

State of Art: Experimental and Nonlinear Analysis of prismatic and Non-Prismatic Double Tee Beams

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Abstract:

This paper manages a survey of the significance of kaleidoscopic and non-kaleidoscopic twofold tee-bar substantial designs, the motivation behind their utilization, their field of use practically speaking, their conduct affected by flexural and shear and the perception of the kinds of breaks that happen in the lintel affected by administration loads and consistent over an extensive stretch. What's more, the exceptional kind is Twofold tee with High-strength Concrete (HSC) and Superior execution concrete (HPC) in light of the fact that is addressed a fantastic option for shallow profundity, long range radiates in stopping and business structures that need high heights because of its better mechanical and toughness highlights. Notwithstanding, in light of the fact that to the restrictively high material expenses, such an application presently can't seem to be accomplished, where it very well may be summarized by saying that the approach of behaving of such a limit has been concentrated on by determined researchers. double tee-shaft addresses a superior choice for significant distances then covered huge regions and business structures that need high rises.

Keyword: double tee beams, prismatic و non – prismatic, HPC, HSC, RC beam, history.

Introduction:

Previously, double tees were generally used for country and optional streets. Cost viability, then again, is a consequence of their underlying strength. There is additionally the comfort of development. The utilization of twin tees is acquiring fame. Longer ranges [up to 80ft (24.4 m)] are conceivable. Twofold tees are

generally used as floor and rooftop parts in different designs, including parking structures, places of business, and modern designs. As a result of its inborn adaptability, twofold tees are the ideal decision for structures with long ranges and no extra roof wraps up. Twofold tees are produced in plants. The cycle is equivalent to in other prestressed substantial assembling by building them on pre tensioned beds. The beds for making twofold tees are of the regular sizes of the area that twofold tees will be utilized. As a rule, the lengths of the pretensioned beds are of around 200 to 500 feet (61 to 152 m) long

Non-prismatic segments are utilized in an extensive variety of development applications (structures, long range corridors, spans, towers, RC brackets, and so forth.). The broad utilization of built-up cement footers in the development of structures and extensions is because of their solidarity. Non-kaleidoscopic individuals act uniquely in contrast to kaleidoscopic individuals because of the adjustment of shaft cross-area (over the pillar length) and irregularity of its slant, or the centroidal hub. The impact of cross-segment minor departure from primary way of behaving, typical and shear pressure appropriation, and extreme limit in non-kaleidoscopic underlying individuals has been concentrated on in a few explorations. Pillar activity versus curve activity system lessens shear limit extraordinarily (size impact, changes in conduct, and way of shear move after disappointment). As indicated by building

rules, individuals from outlines and consistent development should be worked to endure the greatest impacts of calculated still up in the air by the hypothesis of flexibility. For cost reasons, many of designs are comprised of prismatic components, and the size of every component is chosen by the greatest shear, twist, pivotal pressure, and bowing second along the range. . Non prismatic components are rarely taken care of in underlying frameworks, yet planners regularly model them during examination and ensuing plan utilizing a predetermined number of kaleidoscopic portions. In spite of the boundless utilization of non-kaleidoscopic built-up cement footers in structures and extensions, existing principles give no unique necessities. The plan of supported concrete non-kaleidoscopic pillars is principally founded on experience and the plan specialist's judgment. By and large, non-prismatic parts' shear limit can be determined by regarding them as kaleidoscopic components and working out the extremely successful profundity at the most profound point. Development or configuration imperfections, alterations of underlying part capability, refreshes in plan guidelines and codes, absence of support, primary framework change, expanding roadway volumes (for spans), blasts, quakes, fires, amassed harm, and coincidental over-burdening can all prompt the requirement for fixing or reinforcing.

Literature review:

In 1951, Harry Edwards and Paul Zia involved a tee segment as a kind of perspective to construct a 4 ft (1.2 m) wide by 12 in. (300 mm) profound pre-stressed substantial twofold tee area. In spite of the fact that non prestressed twofold tees were underlying Miami, Fla., in 1951, no prestressed substantial twofold tees were made in Florida until 1953.

In late 1952, designers in Colorado fostered the first pre-stressed substantial double tee, autonomous of the Florida work. Nat Sachter (designer), George Hanson (underlying specialist), Jack and Leonard Perlmutter, and Michael Atenberg were among the 12 individuals that chipped away at it (makers). Their most memorable twofold tee, named a twin tee, was delivered in 1989.

W M D N Ranasinghe M.T.R. Jayasinghe 2000 It is favorable to limit the complete link force (JPs) utilized for a nonstop prestressed concrete kaleidoscopic double tee bar span regarding economy and constructability. It is showed in this paper that the all-out link force can't be limited by utilizing a steady link force all through the length. For that, different link powers ought to be utilized in length and backing locales. It is likewise shown that for some random segment, there is a most extreme link force that ought not be surpassed over the backings. Whenever the link force changes, there will be point minutes and point powers that will act at those areas. A clear technique is introduced for managing these

while finding the link profile that will fulfill as far as possible and furthermore create the optional second circulation chose.

yP. Casadei, A. Nanni, T. Alkhrdaji, and J. Thomas2002 show that the test results to disappointment of three shafts: a control example, a pillar fortified with one employ of SRP and a third bar reinforced with two handles of SRP moored at the two finishes with SRP Uwraps. Results demonstrated the way that SRP can essentially work on both flexural limit and improve pseudo–flexibility

Hussam Ali Mohammed, 2005 test three non–prismatic pre stressed substantial double tee radiates were tried. An 18 m range bar was tried under help loading condition, while a 13 m and a 20.7 m range radiate tried up to disappointment. Load avoidance bends were acquired and break not entirely set in stone for the last two pillars.

Pei–Chang Huang and Antonio Nanni 2006 The uncommon state of the dapped–end pillar fosters a serious pressure fixation at the re–participant corner. In the event that appropriate support isn't given near the re–participant corner, the askew pressure break might develop quickly and disappointment might happen with practically zero advance notice. This paper reports the testing of three full–scale prestressed concrete (PC) double tee radiates (five tests) in shear at the re–participant corner. One dapped–end of each pillar was supported with inside steel support as a seat mark and the other was fortified with remotely fortified carbon fiber built

up polymer (CFRP) overlays. Of the two CFRP fortified dapped-closes one utilized one-handle remotely reinforced CFRP support and the other two-employ remotely reinforced CFRP support with a U-anchor. The tests uncovered that the support courses of action have critical impact on the part reaction. For one of the CFRP cases, the use of the anchor was with the end goal that disappointment by fiber crack instead of stripping was accomplished. Results from plan calculations were affirmed.

Earth J. Naito Liling Cao Wesley Peter 2009 An exploratory investigation of rib to-rib associations of double tees was led as a feature of the PCI-subsidized research exertion in fostering a seismic plan technique for precast substantial stomachs. The exploration program classifies the strength and distortion limit of normal twofold tee spine and harmony associations under monotonic and cyclic stacking. This paper centers around the strain reaction of associations contrasted and plan assumptions and the commitment they give in flexural obstruction of the stomach. The pretopped rib associations were found to oppose a moderate ductile power over an enormous disfigurement range. Rib associations in bested stomach frameworks gave a high beginning elastic opposition however got back to the untopped reaction once the garnish support fizzled. The qualities of the harmony and spine associations were overpredicted by PCI conditions because of fragile techniques of weld disappointment. Thusly, consideration

ought to be paid to handle weld arrangement, and worked on models were created to all the more precisely gauge the distortion limit and strength.

Rene Suter, Daia Zwicky and Lionel Moreillon 2010 present Current admixtures as well as the expansion of strands permit creating concrete with remarkable properties. With such elite execution concrete, it is presently conceivable to lay out underlying components impeccably adjusted to commonsense necessities. Precast prestressed double tee radiates permit fabricating enormous modern or business floors and stopping decks in a quick and monetary manner. This double tee radiates are exceptionally pre-stressed by fortified strands and contain just a decrease the steel support. A specific issue subsequently emerges in the plan for shear opposition; as per public and worldwide codes, the networks should contain a base shear support (stirrups) for which the laying slows down creation. The chance to supplant these stirrups by an elite execution concrete built up, if vital, by steel strands in this way appears to be alluring. The College of Applied Sciences (UAS), Fribourg, completed hypothetical and exploratory examination on full-scale substantial double tee radiates to dissect the association between the nature of concrete, the expansion of strands and prestressing on flexural conduct and shear obstruction.

Ehsan Sharbaf, Khaled Mahmoud Shaker, Hussam Ali Mohamed,2010 Under flexure, explore the nonlinear limited

component investigation of non-prismatic prestressed substantial double tee radiates. The mathematical assessments were performed on radiates chose from existing exploratory examination. There were two distinct game plans assessed. Mohammed 2003 explored different avenues regarding Bars B2 and B3, which should mimic the instance of a non prismatic-prestressed substantial double tee shaft. Pillar B3 portrays a bar with a limited capacity to focus specific. Bar B2, then again, is a delegate illustration of a pillar with a somewhat lengthy range. These two pillars were scrutinized until they broke.

satish Jain, sri Sritharan 2013 presents a reasonable plan approach after a conversation on the idea of UHPC double Tee radiates. A period subordinate examination program to compute long haul redirections involving different shrinkage and creep properties for UHPC as well as a non-straight strain-similarity segment investigation program have been created to plan the plan approach. UHPC double Tees are looked at against post-tensioned bars and steel radiates with regards to profundity and weight.

Fares et al. (2016) give vierendeel plan reasoning of fortified and cell steel radiates, which could be adjusted to design cell UHPC shafts to improve the material utilized. The UHPC double Tee in this paper is the most important move towards the utilization of this way of thinking.

W. Zhou and W. Zhang 2018 The floor or top of the multi-story precast stopping structure was intended to be pre-assembled with 18 m or 24 m range double tee radiates. The inclines were utilized to stop or drive, causing huge floor openings, debilitating the firmness of the stomach. double tee radiates were isolated into un-beat and pre-topped shafts to guarantee the trustworthiness of the stopping structure and its opposition under various seismic powers. Twofold tee radiates with the range of 18 m or 24 m were intended to be liberated from breaks under the assistance load, whose bearing limit meets the prerequisites of slopes and floors in light of the general solidness of the stomach, and was integrated into the plan drawing standard. To examine the contrast between un-beat and pre-topped radiates, four full-scale double tees of 18 m or 24 m range were projected and stacked statically under three-point loads thinking about both the dead burden and live burden (recreating stopping and driving burdens) to get the shear limit, solidness and breaks proliferation. Pre-beaten double tees were tried which showed huge flexibility. The experimental outcomes show that the twofold tee radiates have elevated degree of malleability of critical mid-range redirection and sufficient proliferating breaks, and met the prerequisites of floor or inclines under two sorts of cutoff states. The examination results can be utilized as trial proof for planning precast stopping structures and for creating plan norms.

W. Zhang W. Zhou 2018 To accomplish reasonable plan of stomachs and slopes in precast stopping structures, the precast cement bested and un-finished off double tees with the range of 18 m and 24 m were planned and built. A progression of full-scale tests, both of flexural conduct under two-point loads and shear limit with shear-length proportion of 3.0, were completed. The trial results confirmed general possibility of these double tees to meet the help prerequisites of multi-story stopping structures. Since it is difficult to acquire static execution of twofold tees under different stacking designs from restricted greatness of exploratory examples, nonlinear investigation of twofold tees individuals on premise of discrete models was completed. The scientific outcomes showed that the dissecting load-misshapening bends under recreation of exploratory stacking condition corresponded with the trial bends. Both the flexural conduct of twofold tees under uniform loads and shear execution of the double tees with shear-length proportions going from 1.0 to 9.0 were recreated and broke down. Besides, a nonlinear limited component model (FEM) of driving or halting on the neighborhood spine locale of double tees was directed. Mix of this reproduction examination with static stacking test reflected worthwhile execution of the precast prestressed substantial double tees, including reactions of the break and diversion control, shear and flexural limits and nearby bearing limit. Collected actually, these

twofold tees can be applied to the stomach and inclines and give great execution to precast stopping structures.

Hussam Ali Mohammed 2018 Displaying of built-up cement footers was the most inexact technique to anticipate the way of behaving of such pillars under working, extreme, unnecessary stacking state. With exact strides on the assembling the shape and with precise deciding for the material trademark details, the model bar will follow the means of full-scale pillar, and with considering the relative part on the review, the outcomes will come shut to the genuine bar conduct. Lab chips away at planning mold for double Tee pillar with enough adaptability to project multi-dimensioning shafts and with relative scale to carry on a few stackings test up to disappointment. Inside a few tests, a way of behaving of the model pillars will recode and checking with full scale testing get from written works, to get viable instrument to check and plan new items or making parametric concentrate on these models. The picked model has length reach to 20m, so the nipple will carry on that range and less. The scale will contract multiple times the genuine aspect, so the model bar will have biggest length up to 2.85m, in which that length can be taken care of by testing group, and the stacking will be conceivable. In a similar time, that will make the perusing and recording results all the more without any problem. Parametric review will be carried on after get the matching accomplished and demonstrate that the displayed pillar will give

exact way of behaving of the testing shaft. Where a few boundaries will be changed and dealing with make configuration helps outlines for built up substantial double Tee bar under broad condition of stacking constrained by the specialist.

Hussam Ali Mohammed 2018 the impact of prismatic models has been explored in this concentrate all through parametric examinations, and the exploration stretch out to look at some significant material and arrangement boundaries on the mathematical outcomes. Likewise, the impacts of cement compressive strength, measure of pre-stressing steel support, and beginning prestressing powers are considered. A numerical model reasonable for the nonlinear examination of pre-stressed cement footers under monotonically expanding load is utilized. The legitimacy, exactness, and proficiency of the computational model are inspected by contrasting the limited component results and the exploratory outcomes conveyed by ongoing review [1]. Radiates have been tentatively tried up to disappointment, while this pillar has been mathematically investigated utilizing the limited component model. Bar assigned B2 tentatively tried and another indistinguishable PB2 was taken on thus with the respect of prismatic models. Shaft PB2 has been examined with similar material properties and limited component admiration and boundaries utilized for investigating non-prismatic pillar B2. same technique accomplished for Shaft assigned B3. The two new shafts

PB2 and PB3 have been broke down to up disappointment utilizing the limited component strategy. Full examination completed to anticipate the impact of prismatic rules for acquire more range length and high part strength.

Hussam Ali Mohammed,2018 This paper surveys mathematical program on examination recently put substantial garnish on precast double tee radiates as a completing layer for floor frameworks and layouts the presentation boundaries that should be viewed as in the plan and specifying for such frameworks. Withdrawal joints typically control the arrangement of breaks in recently positioned substantial fixing. Notwithstanding, in certain conditions, different plan and development factors impact the capacity of withdrawal joints to control breaking. Significant changes in the climate during and after development additionally can actuate uncontrolled breaking notwithstanding typically satisfactory plan, development and jointing methods. Because of the intricacy of expecting and representing the interrelating factors, uncontrolled breaks really do happen in some recently developed substantial garnish. Limited component model was ready and done to mimic the way of behaving of both the garnish concrete and the twofold tee bar. Results will contrast and past tried shaft in written works and in general breaking will contrast and a current structure taking on comparable framework. At the point when early uncontrolled breaking happens, offices and workers for hire should decide how to address the breaks. There

have all the earmarks of being little consistency in such manner. This examination article surveys factors that can cause or add to uncontrolled breaking, and analyzes jointing and remediation methods. Likewise, in this suggests healing fixes for breaking in view of current practices and accessible procedures. All procedures proposed thus in this exploration work is inside the expertise capacity of the accessible work and groups.

Hussam Ali Mohammed, 2018 review demonstrate the capacity of utilizing precast substantial double tee radiates under different situation and its ability to surpass every one of the shortcomings in plan. By utilizing mathematical program on examination precast twofold tee radiates as floor frameworks and layouts the presentation boundaries that should be viewed as in the plan and enumerating for such frameworks.

Victor Torres, Navid Zolghadri, Marc Maguire and Marvin Halling 2019 In this review, the Cold Springs Scaffold, situated in Coalville, Utah, was load-tried to measure impacts of critical weakening on its live-load conduct. Visual examination and burden testing of the double tee structure showed a seriously weakened deck, unharmed support stems, and to some extent powerful cross over associations at the joints. At the difficult period, the scaffold was load-posted at 35.6 kN (complete gross vehicle weight) with a most extreme speed of 8 km/h because of moderate rating suspicions. After a nitty gritty examination, a truck that was 7.5

times the posted weight was utilized for a heap test. A shell-based limited component model was made that pre-owned variable spring components to show the disintegrated rib to-spine associations, which precisely imitated the way of behaving of the extension from the heap test and approved the demonstrating method. The model was utilized to play out a parametric report, utilizing glorified spine to-rib associations, to contrast the determined support dissemination factors with the limited component model-assessed brace conveyance elements, and unfortunate understanding was found ($R^2=0.449$ and 0.237 for second and shear, individually). A multi-variable direct relapse examination was utilized to foster second and shear support dissemination factor conditions for twofold tee spans like the one researched in this review, with a greatly improved connection of $R^2=0.86$ and 0.83 for second and shear, separately.

Ali Fadhil Naser, Hussam Ali Mohammed ,2020 making a correlation between double tee shaft produced using lightweight substantial versus ordinary load in the fundamental of planning issues for its significant viewpoints. The exploration depended on the Precast/Prestressed Substantial Organization's segment, as well as a parametric investigation to conjecture a plan guide for both lightweight and ordinary weight segments. Load-range graphs were made and exhorted for use in a clear way to exhibit the impact of using lightweight cement to decrease the complete load of the part.

The impact then reaches out to cover erection camber as well as long haul camber. As a general rule, the fluctuation in load bearing capacity of the segment for lightweight cement was considerably more noteworthy than for ordinary weight concrete. Likewise, predominant camber conduct was seen at the two phases (from erection to long haul).

Wei Zhou Hao Li Wenlong Zhang 2021 The motivation behind this examination is to accentuate the size impact on the shear properties, particularly the shear strength, of precast prestressed double tees for cross-sectional profundities at the very least 27.56 in. (700 mm). A sum of four full-scale prebressed double tees with a solitary explicit proportion of the shear range to successful profundity were tried under monotonically concentrated stacking up to disappointment. The double tees were made out of two ostensible ranges of 59.06 ft (18 m) and 78.74 ft (24 m) and untopped and pre-topped spines of thicknesses 1.97 in. (50 mm) and 5.12 in. (130 mm), separately, with four cross-sectional profundities of 27.56 in. (700 mm), 35.43 in. (900 mm), 30.71 in. (780 mm), and 38.58 in. (980 mm). The slanted breaking, diversion of point-burden, and disappointment properties noticed were utilized to assess the shear qualities of the double tees. The shear lead and break improvement were in a general sense affected by the convincing sectional significance and prestressing load which is gotten across a destined length near the furthest

reaches of people. The shear qualities acquired from six codes, including GB50010–2010, Model Code 2010, AASHTO–2012, JDG D62–2012, ACI318–14 and Eurocode2 digressed from our exploratory outcomes by enormous edges.

Conclusion:

The accompanying ends can be drawn from the data introduced in this paper:

- the double–tee is quite possibly of the most financially savvy, versatile, and regularly used building parts. It tends to be used as a heap bearing part both evenly and in an upward direction.
- When contrasted with single tees and other single–stemmed wide–flanged individuals, the double tee enjoys a critical benefit regarding solidness during capacity, transport, and erection.
- The double tee's top spine fills in as the design's floor and roof, as well as the pressure side of its flexural obstruction. The stems give the part's ductile part of flexural strength, shear obstruction, and solidness. Thus, the double tee isn't just structurally yet additionally practically productive. The top spine's broadness essentially affects the design's economy. Less precast substantial components in the design require less associations, bringing down make, taking care of, transportation, and erection costs.

- Expanded prestress force for a given segment size further develops length capacity, decreases the possibility breaking, and builds the part's life span.
- double tees have a range length of around 100 feet (30 meters), despite the fact that with current innovation, they could arrive at 160 feet (48 meters).
- the breaks can happen in the prestressed double tees during projecting, shipment or stripping. Albeit a few breaks can and do happen under help loads, for example, rib break out of the legs, breaks between the legs, flat end break in legs and vertical breaks at the top and lower part of the of legs.
- The utilization of super elite execution concrete affects limit at full help loads because of the enormous width of the top spine and the low interest for strength at administration. Be that as it may, the more troublesome ascent in substantial strength during prestress discharge considers extra prestressing to be applied, which further develops administration load limit in a roundabout way.
- In lengthy range building structures, UHPC double Tees are lower in weight per unit region and shallow in profundities contrasted with concrete precast prestressed double Tees. The mix of utilizing UHPC and decreased shallower profundity prompted a decrease in seismic load of the construction, decrease in section

and establishment sizes, and lower upkeep costs during the help life of the design

- The principal slanted breaking and extreme shear strength of non-prismatic tried radiates not entirely settled by the tightened point. expanding tightened point prompts a decrease in extreme burden limit by (half) and delivered higher diversion values.
- self-weight ought not be overlooked while choosing the tar framework in above applications.

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