-storey structure Life safety performance has changed. Due to the fact that with increasing height, the rotation time of the structure increases and, in another direction, the acceleration to the structure decreases. As a result, the amount of reflection coefficient of the structure decreases and less force is reflected on the structure. Contrary to popular belief, 30-story structures have more joints than 10- and 20-story structures, which means that the elements of a 30-story structure, including beams and columns, are stronger than other structures under study. In other words, the elements reach the flow point later.

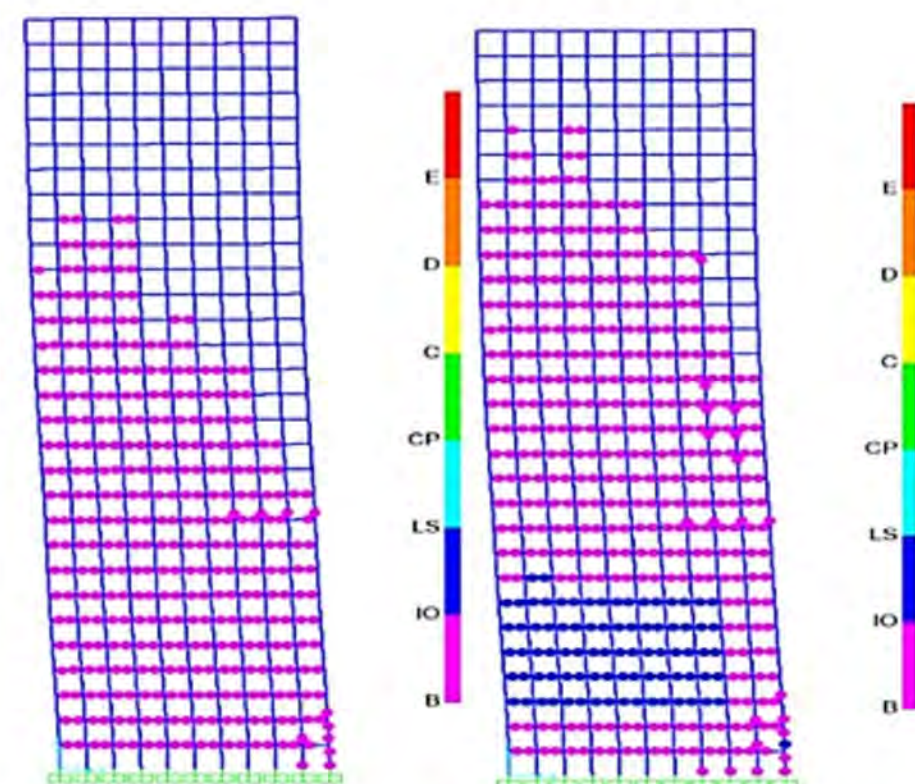


Figure 14 - Forming plastic joints for regular and irregular 20-story structures under the North Palm earthquake

Conclusion:

The diagrid structure provides the basis for more subtle designs and more efficient structures, enabling architects and engineers to implement their mental ideas in the best possible way. As a result, the system has made significant progress over the past decade, although it is considered a completely new trend. In fact, recent developments show that this structure has been able to meet most of the design requirements. Diagrid can be used not only for high-rise structures, but also for a wide range of different projects.

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A low-angle, upward-looking photograph of several modern skyscrapers with glass facades. The buildings are arranged in a way that creates a sense of height and scale. Overlaid on the image are several bright orange lines that form a grid-like pattern, suggesting structural engineering or architectural design. The sky is a pale, overcast blue.

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Next Article Is:

"Reinforcement of Structures by Using Seismic Isolation"

Written by En. MohammadReza Akhtari

"Reinforcement of Structures by Using Seismic Isolation"



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Abstract:

Today, the advancement of civil engineering and the need to pay attention to the strengthening of structures against earthquakes, has created a positive research environment in which the new technology of seismic dampers has found a special place.

Earthquake and the concept of basic insulation of structures against earthquakes has a history of 100 years, but due to lack of knowledge and facilities, until recent years was less welcomed, but recently this concept has become a practical reality and has been able to take its place. Stabilize as an alternative to earthquake-resistant fixed base structures.

In this article, the basic elements of a modern damping system and how these systems work are examined and finally the performance of structures with damping systems against real earthquakes will be examined.

Introduction:

Seismic isolation is a structural design activity that is based on the assumption of separating a structure from the ground and protecting it from the destructive effects of earthquakes and reducing damage to the structure. To do this, while observing all seismic requirements for structures, additional flexibility is considered for the base of the structures, while additional damping is provided to control deviations and movements at the interface between the structure and the ground. This is done using basic damping systems.

The concept of isolating structures against earthquakes is not a new concept, and many suggestions have been made since the beginning of the last century for "devices that absorb or minimize the shock caused by earthquakes to buildings and vibrations caused by earthquakes ..." Is.

Due to advances in structural craft hardware in the last century and now, there has been a resurgence in the discussion of seismic separation of structures around the world, but several other factors also play a key role in this increase, such as the emergence of Elastomeric bearings (energy dissipators) have emerged from seismic isolation, but recent advances in three parallel but independent axes have also had far-reaching implications for the discussion of seismic isolators.



The first development was the development of reliable software for simulating structures and analyzing their performance in the event of an earthquake and determining critical parameters for design. "Dynamic loads are on."

The second development was the construction of large shock tables that could realistically model the effects of seismic movements on structures.

Third, the development of individual skills of civil engineers (earthquake orientation) to analyze the movements of the earth on a structure and the adoption of seismic isolation technology has been important, which has led to recent advances in seismology.

History:

In 1906, Jacob Beshtold applied for a patent for an earthquake-proof building in Munich, Germany. He explained that "an earthquake-proof building consists of a rigid base plate to carry the building and a mass-shaped mass with a body made of hard material to carry the base plate freely ..."

In 1929, Robert Vladislas applied for a patent application from Wellington, New Zealand, in Montaeck, which means "a device by which a flat plate ... is placed and held between the base of a building and the solid base of a device." "It absorbs or minimizes impact and thus protects the building from damage."

These are just a few of the many suggestions for seismic isolation systems that were made before 1960, but none of them were scientifically developed, mainly because of a lack of confidence in engineering knowledge at the time.

Structure and main reasons for using dampers:

The basic components and elements of a seismic damping system are:

A flexible component that increases the vibration period of the entire system enough to reduce the response of forces.

An earthquake energy dissipator is used to be able to control the relative changes and deviations between the ground and the structure to the extent of practical design.

A piece to provide the rigidity needed to prevent relative deviations between the structure and the ground against low forces such as wind and minor earthquakes.

The flexibility of dampers:

The use of a basic seismic insulation system is common in bridges, where even bridge.

structures have been designed and built on elastomeric bearings for several years, and as a result, these bridges have flexible foundations.



Horizontal cracks of infilled walls.

The construction of structures on holly elastomeric bearings is equally applicable and practical, and there are more than 150 examples in Europe and Australia that have been successfully designed and implemented. This is mainly done to separate the structure from the ground and control the effect of vertical vibration of the earthquake on the structure, but today, by increasing the bearing thickness, additional lateral flexibility can be achieved, as well as changes in the period and period of the structure.

Elastometric bearings are not only a means of creating flexibility in a structure, but certainly have the widest range of applications in the design and construction of high-rise structures, but other widely used components used in basic seismic insulation system are rollers. Sliding plates, cable suspensions, coated piles, rocker (step) bases, air cushions and coil springs.



The decrease in force by increasing the flexibility schematically shown in the force response curve in Figure 1, which due to the prolongation of the vibration period or the increase in flexibility causes the shear force at the base of the structure to decrease to a suitable value. The shear force at the base of the structure depends on the type and shape of the response curve and the flexibility of the fixed base in the initial state, and the longer the vibration period is considered, the greater the ductility and relative displacements throughout the flexible base. We will see.

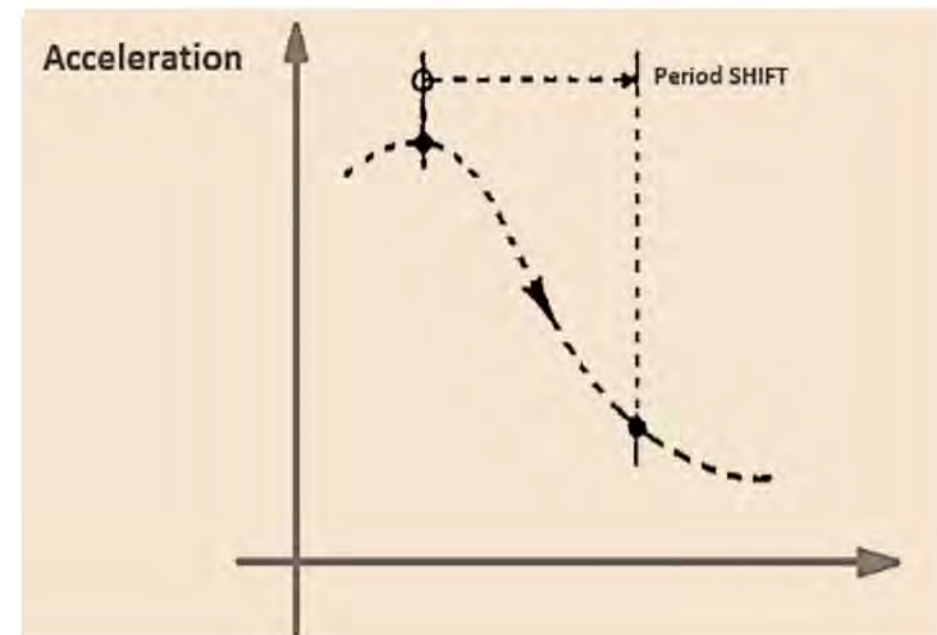


Figure 1- Acceleration spectrum curve in normal mode (ideal) which shows the reduction of acceleration by changing the period)

Figure 2 shows the displacement response curve of a typical structure, which increases with relative period (increasing flexibility) relative displacements between the base of the structure and the ground if a basic seismic damping system is used in this structure. The amount of movement can be reduced.

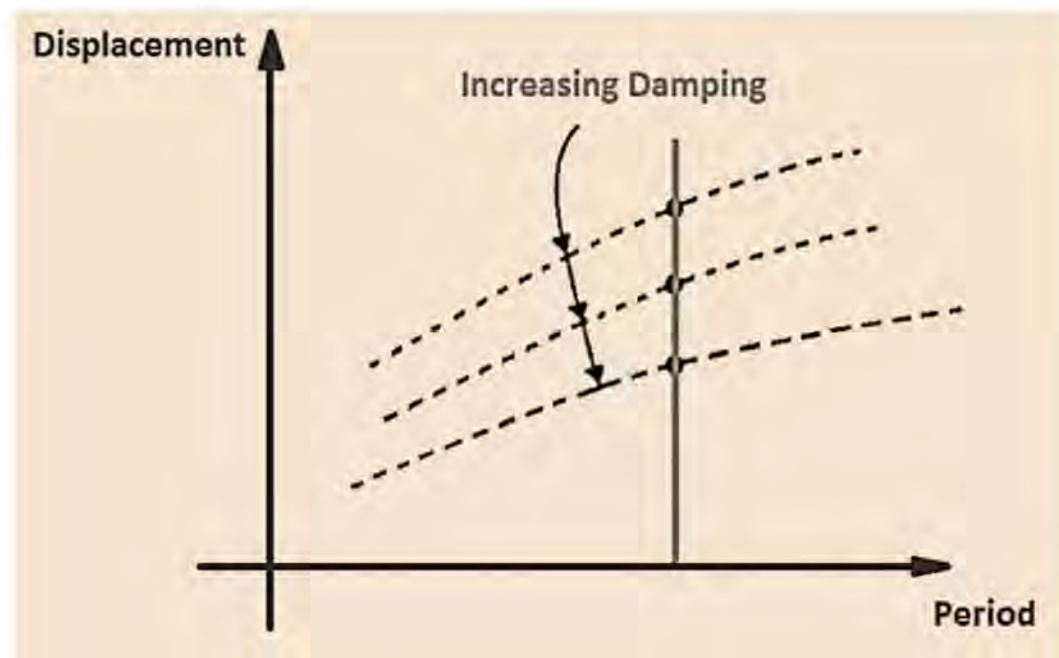
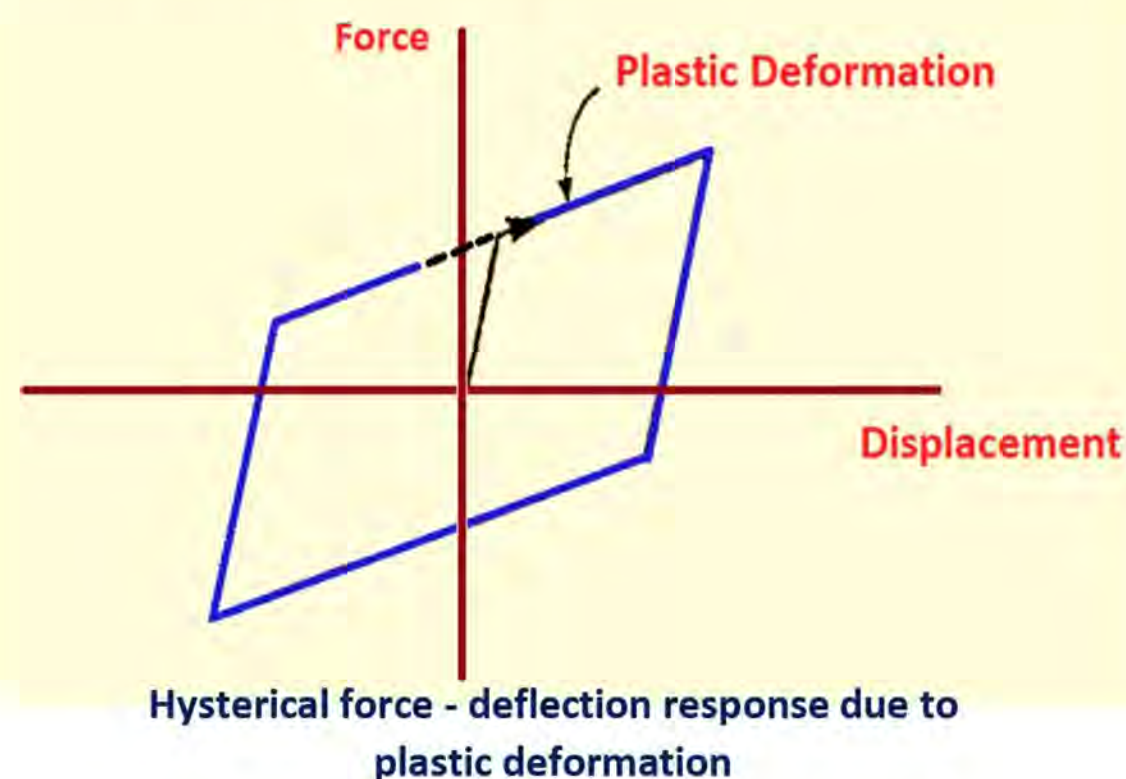


Figure 2- Normal mode displacement curve (ideal) showing displacement reduction with damping system

Energy loss:

Energy loss is one of the most effective ways to increase the damping of the structure and as a result it is considered to control the period and displacement of the structure. Among these, energy loss by hysterical method is one of the common methods. "Loading and unloading refers to cyclic loading."



Challenges of using viscosity dampers in structures:

Structural engineers identify the elements of the structure that need to create structural dampers and design and implement viscosity dampers in those stressful locations to prevent excessive deformation and damage to the structure.

For example, under severe earthquakes, a continuous bridge is damaged due to damage to the separation system (bearing) or the base of the bridge. Strong connection between the beam and the base reduces the displacement of the bearings, but increasing the transfer of inertial force of the beam to the base of the structure leads to damage to the base. Conversely, a weak connection between the foundation of the structure and the ground during an earthquake causes damage to the seismic isolation system (bearing). In many cases, the structure loses its function due to damage to some of its sub-members, while other members remain unharmed. To simultaneously protect the seismic and ground isolation system during an earthquake with a uniform distribution damage pattern, a new real-time semi-active control algorithm based on structural member damage using rheological magnetic dampers is used. Two displacement indicators are created to indicate the condition of the bearing and base damage.

Research on previous earthquakes shows that damage to the seismic isolation system (bearing) and the foundation of the structure is the main reason for the collapse of structures during severe earthquakes. Seismic damage in a structure is usually focused on local members, while the remaining members are not affected by the earthquake. For example, the seismic damping system (bearings) may fail when moving with high displacement, but the foundations can remain intact after an earthquake. In other cases, some of the foundations of the structure were severely damaged by the earthquake, while the rest of the elastic members (bearings) remained completely intact.

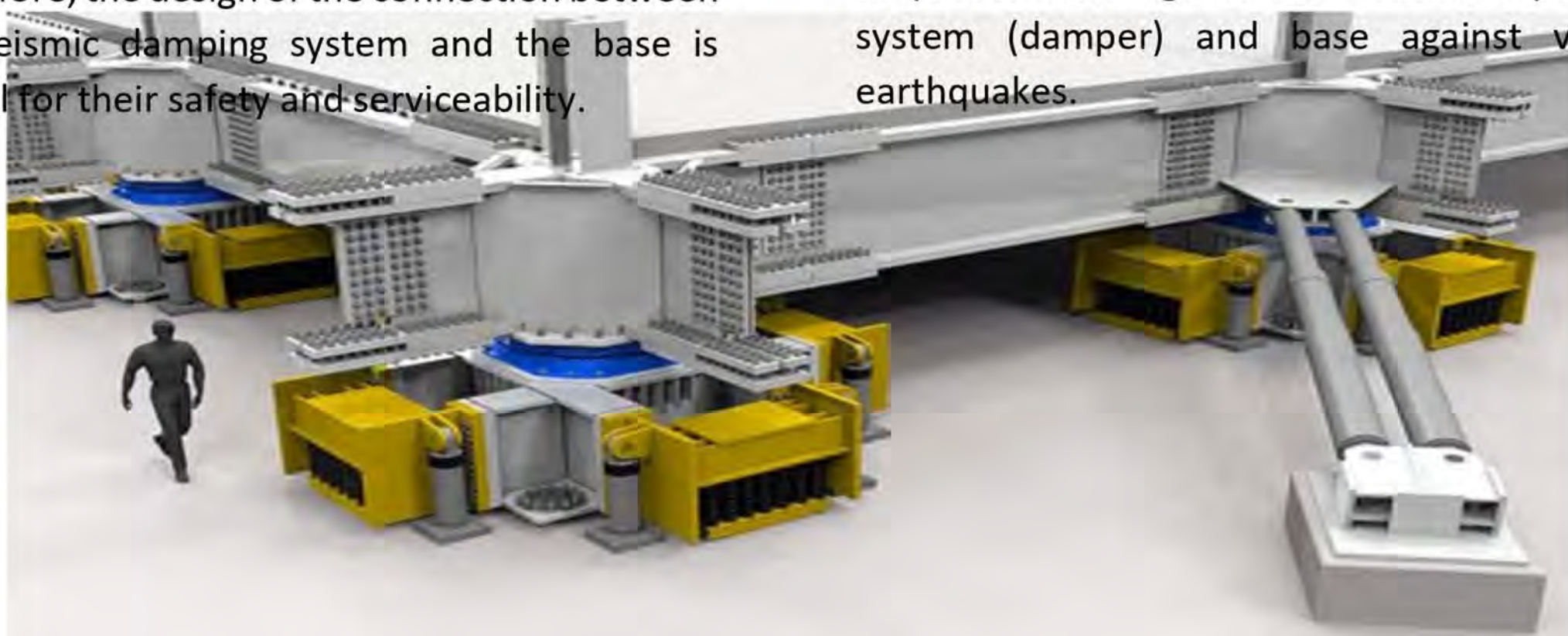
In these cases, the seismic energy loss capacity of the affected limbs cannot be increased as it

further increases the damage to other local limbs.



Analytical model of the structure.

The focus of damage in structures is usually due to improper initial design based on the different capacities of the structural members, as well as the unexpected dynamic properties of ground movements that may give rise to different force patterns considered in the design. The type of connection of the beam to the column or the type of connection of the base of the structure to the seismic isolation system is one of the most important factors in creating the focus of damage to local members. Although a strong connection reduces the displacement of the seismic damping separation system (bearing), but due to the earthquake, it transfers more inertial force from the beam to the base of the structure and thus increases the shear force of the base. As a result, the entire structure may be in danger of total collapse. On the other hand, because the bearing displacement will be excessive and if a weak connection is used, serious damage will be done to the base. Therefore, the design of the connection between the seismic damping system and the base is crucial for their safety and serviceability.



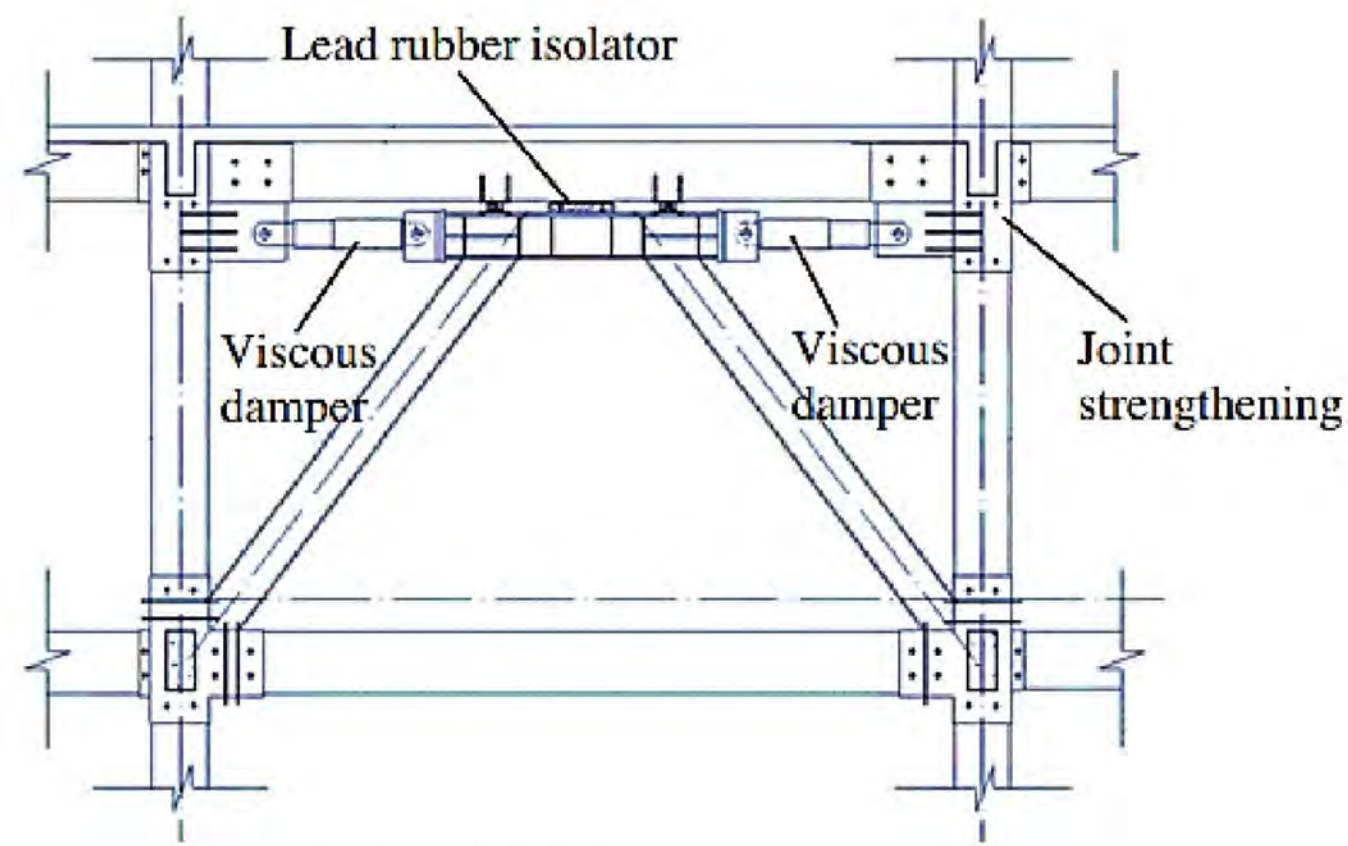
Damper installation:

In recent years, the control of seismic responses of structures has been implemented using viscosity seismic dampers, because high-capacity dampers have entered the construction industry by placing viscosity dampers between beams and columns or the base of the structure and the ground as shown in Figure. 4 It is shown that the damper force created by the piston movement is adjusted independently for each damper based on the control algorithm discussed below. The maximum force capacity of MR dampers is designed as the amount of yield force of the bases.

Use of control algorithms:

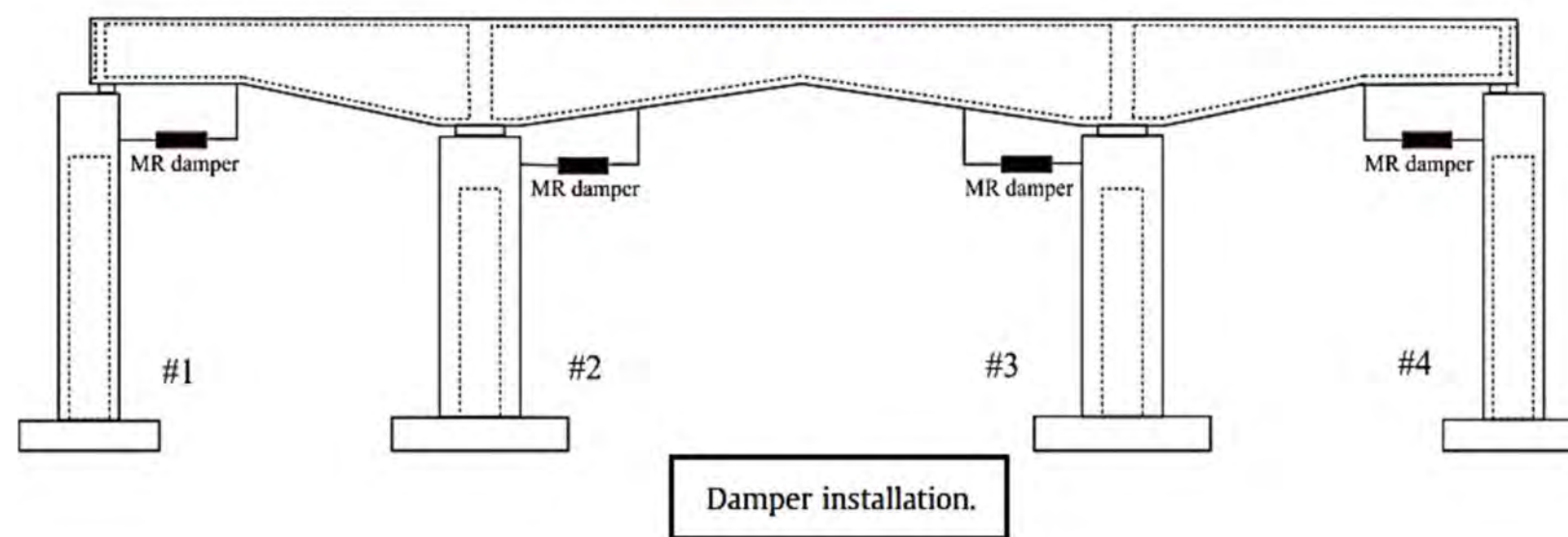
Today, using control algorithms, they control the amount of activity and forces entering the viscosity dampers and optimize the design and performance of seismic damping systems by using the seismic damping system as a control signal for the damping forces. Be. These control algorithms have different operating ranges, such as UNC, RTSD, PMR & PVD control algorithms.

The results of multiple numerical simulations, such as a bridge simulation, show that the method of using rheological magnetic dampers is more effective in protecting the bearing and base than passive controls. With more RTSD controls, the damage to the bearing and base can be balanced and limited damage to each base can be evenly spaced within the allowable range. In addition, the primary damper force can be adjusted over a wide range for RTSD control to prevent damage to the seismic separation system (damper) and base against various earthquakes.

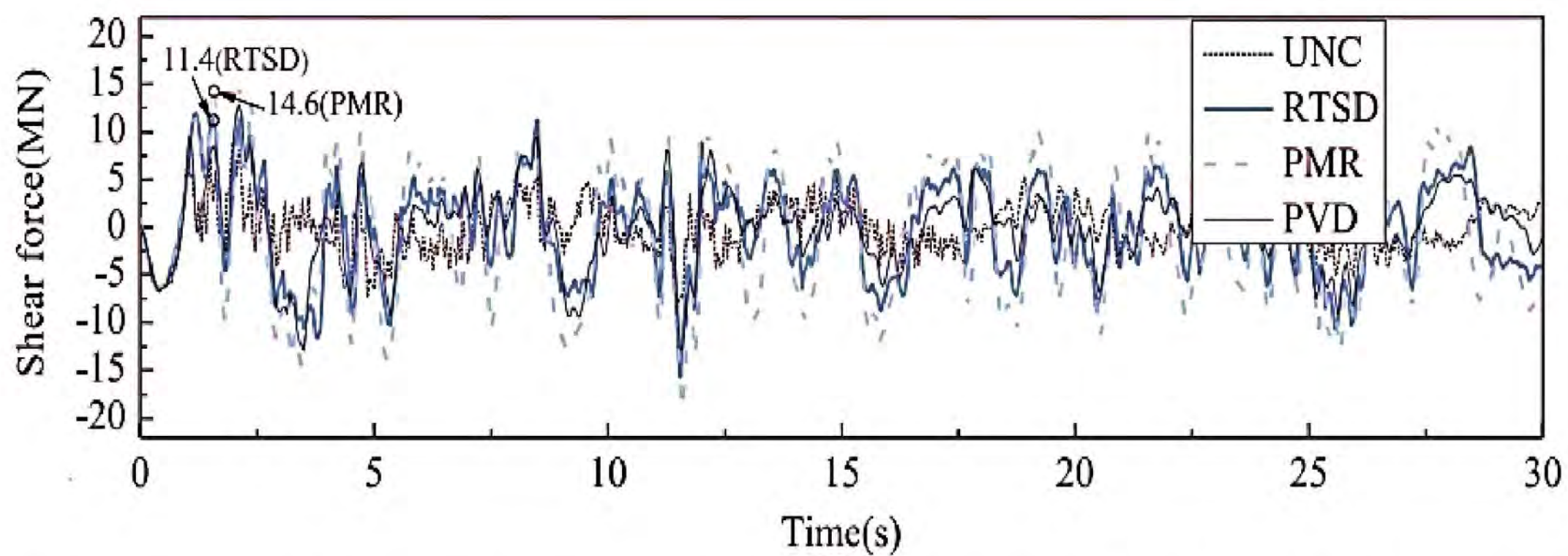


Configuration of viscous dampers.

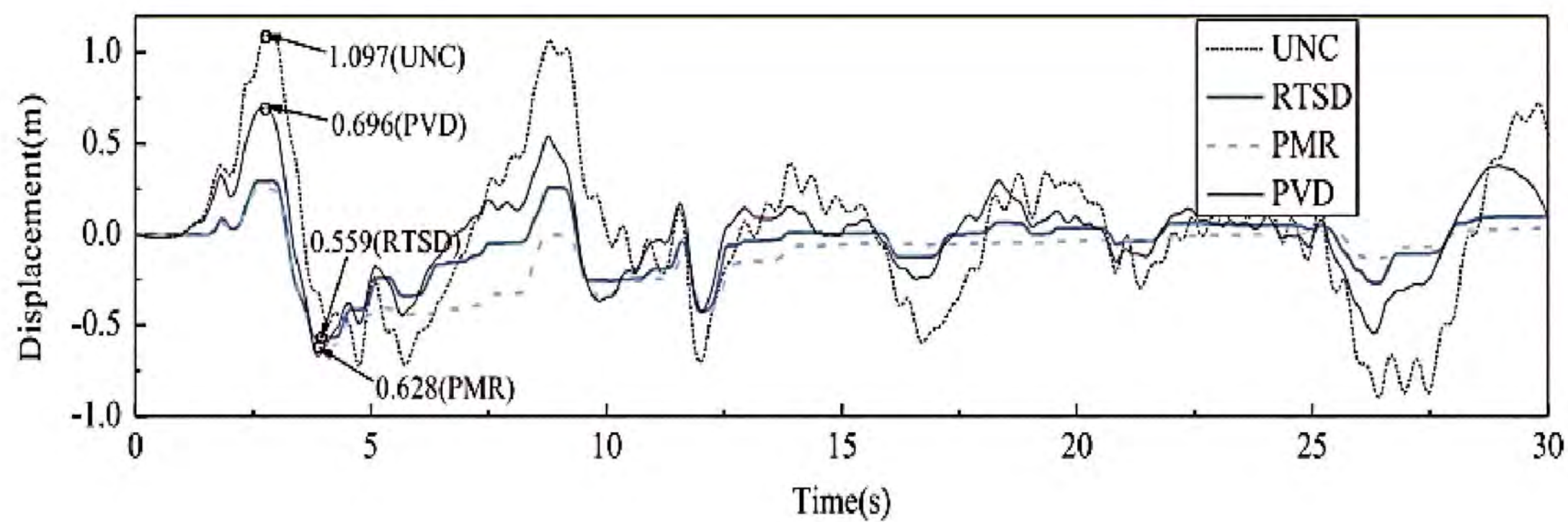
Figure 4



Changes related to the use of different control algorithms can be seen in the time and displacement curves.



Also, changes related to the use of different control algorithms in the shear force curve based on the structure and time can be seen.



conclusion:

Today, due to the importance of preventing human and financial damage to earthquakes that threaten human life and safety, the need to pay attention to the use of seismic dampers in buildings is an inescapable point that due to scientific advances and the growing use of This almost emerging technology has made it possible to use these seismic damping systems in all areas of the construction industry. This type of earthquake damping systems used that will be designed and implemented efficiently.

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Next Artical Is:

“Introducing different types of structural roofs”

Written by En. Zahra Rasoulpour



“Introducing different types of structural roofs”



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Introduction:

The roof is the most important covering of the house that gives a beautiful effect to the house. Today, roofs and roofs are made to be more durable and resistant to fire, earthquake, and other damage. Also, the ceilings have a higher variety of designs and are made of different materials. The roof is the upper level of a room or a structure. In single-story buildings, the roof is used to protect from sunlight, cold, rain and snow, and in multi-storey buildings, in addition, it is used to separate the floors from each other, so that the roof is considered another ground. In cold regions, the height of the ceiling to the floor is usually low to heat the place more easily, and in tropical regions, due to the flow of air, the ceiling height is generally considered higher.

Types of roofs:

1. Multiplicative arch roof
2. Clay, cement and foam block joist roof

3. Chromite beam roof
4. Composite roofing
5. Steel deck roof
6. Concrete slab roof
7. Beam-slab roof
8. Waffle Roof
9. Wall and Knauf ceiling

Multiplicative arch roof:

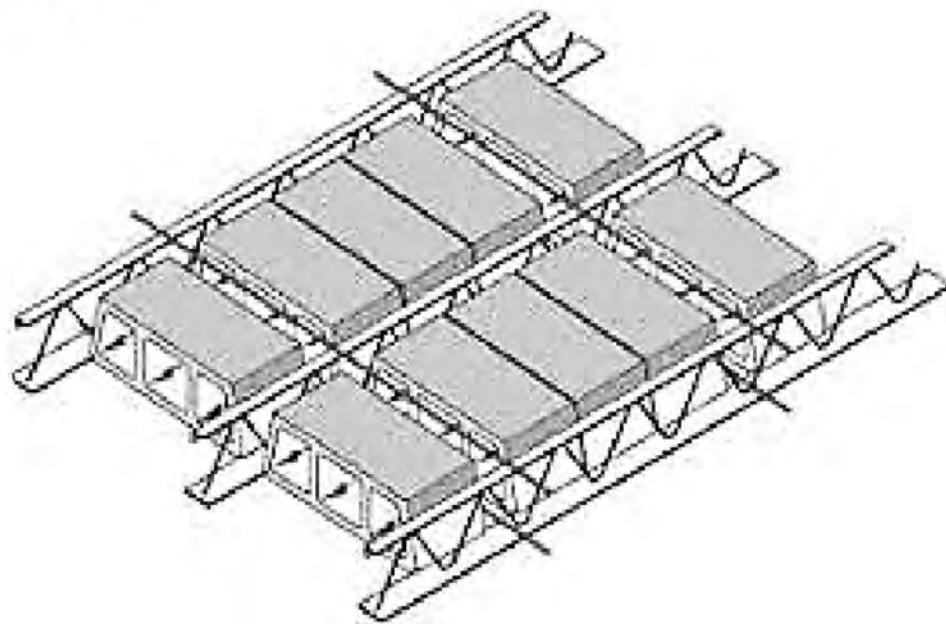
This type of roof was widely used in recent years, which was used for the following reasons:

1. High execution speed
2. Availability of materials
3. No need for high performance expertise

The multiplicative arch system is one of the oldest and most traditional types of common roofs in the country. In order to implement this roof, parallel beams are installed parallel to and parallel to the bridges between two parallel beams, which is called a bridge.

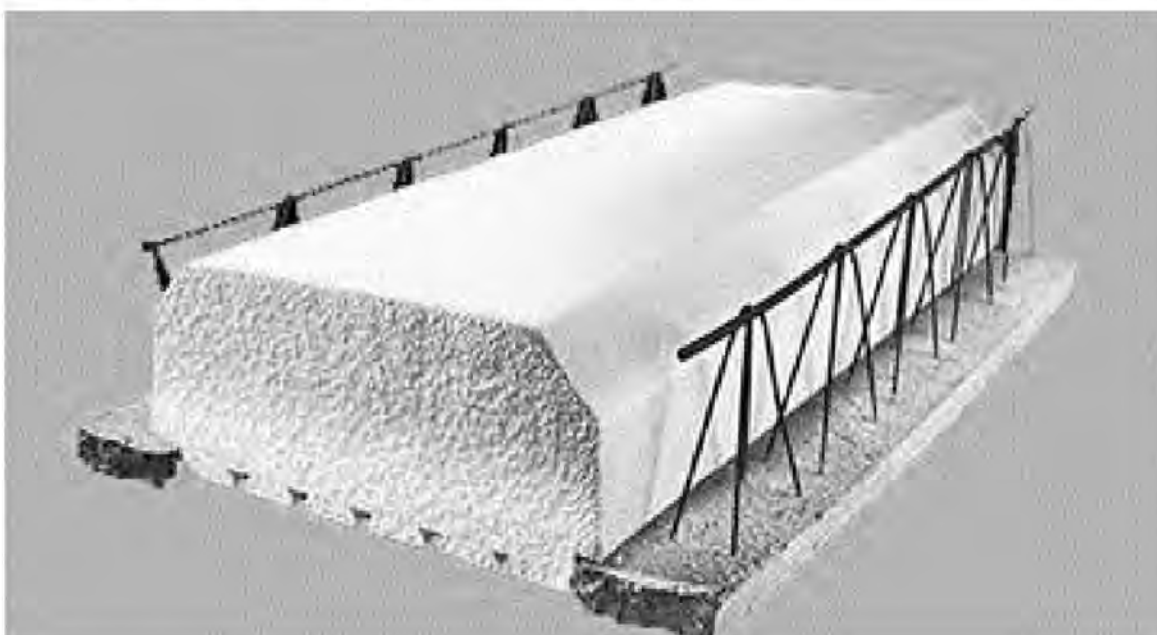
In some cities of Iran, such as Yazd, multiplicative arches with a high rise of about a semicircle are performed on openings up to about 6 meters. In recent decades, due to the weakness of this type of roof during earthquakes and its insecurity, new roof systems such as beam and block roofs have replaced this type of roof. It is not suitable to use multiplicative arches in large and multi-story buildings.

Clay, cement and foam block joist roof:



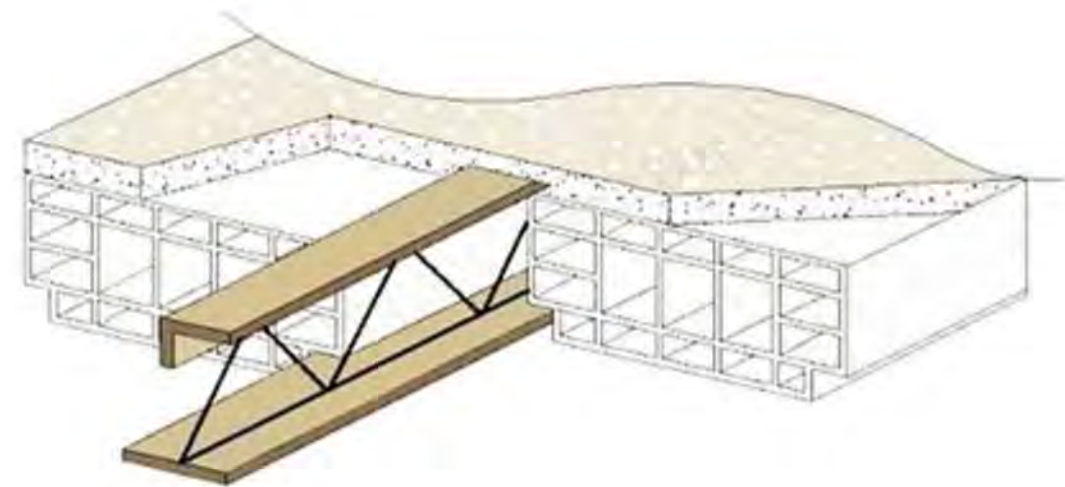
Block joist roofs consist of joists, lightweight cement blocks or clay blocks. Block joist roofs are divided into two general categories: concrete joists, or steel joists.

However, each of these types of roofs varies in terms of executive details and consumption blocks, such as roofs with concrete blocks, clay blocks, polystyrene blocks, etc.

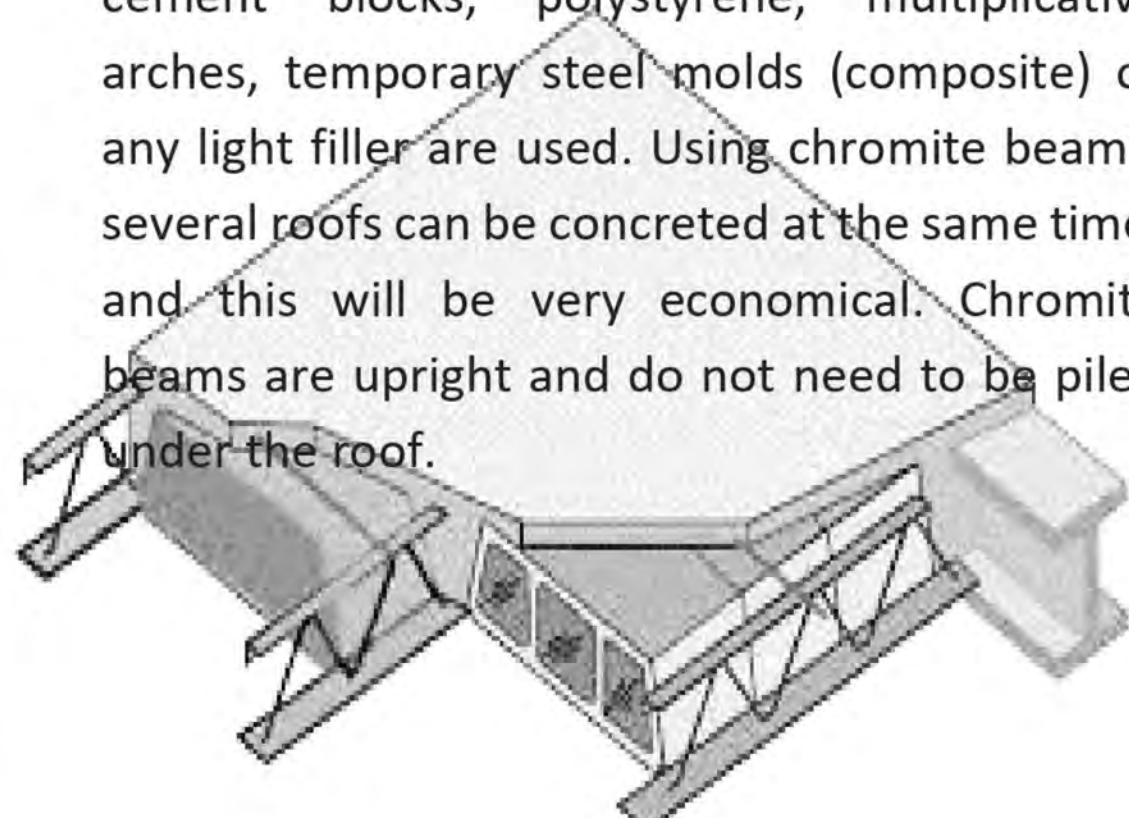


We know that all building materials except steel cannot withstand tensile forces. In this case, the presence of concrete or any other member, in addition to not helping to withstand the forces, but raises the dead load of the roof or slab, which must be supported by more steel. Thus, in the beam roofs of the concrete block, the tensile zone is removed and only the amount of concrete that should accommodate the tensile steels is retained. The removal of tensile concrete in block beam roofs that are replaced by blocks has made this type of roof very economical.

Chromite beam roof:



Chromite roof system Open beams are used in combination with concrete. In the construction of beams, a belt is used, in the lower wing, as well as a bent rebar in the core. To fill the empty space between the beams, fixed molds such as cement blocks, polystyrene, multiplicative arches, temporary steel molds (composite) or any light filler are used. Using chromite beams, several roofs can be concreted at the same time, and this will be very economical. Chromite beams are upright and do not need to be piled under the roof.



Chromite roof components:

1. Open beam steel beam
2. Thermal rebar
3. Fill block
4. Transverse coil
5. Concrete surface

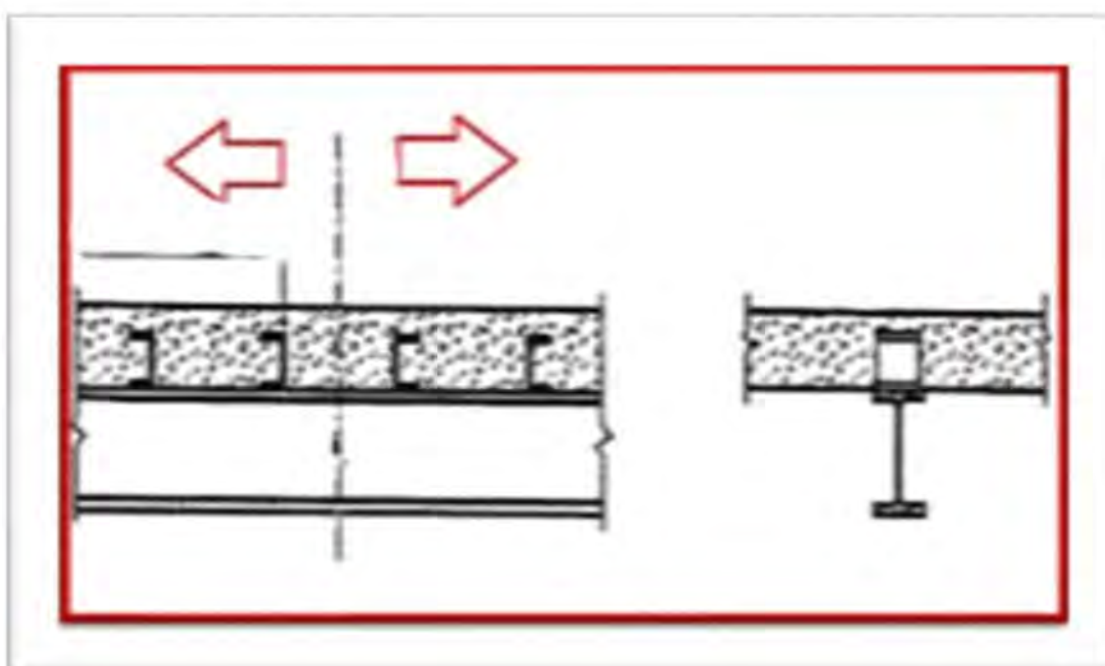


Composite roofing:

Its components include sub-beams (honeycomb-profile), shear, concrete and thermal reinforcement. This type of roof can only be applied to metal structures. Since composite roofing does not require piling, it is possible to concrete several roofs at the same time. In composite ceilings, formwork boards or sheets should not be returned prematurely in any way. In general, there is no ionolite in composite ceilings, so in the joinery stage, in order to have a uniform level under the ceilings, then the entire area under the ceiling must be done using rabbits or false ceilings. (It is not necessary to do this in the basement. It can be left exposed

The role of cutters along the side beams is used for connection and integration of beams and concrete slabs. For metal deck roofs, the cutter is a stud type and connects the cover sheets to the side beams. For composite roofs, the cutters are studs, although some also use corner pieces instead of studs, which is not recommended. In the tenth article, the executive rules of cutters and studs are given on the side beams. If we divide the beam into two parts from the middle, the dowels should sit on the beam so that it is on the outside of the beam on each side. This clause is sometimes neglected.

Composite roof cutters:



Steel deck roofs:

There are roofs that are distinguished from other roofs by using trapezoidal galvanized steel sheets and cutters that are used in this type of roofs, and of course, this type of roof is executed by using reinforcement and concreting on this steel sheet. One of the main parts of composite steel deck roofs is the required side beams among the main beams of the structure. The height of steel decks should be between 5 and 7.5 cm.

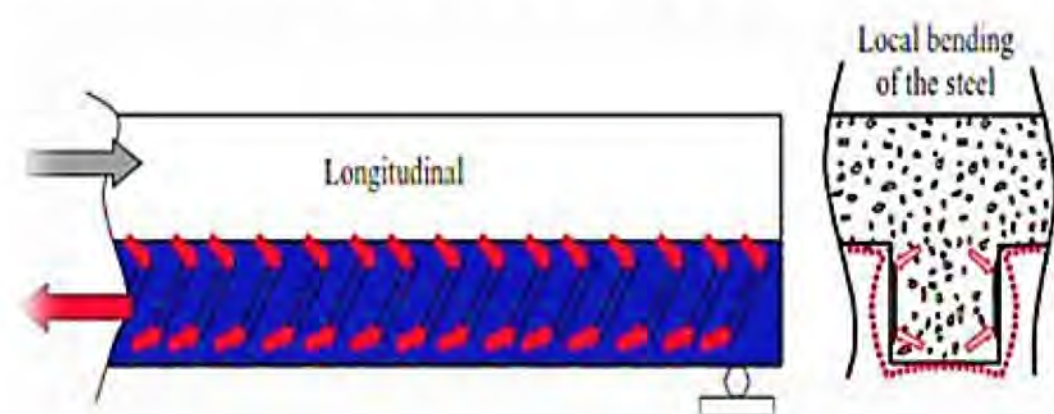
Non-composite steel deck:

These types of decks are only used as concrete slab formwork on roofs. These decks have no tread or have a weak tread. Therefore, they do not have a composite behavior with the concrete slab and the concrete slab is designed in a conventional way, and therefore tensile reinforcement should be used in the lower section of the steel deck to strengthen the concrete slab.



Composite steel deck:

This type of deck is the most complete type of deck in terms of load-bearing capacity and performance. These decks have various treads and protrusions in their body, so they work in combination with concrete slabs, and in addition to having the efficiency of non-composite decks, the most important advantage is the use of the deck in the role of lower tensile reinforcement. This distinctive feature is due to the presence of bumps or treads on the decks. The role of the treads is the mechanical connection between the slab and the deck according to the figure below to withstand the shear force, the connection between the slab and the steel deck.



Concrete slab roof:

One of the most common types of roofs is concrete slabs that are used in roofs, floors and foundations and withstand normal loads on the surface and have a thickness of 5 to 10 cm. In this type of roof, the floor load is first transferred to the beam and then to the column.

This type of roof is less used due to its high weight and low execution speed, as well as its higher cost. In some buildings that are of great importance, such as buildings located in power plants or large industrial centers, the concrete slab roof system is used. Components. This is a reinforced concrete roof. Slab is basically divided into two categories of one-sided and two-sided slabs, and the difference between these two types of slabs is in the amount and direction of their reinforcements. The factor that distinguishes one-sided slab from two-sided slab is the ratio of its size to its width.

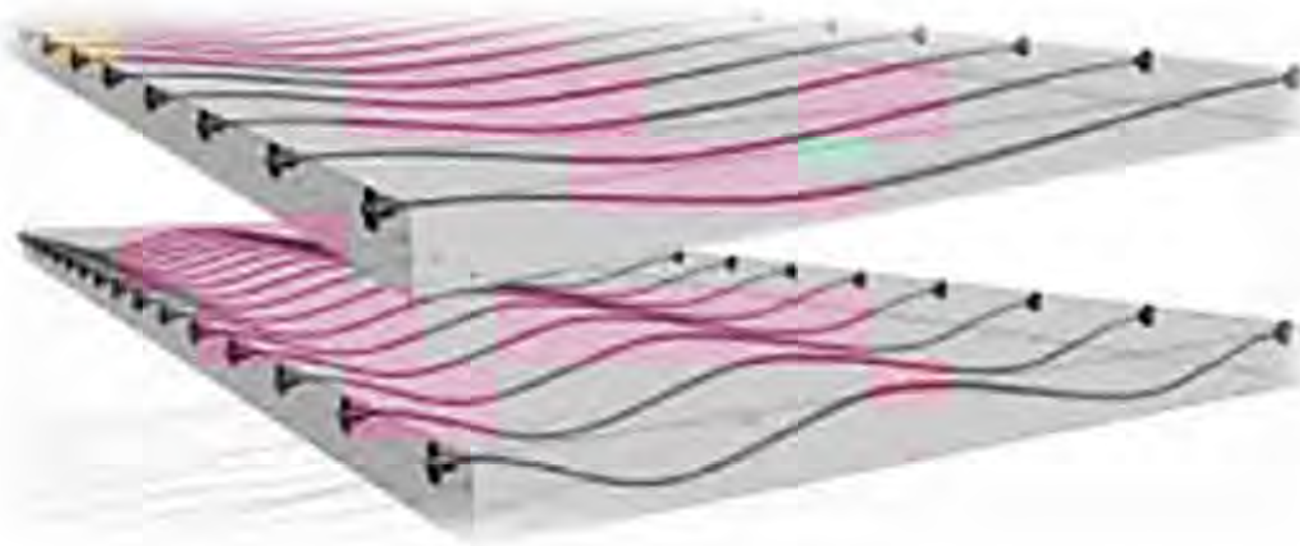
Beam-slab roof:

The difference between these roofs and composite roofs is that the side beams are concrete. Beam-slab roof is executed in concrete frame and in prefabricated metal frame. The prefabricated beam-slab roof is called a double T because its cross section is similar to the two English letters T next to each other. Slab contraction joints should intersect at the openings for columns, and should intersect at the openings for columns. Slab contraction joints should intersect at the openings for columns and should intersect at the openings for columns. It is necessary to remain.

Prestressed roof:

This type of roof is the newest roof that has entered the Iranian construction industry. In prestressed roof using cable and how it is placed in the concrete slab of the roof, an initial compressive force is created in the tensile area of the concrete slab before the operation of the

structure so that this tensile zone does not crack after the operation of the structure. From the maximum Use the bearing capacity of concrete and reduce the dimensions and dimensions accordingly. One of the main advantages of using a prestressed roof is that it allows the structure to be executed with a smaller number of columns than other roofs. This issue is very effective in discussing the architecture of the building and also providing parking. This advantage causes some builders Despite the high cost of implementing pre-stretched roofs, still use this roof system.



Easy Slab light roof (plastic mold of waffle roof and in-place joists):

Light roof is one of the most important pillars of the structure in styling. So that in the near future it will replace the majority of common ceilings. EASY SALB templates have a very strong design. In such a way that it can withstand several times the design load. Also, in the type of materials used, an advanced composite polymer is used, which in any conditions, water and Air to have the necessary efficiency. The roof of EASY SALB structures is the strongest, safest, most optimal, fastest, lightest and most economical roof available compared to similar concrete roofs such as block beams, ionolite, chromite, composite, metal deck, balloon, ball and. Some of the advantages of this type of waffle roof is

that in a very short time, the roof of the beam can be molded and reinforced in place and executed in place without the need for beams and blocks (concrete, pottery and ionolite). In this method, pumice will also be removed by passing the installation pipes through the roof.

Waffle Roof:

They are a kind of lattice roof. This type of roof, which acts as a double-sided slab, has a relatively lower implementation cost compared to the conventional methods of hollow slab roofs, such as Cubiax, Uboot, and also much lower cost than steel deck structures and block joists. This type of roof does not need reinforcing bars and their connection to the beams, so it can have less execution time.

The formwork system of this type of slab is pot and this roof has less weight than other slabs. This type of slab is suitable for covering wide openings and because it is two-sided, it has a support on all four sides. Of course, this type of roof has a one-sided type or in other words, one-sided slab, which can be used instead of block joists, which reduces the cost due to the removal of foam.

False ceilings:

To heat and cool the building, energy must be saved, which is one of the most important points in construction. Double glazing the roof saves energy and largely prevents it from being wasted. If a roof is created under the main roof or the same as the load-bearing roof, it is called a false roof, which has the following characteristics:

- Reduce the height of the building in some parts of it, such as baths
- Secret passage of utility channels
- Suitable sound and heat insulation
- Avoid seeing some structures in the building, such as trusses, which are not particularly beautiful

In the implementation and creation of false ceilings, care must be taken that these ceilings are made with low weight and lightness, and the more delicate the execution, the more it will add to its beauty. Because these roofs have no bearing properties and cannot withstand any force. In the following, we will refer to the types of these ceilings and the materials used in false ceilings. Wooden false ceiling, brick false ceiling, Kantex false ceiling, Rabitz false ceiling, acoustic false ceiling, false ceiling covered with prefabricated gypsum parts, fabrication of false ceiling using sheets such as aluminum and fiberglass.

Easy Slab style false ceiling:

In this roof, after the installation of installation pipes, the false roof can be installed Rabitz, Knauf, PVC and roofs can also be installed in this roof. But the Iranian house group has invented a false ceiling, which is very light and cost-effective in terms of styling, and combines a special type of plaster, additives, polymer fibers and mesh that eliminates sound, delays in fire, moisture resistance and without debris in an earthquake and can easily be installed with glue or building materials between the beams and level with them, and will cause a two-way collision of the false roof with the roof.

This connection is very strong and this false ceiling will never be separated from the main

ceiling and it will be installed on it with white plaster without the need for plaster and soil. It is also possible to install patterned panels on these ceilings.

Composite style roof:

Lightweight composite roof LCP roof is a combination of steel and lightweight concrete (Light Composite Panel). This roof has a composite function and is fully prefabricated in the production factory and after being transported to the project site, it is connected to the main or secondary beams of the structure with welded or mechanical connections. The weight of each square meter of this roof is approximately 80 kg. The composite roof is a roof ready to be installed. These panels are produced in width of 62 cm and length of 4 meters and height varying from 14 to 20 cm. On both sides of the end and the beginning of the panel, studs resulting from bending the sheet in a thickness of 3 mm (in the form of brackets or U) are installed.

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Next Artical Is:

"Smart Concrete"

Written by En. Mir Shahriyar Hashemi Zonouzi

“Smart Concrete”



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Introduction:

From the past to the present, several materials are used in the construction industry, each of which has its own characteristics.

Building materials that were traditionally produced in the past did not have the capabilities and benefits of today's materials because technology has reached its highest level over time and the products used recently are outstanding in terms of performance and longevity.

The materials used in construction projects must be of high quality and durable so that they do not react to environmental factors and remain undamaged for years. Fortunately, with the advancement of science and the innovations that have taken place, quality materials can be used with ease in construction, road construction, bridge construction, and so on.

Since the production of Portland cement in 1824, concrete has been most used in construction. Concrete materials in the construction of infrastructure due to low cost, high compressive strength and extensive compatibility of concrete with different climatic conditions has led to the

widespread use of concrete. However, due to the semi-brittle nature of concrete, mechanical properties in terms of toughness, tensile strength and impact resistance are the weaknesses of concrete. However, the presence of raw materials and strength in different environmental conditions leads to the reliability of concrete. Things that challenge concrete include increased load, temperature, humidity and other factors that cause cracks and damage to the concrete. After a series of structural damage to structures caused by materials in the 1970s and 1980s, researchers realized the safety and reliability of the structures. Catastrophic events are reduced if the materials have the capacity to be self-sensor, self-adjusting and self-healing. Since then, intelligent materials, defined as materials, have been developed with reasonable operation and controllable by changes in the environment.

materials intelligent:

There are materials that can adapt to environmental changes. These materials are flexible against the physical and chemical effects of the environment. One or more properties of these materials, such as their shape, hardness,

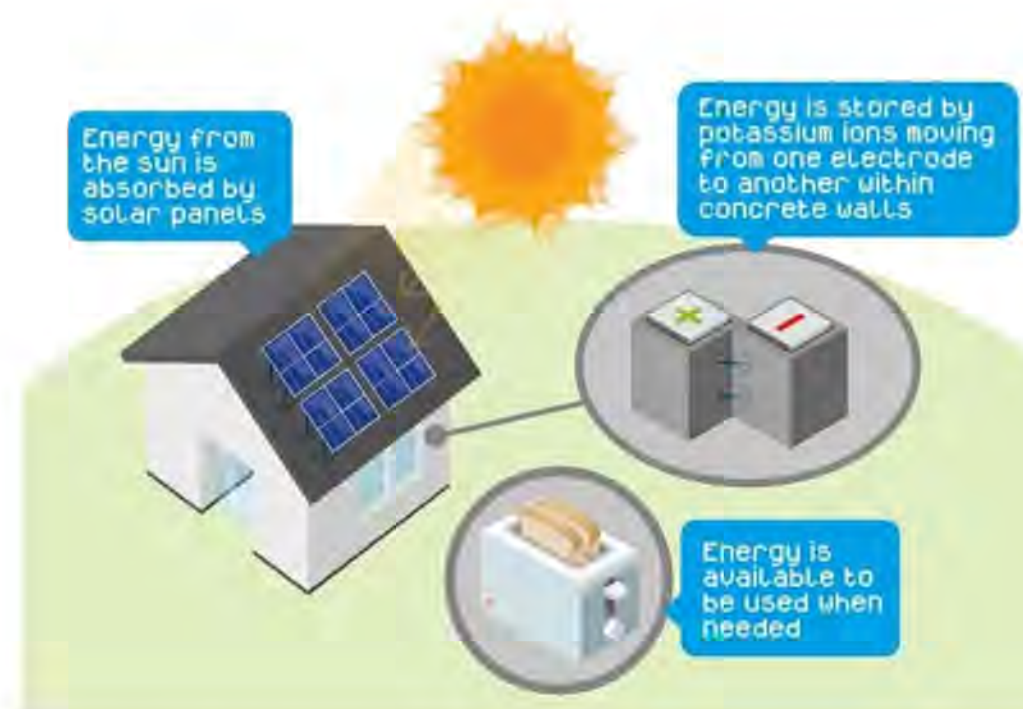
frequency, and color, change significantly in a controlled state or under the influence of an electric force or magnetic fields. They have the ability to perceive and react to environmental events and changes. These materials react against UV rays, magnetic field, pressure, temperature, chemical environment and so on and change their properties according to that stimulus and adapt to that environment.

One of the smart materials that has a very special and vital place in construction is concrete. This material plays a very important role in determining the strength and strength of the structure and if it is of high quality, it will remain undamaged for years.

It should be noted that Scientists have developed a new type of concrete that is infused with potassium ions, which allow it to store electricity for long periods of time. When energy production levels drop, the concrete would kick in and power a house using the reserve stock of energy it has saved up. This would mean that the walls of your family home could soon double-up as a battery, storing energy in its blocks.

'We have a lot of buildings. If you could convert them into batteries, it would pretty much solve a lot of our energy problems. The idea is to store electricity in the structure itself and release it at times of peak demand,' said Mohamed Saafi, from Lancaster University's engineering department, who developed the technology.

Professor Saafi notes that capacitors hold less energy by volume than batteries, but there is far more volume available if the new form of concrete was to be widely used as a building material.



Smart concrete is the newest concrete that has unique advantages and guarantees the strength and longevity of the structure.

Properties of smart materials:

Smart or adaptable materials can be divided into smart and semi-smart. In intelligent materials, reversible physical and chemical changes occur in the face of physical or chemical stimuli. These changes in completely intelligent materials are infinitely reversible. If semi-intelligent materials have a limited ability to change the number of times, one stimulus can make several changes in matter, or several different stimuli can cause a particular change in matter. Major stimuli include changes in the chemical environment, magnetic and electric fields, pressure, heat, light, and ultraviolet light. The resulting changes cover a wide range of returns. Some of these changes are as follows.

1. Deformation, dimensions, surface and texture homogeneously or locally.
2. Alteration in electric current and generation of electricity, which is used, for example, in high-rise flooring to generate electricity.
3. Color change and transparency that is used to create privacy and close the space.
4. Noise change and annoying noise control
5. Production of pleasant odor due to external stimuli
6. Ability to modify, repair, strengthen and self-clean that are widely used in skyscrapers today.
7. Ability to absorb or diffuse a specific molecule, atom or substance in three states of matter,

which is especially used to reduce environmental pollution and produce desirable and essential materials such as air or water purification.

8. Possibility of energy exchange such as phase change materials that are used in the building shell to control the temperature of the indoor environment and these materials take heat from the environment and by changing the phase to liquid or gas, store it secretly and in When the ambient temperature decreases by returning the phase again, the heat is returned to the environment.

Application of smart materials:



One of the most important issues in the field of environmental sustainability is reducing the consumption of non-renewable resources and optimizing the consumption of renewable energy. Since buildings account for more than 40% of the total energy produced in the country, the environmental field of sustainable architecture is of great importance in the sustainable development of the country. On the other hand, due to the importance of building shells in controlling heat exchange between inside and outside the building, the materials used in them are very important in creating thermal comfort conditions in the building. Accordingly, one of the most important ways to achieve sustainable environmental architecture is to recognize new technologies and the benefits of using them to use materials that reduce energy consumption and provide optimal comfort for building occupants.

The importance of smart materials becomes clear when their role in creating more compatible systems is considered. These materials form the basis of the work of other

sensor systems, compatible and controlled. The ultimate goal is to make materials intelligent in nature. By creating the desired properties at the molecular level, it is possible to create intelligent cloud materials that are able to play the role of existing intelligent systems. An advanced intelligent building system can measure the effect of wind and earthquake loads in addition to controlling the safety system, load transfer, heating, air conditioning and HVAC, and use anti-vibration systems against external driving forces. With the supply of smart materials, it will provide new capabilities and facilities to engineers and designers. With recent advances in the field of creating suitable intelligent structures, the needs of today and the growing future must be kept in mind. One of the most important smart materials in the construction industry is concrete and smart glass used in buildings.

Smart concrete:



Smart concrete is malleable, flexible and self-healing. By adding polymer fibers and silica nanoparticles to ordinary concrete, it increases the tensile, flexural, shear, abrasion and self-healing strength of concrete. The use of polymer fibers and silica nanoparticles in concrete causes excellent cohesion and integrity.

Silica nanoparticles give a pozzolanic reaction to $\text{Ca}(\text{OH})_2$ calcium hydroxide crystals to form a dense, integrated and insoluble calcium hydroxide (C - S - H) gel. Due to its high specific surface area, nano-silica acts like a core and forms a very strong adhesion to hydrated

cement. Reduces the permeability, increases the strength, durability and useful life of concrete structures. Due to the weather, the fine cracks and pores of the concrete cap, self-healing and damaged concrete regains its strength.

This smart concrete has a high resistance against SECC (severe premature decay of composite cement). Researchers have estimated its lifespan to be 120 years compared to conventional concrete, which is about 40-50 years.

This type of concrete is more expensive than ordinary concrete, this concrete is mainly used in areas where there is more damage, such as bridge construction. Researchers are trying to use smart concrete in the future, both in transportation and in nuclear power plants.

It is also a kind of artificial stone made of cement, water and aggregate that is widely used in the construction industry today.

This material is one of the most widely used materials in the world. Ordinary concrete is brittle and brittle, and if pressure and earthquake force are applied, it will crack and cause the structure to collapse.

Today, with the advancement of technology, a type of concrete called smart concrete has been made, which has unique capabilities and features and has a very high resistance against ordinary concrete.

Smart concrete is a new generation of structural materials created from carbon fiber reinforced concrete (CFRC) in the 2000s and 2010s using strength forecasting to measure pressure. Smart concrete is a very wide range of materials, including self-measuring concrete, self-leveling concrete and self-regulating concrete, etc. (By adding these materials to ordinary concrete, its tensile wear flexural strength increases).

The smart concrete has excellent mechanical properties, long durability and easy

maintenance. Also, the use of smart concrete is expanding day by day and due to the durability and mechanical properties required in special conditions, a wide horizon in civil infrastructure such as: high-rise buildings, highways, bridges, airport runways, Dams and nuclear power plants are open.

- This material is a smart choice to maintain sustainable development in concrete materials and structures that can have a beneficial impact on the economy, society and the environment.

The initial process of making smart concrete is shown in Figure 1.



Intelligent concrete information processes include simulation, cleaning, analysis, judgment and operation. Extensive research has been done on various smart concretes to date. The composition, manufacturing process, mechanism, measurement and application of smart concrete have been extensively researched by experimental study, theoretical analysis and numerical simulation.

Application of nanotechnology in the manufacture of smart concrete in the construction industry:

Nanotechnology has entered with a new perspective of producing nanoscale materials with special and different atomic arrangements to achieve special properties in various fields, including the construction industry. So far, nanotechnologies in the construction industry and especially in the field of concrete technology such as the production of reinforced concrete with significant compressive and tensile strength, flexibility and resistance to chemical attacks, production of sensors and smart aggregates, antibacterial concrete coatings, self-

cleaning concrete surface Applicable, air purifier and self-healing property of concrete has been used. خود Concrete self-healing system (smart concrete) is a model of the body defense system of living organisms in repairing damaged parts so that concrete structures can identify and repair themselves after the damage with the help of materials such as biological samples. The use of such intelligent materials for important and sensitive structures such as space structures, underground structures or fluid storage tanks is very important due to the very limited and difficult access to the monitoring system and the high costs of repair and reinforcement.



Types of smart concrete:



Exothermic smart concrete

Another type of smart concrete is exothermic concrete, which actually refers to concrete that uses electric resistance heating method and joule effect.

This is why some call them all electrothermal batons.

This type of concrete is designed and made according to the latest technology in the world.

This type of concrete is equipped with temperature sensitive sensors and a kind of monitoring to control temperature and temperature changes in different conditions. Nanoparticles such as TiO_2 , Al_2O_3 , Fe_2O_3 and paraffin containing polymer nanocapsules and metal fibers are used in concrete to increase the heat transfer capacity of concrete and produce thermal energy.

Heated concrete is used to open roads, airport runways and bridges blocked by snow.

This type of concrete reduces the costs of snow removal and road maintenance, traffic in the cold season and accidents and financial losses and increases road safety. If you use this concrete, there is no need to salt the roads.

Explosion-proof smart concrete

The strength and compactness of smart explosion-proof concrete increases due to the severity of the impact. Explosive concrete is used in places such as petrochemicals, refineries, power plants and dams where structural protection is critical. This type of concrete shows a dynamic reflex when hit, and in the presence of impact, its tensile strength is increased 3 times the compressive strength, and its tolerance in the case of incendiary bombs is excellent.

Self-healing smart concrete

Any cracking in the concrete surface leads to the penetration of corrosive chemicals in structures that are in chemical environments. These cracks reduce the strength of the structure over time and lead to its destruction. Therefore, in order to control and repair various types of cracks, nanomaterials are added to concrete to enhance

its curability. Self-healing concrete is the best concrete for building structures in corrosive and chemical environments.

Self-healing concrete actually has the ability to repair and remove cracks that are mainly caused by low tensile strength in concrete.

The strength and stability of concrete are threatened by these cracks, which are a very good conduit for fluids and gases.

In addition to the structure of the concrete itself, if the cracks are not removed and their progress continues, it is likely that the concrete reinforcement will also suffer serious damage; Therefore, controlling the width and depth of these cracks as soon as possible is of particular importance.

Self-healing in concrete is a well-known phenomenon and is embedded in concrete in many different ways, one of the most common of which is spontaneous self-healing.

According to it, self-healing in concrete occurs due to hydration of clinker materials or calcium carbonate carbonation. However, the repair property of smart concrete is limited to small cracks and will only be effective in the presence of water.



Self-cleaning smart concrete

Due to its photocatalytic performance, this Nanoconcrete eliminates or reduces contaminants. This concrete is the best option

for building exposed structures, urban furniture and sidewalk flooring that are exposed to dust and air pollution.

When titanium dioxide nanoparticles are added to concrete, not only does its flexural and compressive strength increase, but its hydration rate increases and the concrete becomes self-cleaning.

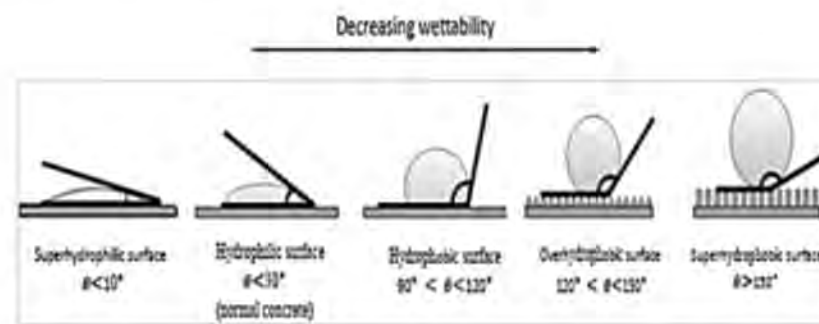
When photocatalysts are used inside or on a concrete structure, they decompose organic matter such as dirty stains including soot, oil, biological organisms including mold, algae, airborne contaminants, and even chemicals that cause odors.

The compounds produced by the decomposition of these pollutants are mainly beneficial to the environment or, at worst, have little negative impact on the environment.

Concrete is a self-cleaning concrete with the ability to resist getting wet by liquids or cleaning hazardous materials on the concrete surface itself. To obtain self-cleaning concrete, two strategies are commonly used: superhydrophobic and photocatalytic. Solids are divided into hydrophilic and hydrophobic according to the contact angle with water (WCA).

Angle contact is described as the angle between the solid surface and the tangent line of the liquid phase at the solid phase surface. For a contact angle of more than 90 degrees, the behavior appears hydrophobic, and a contact angle of less than 30 degrees can indicate a hydrophilic phenomenon. The superhydrophobic surfaces are hydrophobic (and superhydrophobic) hydrophilic, respectively, below the hydrophobic surfaces and the hydrophilic surface, respectively. Above hydrophobic levels are less than 10 degrees, as shown in the figure below. (In order from left: superhydrophobic surface, hydrophilic surface,

hydrophobic surface, hydrophobic surface, superhydrophobic surface)



Ordinary concrete is porous so it has the ability to absorb water, which is called hydrofolic. By adding some chemicals such as WAX, nanoparticles, oils and water-resistant polymers to concrete, a super-hydrophobic or super-hydrophobic and self-cleaning behavior is achieved.

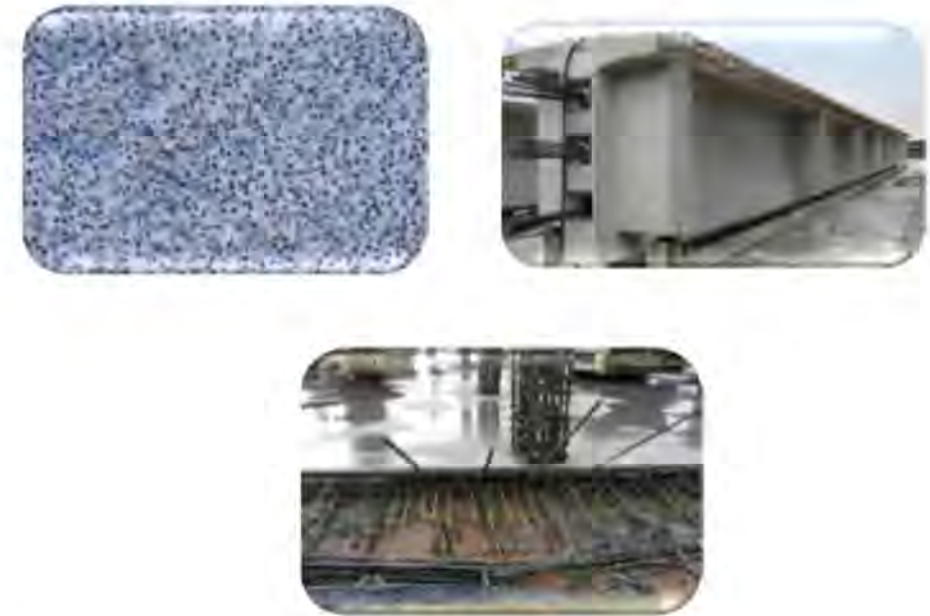
Self-adjusting concrete

Self-leveling concrete is another type of smart concrete. The self-adjusting property of these concretes means the ability of the concrete to respond appropriately to load or environmental changes. Self-regulating concretes also include different types, the most important of which are thermal self-regulating concretes, moisture self-regulating concretes and self-damping concretes.

Self-adjusting concretes reduce the damage caused by various accidents, increase the comfort and convenience of people who use structures made with this type of concretes, and improve the reliability and performance of the structure. Extensive applications for this type of smart concrete have been considered in civil engineering structures, especially for tall buildings, large bridges, high-speed railways and nuclear power plants.

Self-regulating concrete has the ability to regulate internal structures (such as pore structures (and performance) such as heat capacity, moisture content and hydration process (under external factors). And self-regulating concrete is hydration temperature. Self-leveling concrete has the ability to prevent

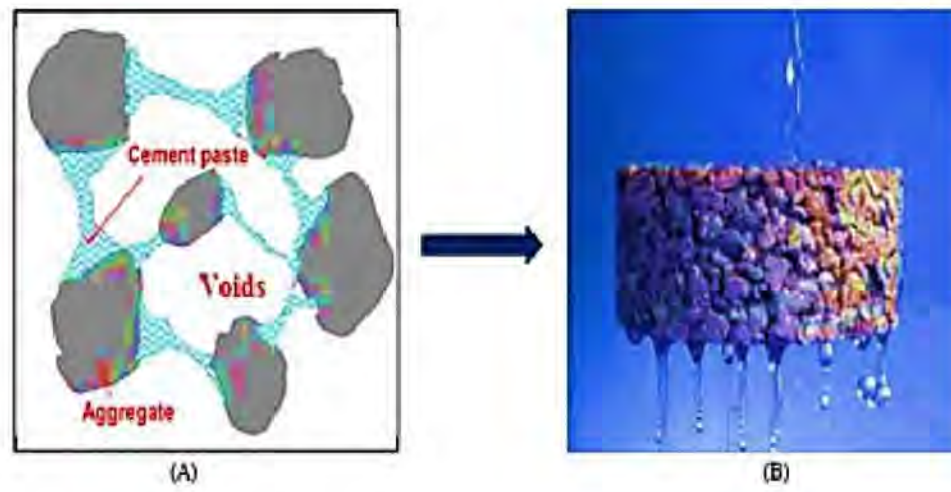
cracking due to heat hydration of cement. Research and applications of self-leveling concrete have attracted a lot of attention in recent years. Or every 45 kg of cement used, 5-9 degrees Celsius, depending on the type of cement, create heat.



Self-Draining Concrete

Concrete drainage is concrete that contains empty pores inside to allow air or water to flow through it. This type of concrete is also known as porous and permeable concrete. When self-draining concrete is used as paving material, it is easy for water to pass through the pavement matrix under the subsoil. Therefore, it is useful for conserving flood water and recharging groundwater. Drainage concrete itself is mainly formed by cement paste and uniform coarse aggregates. A model for the structure of self-draining concrete is shown in the figure below. Concrete structures are made of coarse materials and are bonded together with a limited amount of cement paste. Without the effect of filling fine materials, there is a large amount of open space between the large materials and the normal size of the holes is from 2 mm to 8 mm.

High permeability is the main goal in designing self-draining concrete. In several studies, it has been proven that with increasing porosity, the water permeability of concrete increases.



A: Self-draining concrete model

B: Schematic diagram of permeability



Self-drainage concrete permeability test

Self-compacting smart concrete

Self-compacting concrete is fresh concrete that has three characteristics: the ability to flow under its own weight, to fill the required space or mold completely and to create a dense and sufficiently homogeneous mixture without the need for simultaneous compaction operations.

The advantages of self-compacting concrete can be increase the speed of concreting and thus reduce the construction time and economic savings, especially in horizontal elements such as slabs, providing the possibility of concreting at night in urban areas, the possibility of constructing special concrete structures, such as concreting in Underwater pointed.

Special concrete, such as underwater concreting.

Self-compacting concrete or SCC is self-stabilizing and self-leveling concrete without the use of vibration. The SCC prototype was first created by Okamura in 1986. SCC has the advantages of high fluidity, without separation of aggregates and wetting phenomenon

compared to conventional concrete. Self-compacting concrete not only has a good ability to pass through the space between metal rebars, but also has the ability to compact under its own weight without vibrating. The difference between the SCC and ordinary concrete mix ratios is shown in Figure 3. To test whether the ratio of concrete mix is suitable, some test methods such as: U flow test method, box test method, V funnel test method and T500 test method were developed. In the U stream, the method for testing the height of concrete passing through a barrier is shown in Figure 4. If the concrete can flow from a height of more than 320 mm, the concrete can be considered SCC. The box test method is suitable for testing the separation between mortar and material. If the concrete has insufficient self-compaction, the ratio of concrete mix is adjusted again.

Self-Compacting Concrete				
Air	Water	Powder	Sand	Gravel
Air	Water	Cement	Sand	Gravel
Conventional Concrete				

Figure 3 - Difference between SCC and ordinary concrete mix ratios

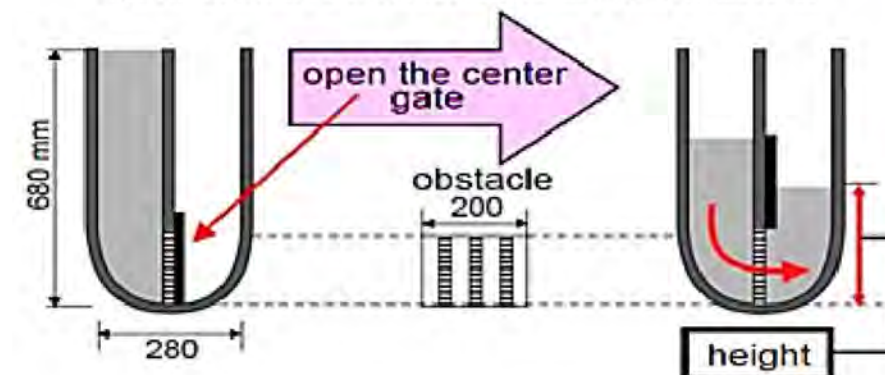


Figure 4 - U current test

The U-flow test method is shown in Figure 4, the height of the concrete that can cross the barrier indicates the density of the concrete. If the concrete can flow from a height of 320 mm, it is considered SCC concrete.



Self expanding concrete

Volumetric shrinkage occurs during hydration and hardening of Portland cement concrete. Microcracking occurs as a result of this shrinkage in hardened concrete. In contrast to conventional concrete, expansion occurs instead of shrinkage in self-expanding concrete. Hence, defects due to contraction can be overcome by expansion. Typically, self-expanding concrete is divided into two types: shrinkage compensating concrete and self-stressing concrete, which is based on expansion energy. Concrete Shrinkage Concrete is concrete that expands to prevent cracking. Compared to shrinkage compensation concrete, stress concrete has a higher expansion capacity and can exert a compressive stress of 2-8 MPa when the expansion of the concrete is inhibited by reinforcement or other factors. Expandable concrete can be produced using expandable compounds such as cements or expandable additives. The ability to expand largely depends on the consumption and activity of the expanding compounds. Detailed information on various cements and expandable additives is summarized in Table 2. By mixing minerals with Portland cement during the clinker production process, expanded cement is produced and identified by ASTM according to different main minerals with three types namely (K, M and S). On the other hand, due to the easy adjustment of the expansion capacity, the expansion minerals have been introduced separately.

مواد منبسط شونده	نوع	معدن اصلی	منابع انبساط
سیمان منبسط شونده	K	منو سولفات، جیپسوم، آهک	ایترینگایت
	M	کلینگر آلومینات و جیپسوم	ایترینگایت
	S	تری کلسیم آلومینات و جیپسوم	ایترینگایت
مواد افزودنی منبسط شونده	اساس سولفو آلومینات	سولفو آلومینات	ایترینگایت
	کلسیم CaO	کلسیا	پرتلندیت
	اساس MgO	مگنیزیا	پروسایت
	هوازا	آهن یا پودر آلومینیوم	هیدروژن، فروهیدرواکسید

Table 2 - Summary of cement and expandable additive

Intrings are needle-shaped crystals that form during cement clinker and are commonly referred to as calcium sulfoaluminate hydrate. Self-expanding concrete is a suitable alternative to improve the behavior of concrete structures. However, the expansion of concrete due to the formation of enterite produces a lot of water and strongly requires more curing. Recently, synthetic and bonded fibers with MgO and MEA expansion additive were used in the construction of the runway at Tibet Airport in China. The results show that the expansion of concrete decreases with increasing steel fibers and SP fibers, as seen in Figure 5a, increasing the volumetric stability of the concrete slab at an early age. Scanning electron microscopy of SEM Figure 5b shows that microcracks are inhibited by hybrid fibers.

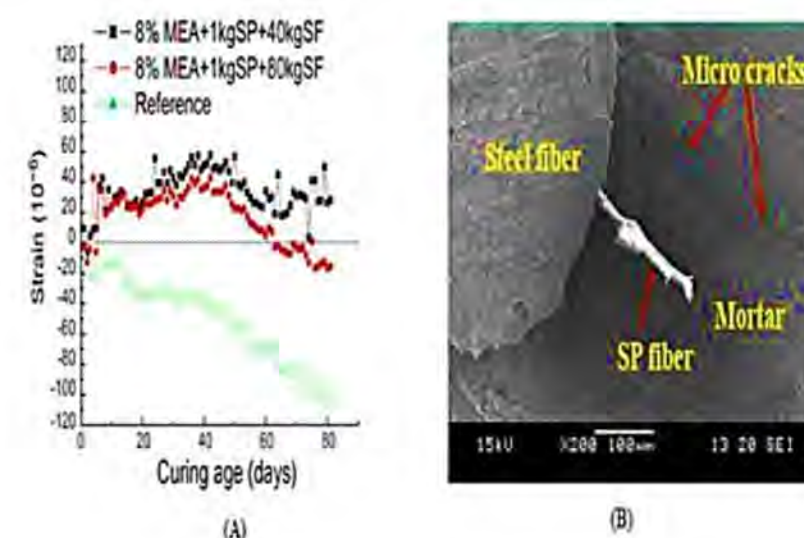


Figure 5: A strain deformation of concrete with hybrid fibers B microstructure of fibers|Hybrid in concrete

Self-curing concrete

Immediately after pouring the concrete, it is necessary to cure the concrete. Due to the possible shrinkage and thermal deformation at a young age, the concrete must be properly cured or prepared. For curing required mechanical properties and durability of traditional pouring methods such as dewatering, spraying and water spraying, wet sacking or plastic films are sufficient for ordinary concrete. However, these curing techniques may not be effective in high performance concrete (HPC).

HPC is made with a low ratio (w / b) and materials such as silica fume, which leads to increased resistance and density at a young age in these conditions, the usual curing method is not suitable and prevents the penetration of external curing water and is only superficial. As a result, not enough water is available to fully hydrate the binder. A series of chemical shrinkage causes excessive and premature cracking. This premature cracking eventually destroys the mechanical properties and durability of the concrete. Currently LWA light sand curing materials such as pumice and SAP super absorbent polymers. SAP has a water absorption capacity of up to 1000 times its own weight. Figure 6

Cure self-concretes have received special attention in the last half century, and most research is based on the Powers model, as shown in Figure 7. The model systematically minimizes the amount of water required to achieve the maximum limit of hydration of the binder. (α_{max}) to achieve the maximum degree in a given w / b .



Figure 6 - Dry and swollen sap

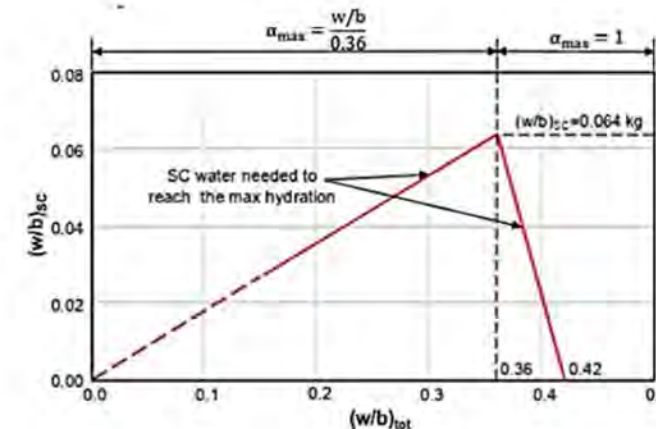


Figure 7. The minimum amount of water the cure itself to obtain the maximum α during Cement hydration

As shown in Figure 7, when α_{max} reaches region 1 (ie, complete hydration of the binder) a w / b equal to or greater than 0.36 is obtained. Below this value, binder hydration is only partially achieved and α_{max} at saturation is estimated to be $(w / b) / 0.36$. Figure 7 also shows the fully saturated state.

Binder hydration can be achieved with a small amount of water. Cure water is suitable for 0.064 kg per kg of binder. As mentioned earlier in HPC concrete, w / b is generally between 0.03 and 0.04. Harmful deformation due to autogenic contraction can be eliminated through curing technology. Here, HPC with a w / b of 0.03 is used as an example to illustrate the case. The effect of the self-curing agent on HPC performance based on the Powers Powers model is presented.

Cure self concrete with well-designed mechanical properties is well designed and extremely durable and has been used in engineering applications. In January 2005, approximately 190,000 cubic meters of self-cured HPC with LWA presoaked was successfully concreted on a large section of the Texas Railroad Transit Site. After replacement due to the development of the cement hydration process, the flexural strength reached 90% to

100% of the 28-day strength in 7 days. In addition, they had much less shrinkage cracks compared to conventional concreting.

Concrete sensor itself

Self-sensor concrete, also called self-sensing or self-reporter concrete, is another widely used type of smart concrete and refers to concrete that has its own stage capacity (stress, strain, damage or heat) without the need to install sensors. Connected or remotely specified. The concrete of the sensor itself can monitor itself without the need to place or connect the sensor or remote control. Compared to conventional structural materials that require additional sensors for monitoring or tracking, the concrete of the sensor itself has received much attention for reasons such as high sensitivity, good mechanical properties, natural compatibility, and easy installation and maintenance.

Sensor concrete itself can be used to check structural health, traffic tracking and border and military security. The materials used in the concrete construction of the sensor are divided into three categories: matrix or background, filler or filler and materials that help to disperse (to indicate the amount and degree of dispersion) of the filler.

One of the most important smart materials in the construction industry is concrete and smart glass used in buildings.

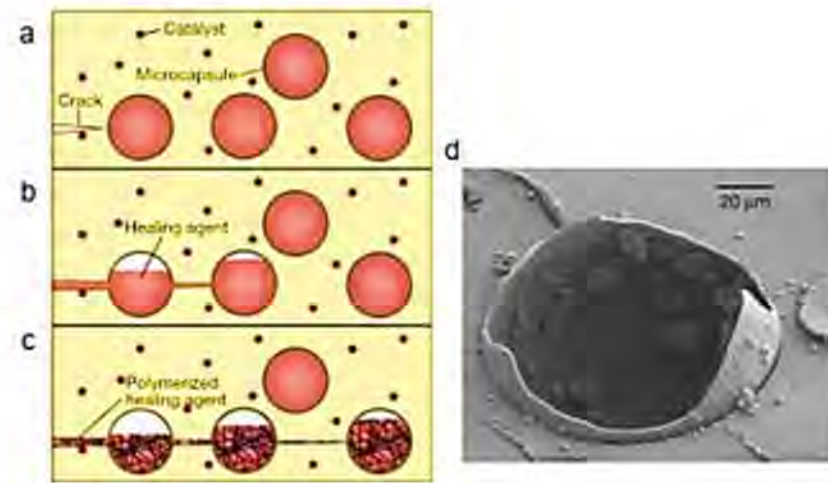
Autogenous

Autogenous self-healing concrete is defined as self-sealing concrete without external supervision or human intervention. Due to continuous hydration of clinker minerals or carbonation of calcium hydroxide [$Ca(OH)_2$], concrete cracks may occur. Self-healing concrete is a combination of complex chemical, physical

and mechanical interactions. Concrete is mainly under constant hydration of cement in the early ages, while in later ages it is more concerned with the formation of calcium carbonate ($CaCO_3$) for Each of the self-healing concrete (autogenous), due to the important role of water in creating a chemical reaction and carrying soft and fine particles in the concrete, the presence of water is necessary. If the crack width is limited, self-healing concrete repair can be more effective. Self-healing concrete is able to complete cracks up to a maximum of 50 microns, and up to 150 microns of self-healing concrete cracks can provide some mechanical properties.

Autonomous

Self-healing concrete has a circular container or capsule that is replaced in the concrete. These containers contain self-healing materials, and when cracks develop in the concrete, they break the container of the repairing material and react. The repair process can be divided into two stages as shown in the figure below. Then a chemical reaction takes place between the restorative material and the concrete to connect the cracked surfaces together and deform the crack tip. When crack development stops, the properties of the material such as stiffness, toughness and strength improve. For the microcapsule method, the system is simple and the capsules are dispersed inside the matrix. Self-healing concrete is not more reliable and environmentally friendly than autogenous self-healing concrete. Although independent remediation itself seems to be a potentially great approach, extending the idea from research to use remains a major challenge. Self-healing largely consists of three parts: a) a hollow tube or tube, a microcapsule, and a microorganism. The tube is made of brittle material that can easily release a restorative material into the concrete.



The main method of the microcapsule approach. a) cracks in the matrix;
b) Rupture of microcapsules releasing the repair material into the capillary cavities of the concrete
c) The repairable agent contacts the catalyst and the crack surfaces close Links.
(d) shows the ESEM image of the torn microcapsule Gives

Anti-spalling self adjusting concrete

Concrete is prone to drumming when exposed to high temperatures or fires. Self-leveling concrete, consisting of synthetic fibers (e.g., polyethylene fibers, polypropylene fibers and polyacrylonitrile fibers) or metal fibers, can regulate its pore structure and thermal performance (e.g., conductivity Thermal and specific heat capacity). Self-leveling concrete was first used by Goldfine in 1965 with polypropylene fibers as additives in concrete.

Currently, there are two major reasons that are widely accepted for pouring concrete at high temperatures. The first reason is the principle of internal steam pressure. Water vapor is blocked by escaping through the capillaries of the concrete cap at high temperatures. This increases the vapor pressure and the stress and expansion in the concrete. Then, with increasing ambient temperature, vapor pressure and expansion stress in concrete increase. The second reason is the principle of thermal stress caused by the temperature gradient of high ambient temperature. The temperature gradient can induce thermal stress which will eventually lead to concrete cracking.

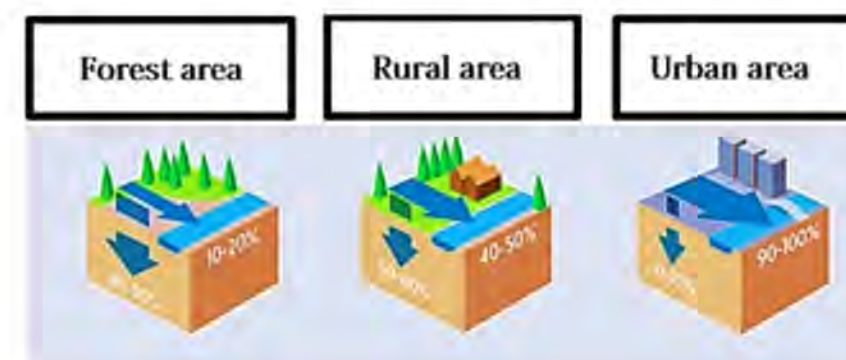
Self-Luminous Concrete:

Recently, self-transparent concrete was developed at the University of Michoacan (Mexico) by Rubio et al. Light concrete itself (also called emitted cement) is a solar-powered

material that traps solar energy during the day and emits light at night. The whole process is done without consuming electricity.

Urban development and its role in the use of smart concrete

Statistics show that in cities where landscaping is very difficult and green space is limited, about one tenth of rainwater is absorbed into the ground. This is while it varies in different regions.



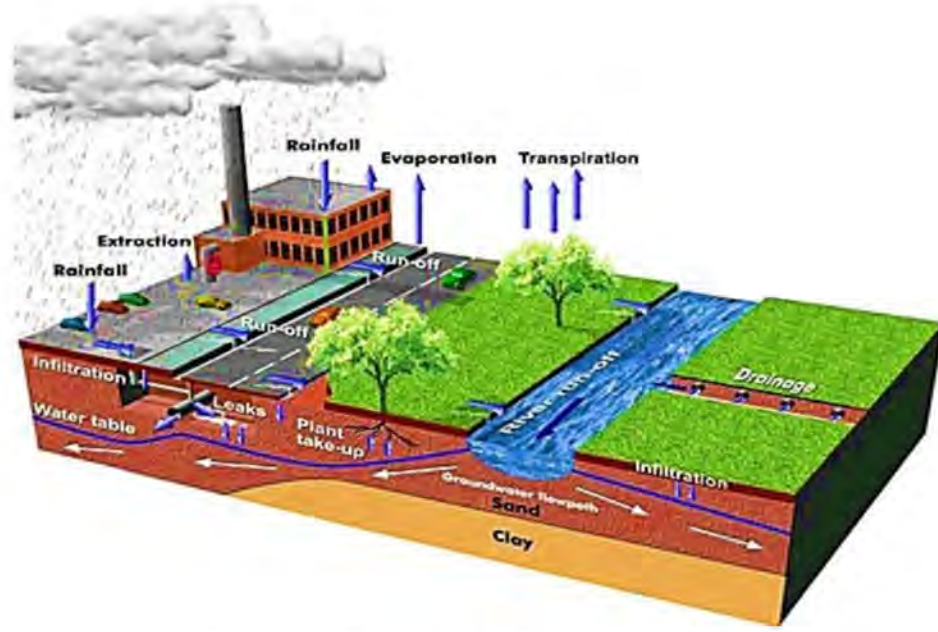
If we pay attention to the above infographic, this image compares the process of water infiltration to the sub-layers in three urban, rural and forest areas, and it means that in an urban area, for example, from 100% of rainwater, 0 to 10% of the total water penetrates to the subsoil and 90 to 100% of the total water is disturbed by floods, and these amounts are different in rural and forest areas.

Emergence of a stable drainage system:

Smart concrete can play a major role in most plans for the emergence of a sustainable drainage system and provides a practical and long-term response to surface water floods.

A new solution for rapid drainage (floods) is the presence of concrete in streets, parking lots, sidewalks and sidewalks, and the interesting thing is that we can recycle this water and many of the problems caused by drought. To solve.

Unlike conventional concrete, smart concrete has a void space of more than 20-35%, and this void allows surface water to seep into the subsurface and drain naturally.



Smart concrete permeability:



Full penetration in smart concrete:

This system allows all the water on the smart concrete to penetrate through the surface layer.

Partial penetration in smart concrete:

This system of smart concrete is suitable for places where the soils offer a good level of permeability and permeability is acceptable.

The outlet pipes are installed below the base surface, which allows any excess water that cannot penetrate the existing ground to penetrate other drainage devices such as water, cylinders or sewage.

This system is usually used in cases where the surface below is not able to drain all the water in the rainy area.

Medium penetration in smart concrete:

This system is used in smart concrete depending on weather conditions and the amount of permeability of other surfaces.

The use of this system is usually adopted in a situation where water recycling is desired. This system is very useful in areas where water may be contaminated, or in cases where the substrate is impermeable.

Expected features of smart concrete:

- 1) High compressive strength
- 2) High permeability
- 3) Low water absorption
- 4) Ability to purify water
- 5) Slip resistance
- 6) Frost resistance
- 7) High durability
- 8) Flexibility for different designs

And...

So, despite the high expectations, the best material for use in smart granite concrete is crushed.

Conclusion

As a durable, versatile and economical material, concrete has been widely used in global construction. It will still remain essential and superior building materials for the long term. Concrete is constantly being developed and exploited. The inherent capacity of smart concrete gained new functions through the combination of traditional concrete with functional fillers or by improving the composition of raw materials.

Smart concrete, as an innovative technology in the field of building materials, despite the challenges, injects a new development for building materials. The development of smart concrete will enhance the use of concrete to a broader perspective and will yield huge economic performance. However, as an emerging technology, research on smart concrete is still in its infancy and the following needs to be addressed before large-scale use.

. Characteristics of functional fillers Applied are the main factors in achieving smart concrete. Therefore, it is very important to explore and exploit more suitable functional fillers. Nanotechnology and bionic technology may inspire the search for more efficient fillers.

2. The mechanical properties and durability of smart concrete require in-depth analysis. The study of smart concrete is essential in the case of multiaxial stresses, because existing research is always limited to the uniaxial stress range, which is far from engineering applications. In addition, the impact of various environmental factors on the performance and durability of smart concrete should be further investigated.

3. Although there are numerous reasonable explanations and prediction models, the mechanism of smart concrete is ambiguous due to the complex system of smart concrete in the properties of several components, multi-phases and multi-scales. Therefore, to describe and predict smart concrete behaviors, a more accurate construction model based on advanced laboratory facilities and numerical analysis is required.

4. The lack of a clear standard for testing smart concrete has made its design difficult and its applications more limited. Therefore, a standard approach, providing standard guidance and specifications for research and use of smart concrete is essential.

In general, inherently intelligent concrete is an interdisciplinary subject that includes bionics (biology), physics, chemistry, engineering and materials science, and civil engineering, etc. Therefore, scientific cooperation and interaction between researchers with different specialties is of particular importance for Further research on smart concrete is needed. The use of smart concrete is a logical choice to maintain the sustainable development of concrete structures and the development of smart infrastructure, no doubt smart concrete will bring a deep revolution in the field of building materials and infrastructure. Its widespread applications will have beneficial effects on society, the economy and the environment in the future.

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“Investigation of Methods for Improving the Mechanical Properties and Strength of Concrete against Earthquakes by Using a Variety of Fibers”

Written by En. Salar Shateri



“Investigation of Methods for Improving the Mechanical Properties and Strength of Concrete against Earthquakes by Using a Variety of Fibers”



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Introduction:

nowadays, human beings are always looking for security. Basically, the existence of structures to ensure the safety of people inside it against environmental factors such as natural disasters.

Earthquakes are the main source of natural disasters that have terrified mankind since ancient times. Earthquakes take thousands of lives each year and increase financial losses.

There are several ways to reduce earthquake damage, but one of the most important solutions is to strengthen existing structures and make them resistant to earthquakes.

In recent years, a lot of research has been done to improve the resistance of structures to earthquakes and increase its mechanical properties.

The results of various researches show that the use of fiber reinforced concrete (FRC) has a significant effect on increasing the earthquake

resistance of the structure as well as increasing its mechanical properties.

FRC is a typical concrete mix consisting of short discontinuous fibers that are randomly distributed throughout the concrete mix. Consequently, the fibers may be partially aligned by the shotcrete process.

Fiber reinforced concrete has such a high efficiency that most researchers know it as a new generation of building materials.

In general, the use of fiber reinforced concrete has many benefits, which in general can be reduced structural cracks, increased resistance to moving loads, increased impact resistance, and so on.

This article tries to describe the different types of fiber reinforced concrete and their advantages and disadvantages in general.

1- glass fiber reinforced concrete (GFRC):



As its name implies, it is concrete that is reinforced by glass fibers, which is used by silica in cement, and the fibers create a crystallization between the concrete and the fibers, which will increase the strength of concrete, especially low tensile strength. There will be no surface cracks.

GFRC was formed by the Russians in 1940, but after World War II, due to the heavy volume of construction in European countries, it was

widely used in the industrialization of buildings, and since 1970, it has been used in special architectures and decorative aspects. It has found a special place, especially in developing Muslim countries such as Malaysia, Saudi Arabia, the United Arab Emirates and Turkey, due to the possibility of using it in Islamic architecture.

There are different types of glass fibers, depending on the type and application, different types are used, which is the highest mechanical properties for glass fibers type (S).

Characteristics of glass fiber reinforced concrete:

- 1- Reduction of cracking
- 2- High tensile strength
- 3- High resistance to environmental factors
- 4- High resistance to heat
- 5- Low specific gravity
- 6- High modulus of elasticity

In general, reinforced concrete reinforced with glass fibers is obtained from a combination of cement mixture and glass fibers, which in fact provides the flexural strength of the fibers and the transmission of force is the cement mixture. The most standard GFRC mixture includes ordinary Portland cement, fine silica sand It is a superplasticizer and glass fibers that to increase the durability of this type of concrete, chemical additives such as micro silica metakaolin, penicynyl powder and acrylic polymers should be used.

GFRP coating improves the previous seismic behavior and reduces human and financial losses in an earthquake. And glass fibers are used in the reinforcement of columns and beams due to their high tensile strength.

Disadvantages of fiberglass:

1. Glass fiber has a lower tensile modulus than carbon fiber, and this is why structural engineers are more willing to use carbon fiber instead of glass fiber to reinforce buildings with FRP.
2. The specific gravity of glass polymer fibers is relatively high compared to carbon and Kevlar fibers.
3. Glass fibers are sensitive to abrasion during transport.

4. GFRP glass fiber is relatively brittle and brittle.

5. The hardness of glass fibers is high and as a result, it causes wear of molds and slows down cutting tools in composite works.

2- Steel Fiber Reinforced Concrete (SFRC):



Steel fibers, also known as metal fibers, are widely used in the construction industry today, just like other fibers. These fibers are used to increase the efficiency and strength of concrete against stresses and strains of physical and chemical agents, which is very widespread today. One of the reasons for this economic popularity compared to reinforcement and at the same time more durable and ductile structure of reinforced concrete with steel fibers (SFRC) compared to the use of mesh or thermal rebars in the structure is also another advantage of using the product. We can mention the control of secondary cracks, reduction of fatigue and shrinkage of concrete and etc. There are different types of steel fibers in terms of cross-sectional shape, including

circular steel fibers, rectangular metal fibers, semicircular steel fibers, and fibers with

irregular or variable length sections. Also, these fibers can be smooth or curved with different dimensions. To describe this

parameter, a factor called image ratio (Aspect Ratio) is used.

This parameter is the product of dividing the length by the diameter (if the cross section is not circular, the diameter of the circle can be calculated equal to the cross-sectional area). These fibers are also available in two forms: hooked steel fibers and sinusoidal steel fibers. The hooked and sinusoidal type is much better than the simple type and causes a lot of conflict in concrete. In terms of quality and quantity, it further improves the properties of SFRC concrete.

These fibers consist of low carbon steel wires resistant to crushing and compatible with the structure of concrete, which has a high tensile strength and is uniformly distributed in all directions during the operation of disturbances with concrete and completely irregular and with performance and Multidimensional collision with concrete improves the performance and physical properties of concrete. Reinforcing concrete with steel fibers increases the strength of the structure and increases its resistance to stress, impact, shock and abrasion.



Usage of steel fiber:

- Concreting and flooring of industrial halls
- Repair of damaged parts in various structures
- Use of metal fibers to reinforce concrete in concrete decks and bridges
- Construction of durable structures with military and nuclear applications

- Airport runway and large sites
- Suitable as an alternative to metal meshes and thermal rebars

Features and Benefits:

1. Increase the durability and invincibility of concrete
2. Reduction of secondary cracks due to concrete shrinkage
3. Steel fibers resistant to crushing and wear factors
4. Economical
5. Increase shear and torsional strength
6. Increase the strength of concrete against expansion and contraction

Disadvantages of steel fibers:

1. Protrusion of steel fibers on the surface of structures
2. It is very important to determine the exact type, amount and length of fibers that should be used.
3. A process of irregular mixing of concrete with steel fibers can lead to the formation of fiber masses.

3- carbon fiber reinforced concrete (SFRC):



Carbon fiber, which was initially developed due to its high strength properties and capabilities in the aerospace industry, has shown its effects as a reinforcer in fiber concrete. Compared to other types of fibers, carbon fiber is definitely more expensive. For this reason, its commercial use is limited. However, further laboratory research has been conducted to determine the physical properties of CFRC carbon fiber reinforced concrete.

Carbon fibers have high hardness and high tensile strength and are ineffective against most chemicals. Carbon fibers are produced by combining suitable organic matter with coal at high temperatures in the form of filaments, and then the resulting graphite crystals (natural carbon, which is soft, black, and shiny) are aligned using the hot-drawn method. These fibers are produced in the form of either type 1 (high modulus) or type 2 (high strength) fibers and their physical properties depend on the source of the material and the amount of stretching in the hot state.

Carbon fibers are available in a variety of shapes and have a filament-like structure similar to asbestos. Some general characteristics of type 1 and type 2 carbon fibers are given in Table 1.

Conventional carbon fibers of types 1 and 2 are basically more expensive than many other types of fibers such as glass and steel. Of course, carbon fibers made from crude oil and coal bitumen have been shown to be much less expensive than conventional carbon fibers made from organic materials (usually acrylic fibers). But conventional carbon fibers of types 1 and 2 are 20 to 40 times stronger and have a modulus of elasticity up to 100 times larger than bituminous carbon fibers.

Length	increases in failure%	Young module, ksi	Tensile strength, ksi	fiber
0.5		55100	260	Type 1 carbon (high modulus)
1		33400	380	Type 2 carbon (high strength)

Usage:

Durable buildings and structures with CFRP composite, fabrication of plates, sheets and carbon laminating, reinforcing concrete fibers, high strength, fabrication of high-strength walls and carbon lightening, fabrication of retracted and prestressed carbon structures in concrete structures, use in the inner wall of the tunnels.

Advantages of using carbon fiber:

- Low weight carbon fiber
- High tensile strength of carbon fiber
- Higher elastic coefficient than glass fibers
- Low thermal expansion coefficient of carbon fiber that keeps the length of carbon fiber constant at different temperatures

- High resistance of carbon fiber to corrosive substances non-explosive carbon fiber
- Strength of trainer fiber against fatigue

Disadvantages of carbon fiber:

1. Low rupture strain
2. Low impact resistance
3. High cost

2-Propylene fibers reinforced concrete (SFRC):



One of the new chemical fibers is polypropylene fibers. Polypropylenes are produced in large quantities in the world and are in the fourth place in terms of production after polyesters, polyamides and acrylics. About 4 million polypropylene fibers are produced annually in the world. These fibers were first used by the US Corps of Engineers in 1965 to make explosion-proof concrete. These fibers became more widely used over time; To the extent that today these fibers in printed form in concrete are used to reinforce it. The use of these fibers in concrete increases tensile strength, increases flexural strength, increases stiffness, increases impact resistance and improves the fracture mode of concrete.

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Uses:

1. Gypsum mortars
2. Coating the navel surfaces
3. Architectural and decorative concrete

4. In all concreting to reduce the shrinkage of concrete



5. Places exposed to dynamic stresses
6. Concreting in tropical windy areas
7. Use in precast concrete parts

Properties and benefits:

1. Compatible with all concrete additives and performance enhancing chemicals
2. No magnetism, anti-corrosion, no alkali and no need for minimum concrete coating
3. In accordance with international standards as an alternative method of secondary reinforcement of concrete compared to old systems
4. Easy and convenient to use without the need for special expertise
5. Save time and manpower
6. Prevent and control the spread of concrete hair cracks
7. Reinforcement of concrete against impact loads and destructive stresses
8. Increasing the abrasion resistance and flexural and tensile strength of concrete and gypsum mortars

9. Increase the durability and improve the integrity of concrete
10. Reduce dough shrinkage and cracks caused by settling
11. Increase the impermeability of concrete
12. Reduction of creep in shotcrete (Rebound) concrete
13. As a reinforcement of concrete to mesh connection (reinforcement)



Disadvantages of Using Polypropylene fibers:

Due to the fact that the behavior of polypropylene or PP fibers is tensile or flexible until the moment of rupture and their fracture is brittle, experts recommend not to use these fibers in thin and thin concretes. Also, these fibers should not be used to increase the distance between concrete joints. Also, the use of polypropylene fibers in concrete increases the air trapped in the concrete.

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Next Artical Is:

***“Introduction of Top-Down method
or inverse structure”***

Written by En. Maryam Fathi

“Introduction of Top-Down method or inverse structure”



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Introduction:

Due to the growing population, one of the problems we have faced is the provision of residential and office spaces

This has led many urban thinkers to consider the simultaneous use of height and depth of land for construction.

For the first time in the 70's, the top-down construction method was used in the construction of metro stations in Paris and Milan

And became known as the Cut & cover method.

In this method, first the tunnel structure is made and then the external environment of the tunnel is filled with embankment materials.

To speed up the construction of a building, in 1935 in Tokyo, the top-down construction method was used

In 1950 in Milan, a combination of diaphragm wall and top down was implemented by ICOS. Over time, this method has been used in various

countries, including Iran Top down is commonly used to execute buildings with limited space Also, in buildings where construction operations can be difficult due to the environment or traffic conditions, the Top-Down method is used to improve the construction performance.

These buildings are usually due

Having a deep pit and at the same time a low level make the space for excavation with certain restrictions

These restrictions will slow down the operation of the machinery and the progress of the project, which will be financially detrimental to the project.

For this reason, the Top-Down method is a good option for implementing these types of projects.

Also, in structures where the groundwater level is high, drilling and execution of guard structures and foundations are associated with problems.

If we use the top-down method, we can use the diaphragm wall and

Deep piles reduce implementation problems caused by high groundwater levels.

Normally, the bottom-up method is used for the construction of buildings. At first, excavation and excavation will begin, which will reach the floor level at the same time as stabilizing the pit walls. There we execute the foundation of the structure and then we start building the columns and floors from the floor level and continue up to the last floor.

While in the top-down method, we no longer act in this way

Top-down construction or top-down is a relatively new method of hollow stabilization that is gaining ground in the construction industry.

In the top-down stabilization method, it is possible to execute the underground floors up to the basement level simultaneously with the execution of the floors on the ground.

Applications of top-down construction method (top down):

Interference with main street traffic	High groundwater level
Impossibility of obtaining consent from neighboring neighbors	Performance space constraints

Top-Down execution steps or reverse structure:

In-situ piles that serve as basement columns and perimeter guard system below the level of columns and walls

Ground floor is poured. First, the perimeter walls of the basement are executed. This wall can be of the wall type, Diaphragm walls are made of precast concrete or bentonite slurry, seated piles, piles.

Continuous or steel sprays. It is possible to use different types of retaining walls in this method after the execution of the retaining wall, according to the project conditions and the depth of excavation, the middle columns of the structure can be executed.

Prior to excavation, the first basement roof slab is available from the ground level.

Slab roof to Acts as a reciprocal inhibition. An opening will be installed inside the slab to remove the resulting soils Excavation operations will be transferred to the off-site through it

After the construction of the roof slab of the first basement floor, Excavation of the first basement is performed.

After the excavation of the first basement is completed and the roof level of the second basement is reached, the slab operation is performed again.

Roofing and then excavation is done. This process continues until the following level is reached.

After the excavation operation of the last basement, the excavation practically ends when it reaches the level below the foundation.

In the last stage, the foundation of the structure is executed and the openings created in the roof slabs are closed and the basement structure is completed.

Benefits of TDM:

This new method has the property of restraint and since the construction operations on the natural soil bed are done step by step, there is no need to worry about the collapse of the excavation walls.

Unlike nailing and restraint methods, there is no need to obtain the consent of the neighbors adjacent to the excavation in terms of subsequent legal issues. Also, if the groundwater level is high, this method will work well.

In addition to reducing execution time and construction speed, simultaneous execution of excavation and structure, especially in busy urban areas, helps to improve the executive conditions in areas with limited space and reduce inconvenience to neighbors.

The use of Top Down (TDM) technique in the construction of underground structures within the city, especially in metropolitan areas, well solves the challenges of urban management in the face of problems such as traffic jams, traffic and the risks of deep excavations.

Disadvantages of Top-Down Method (TDM):

1. Tail access to the outer surface of the walls to seal
2. Complexity of slab connections to columns and retaining walls
3. The possibility of water leakage from the intersection of the slab and the wall if not implemented properly
4. The middle columns come out of their axis due to the increase of upper loads if not properly designed and executed

5. Restriction of access to the pit only through openings or through shafts
6. Limited spaces for excavation and the need for appropriate equipment and machinery
7. High hard work

Comparison of top-down construction method with bottom-up method

Two top-down construction methods with bottom-up construction method (conventional construction method) are discussed in a table.



<i>Execution and construction method from bottom to top (BUM)</i>	<i>Execution and construction method from top to bottom (TDM)</i>
Adherence to the schedule and consecutive execution of activities related to structures and facilities, which leads to an increase in construction time	Increasing the execution speed and shortening the schedule due to the possibility of parallel execution of the structure with electrical and mechanical installations above and below ground
In loose soils with low resistance, it is possible after strengthening and modifying soil properties.	In loose soils with low resistance, it is possible after strengthening and modifying soil properties
Impossibility of creating a large space to equip the workshop and occupy part of the public space for this purpose and possible dangers due to the insecurity of the space around the pit	Using the ground level as a useful surface for continuous equipment of the workshop, by constructing the roof of the first basement and not penetrating the passages around the pit
The need for high economic costs and the potential risk of collapse in buildings with a large number of basements	Extensive efficiency of this method for buildings with high floors in the basement
The need to move large volumes of soil due to excavation operations in order to install supports	Very suitable for excavation projects where installation of supports is not practical and soil displacement should be minimized
Creating more pollution levels due to more space and wider land use levels	Keep pollution levels to a minimum
Execution of the structure from the lowest floor to the top in a row	Possibility of simultaneous execution of the upper and lower floors of the structure by applying the necessary arrangements in the design and construction stages and thus accelerating the construction process
Ability to execute the structure on time and the project to proceed normally	Save on construction time and ultimately reduce costs
The need to use a separate guard structure and pay different costs for the design and execution of each of them and the need for significant space for excavation	No need for large workspace to build foundations and save money by eliminating the cost of constructing a separate excavation guard structure
Direct effect of climatic conditions and geographical factors on the soil of the pit and reduction of excavation safety	Elimination of the effect of bad weather conditions on the subsoil by constructing the roof slab of the first basement as a protective cover

Among the projects implemented with the top-down method, we can mention:

Heron Tower Business Office London (Heron Tower)

A 462-storey skyscraper with a height of 202 meters (63 feet) and an infrastructure area of 46,1478 square meters (430 square meters), with office-commercial use, is located in London, UK. The construction project of this building started in 2007 and was completed and inaugurated in 2011.



Shanghai Tower of China:

It is a 121-storey, 567-meter-high office-commercial skyscraper located in Shanghai, China. Construction of the building began in 2008 and was completed in 2016. It is currently

the tallest building in China and the second tallest building in the world.



Singapore Marina Bay Sands Complex (2010) and Vietnam Business Tower (Bitexco Financial Tower):



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