

Construction of 10 Storied Building in 48 Hours in Mohali Technical Highlights

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Executed by:
M/s Synergy Thrislington, Mohali





Organization

* Introduction

- CSIR-SERC
- Topic

* Emerging Trends

* Seismic Experimental & Analytical Studies

* Launch & Construction - Highlights


* Concluding Remarks

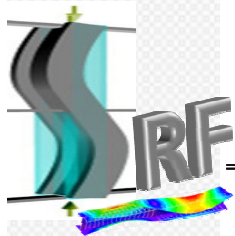




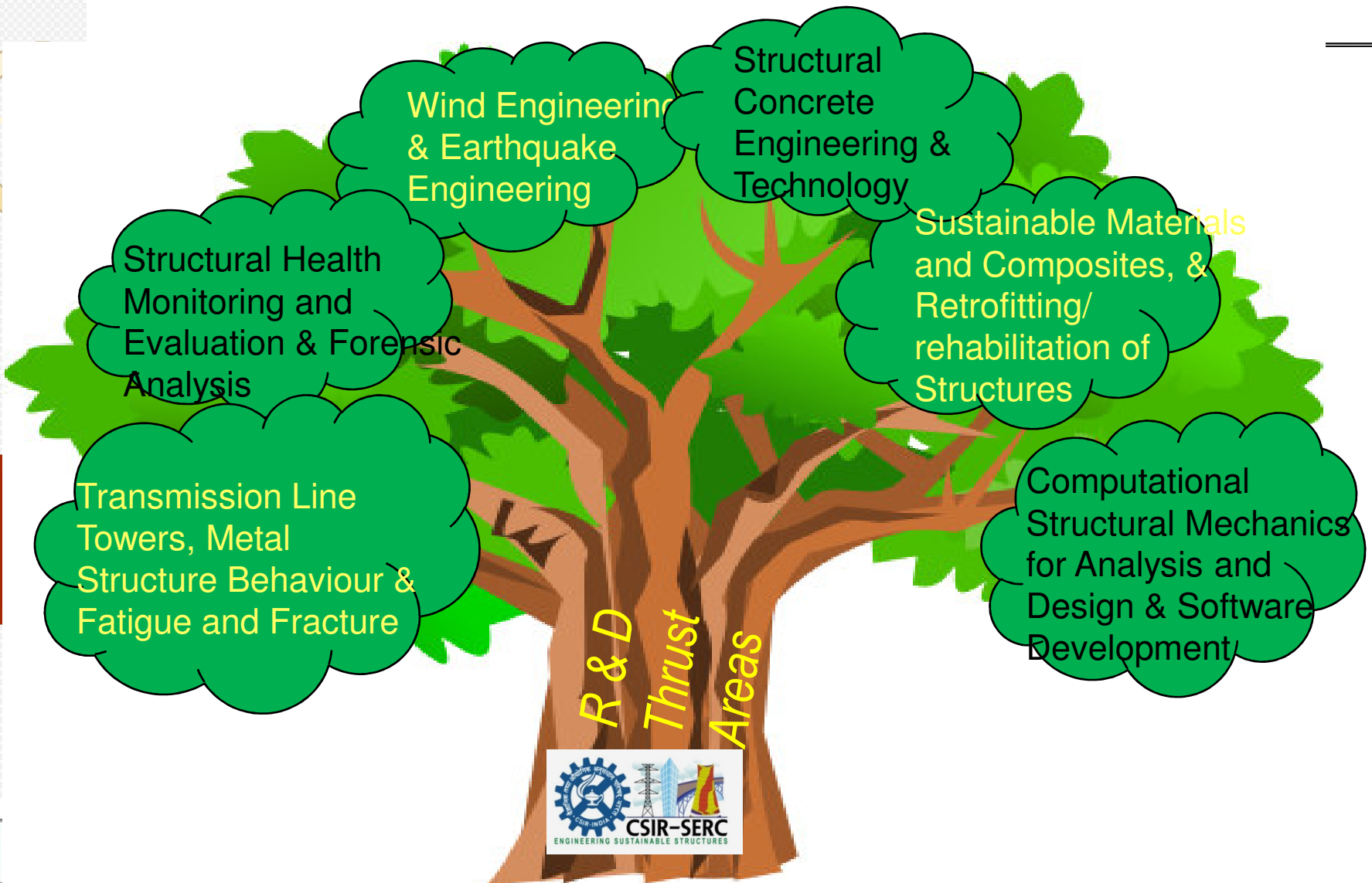
CSIR - Structural Engineering Research Centre

**A premier R&D Institution under
CSIR pursuing advanced and high
quality Research in Structural
Engineering augmented with**

- 
- ✿ State-of-the-art Unique Facilities
for Structural Testing & Evaluation**
 - ✿ Computational Facilities**



R&D Thrust Areas



Major Facilities

A Panoramic view of SERC Campus



Structural Health Monitoring Laboratory

ASTaR Laboratory

Library

Steel Structures Research Facility



Structural Testing Laboratory

Advanced Computational Mechanics Facilities

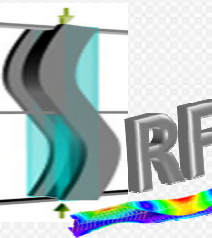
Advanced Concrete Testing & Evaluation Laboratory

Tower Testing Research Station

Advanced Materials Laboratory

Wind Engineering Laboratory

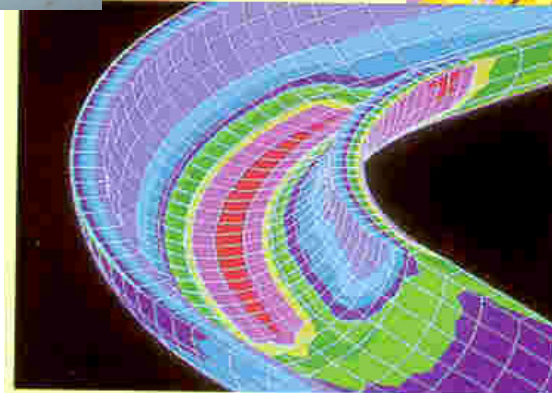
Fatigue & Fracture Laboratory



Wind Engineering Laboratory



Fatigue & Fracture Laboratory



Advanced Seismic Testing & Research Laboratory (ASTaR Lab)



**Tri-axial Shake Tables
(4m x 4m & 2m x 2m)**



**Testing of Multi-
Storied Frame**



Tower Testing Research Station



Testing of Microwave/
Transmission Line
Towers in progress



Load Tests on a Bridge



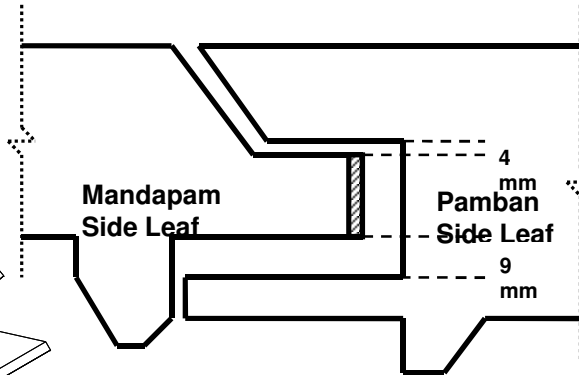
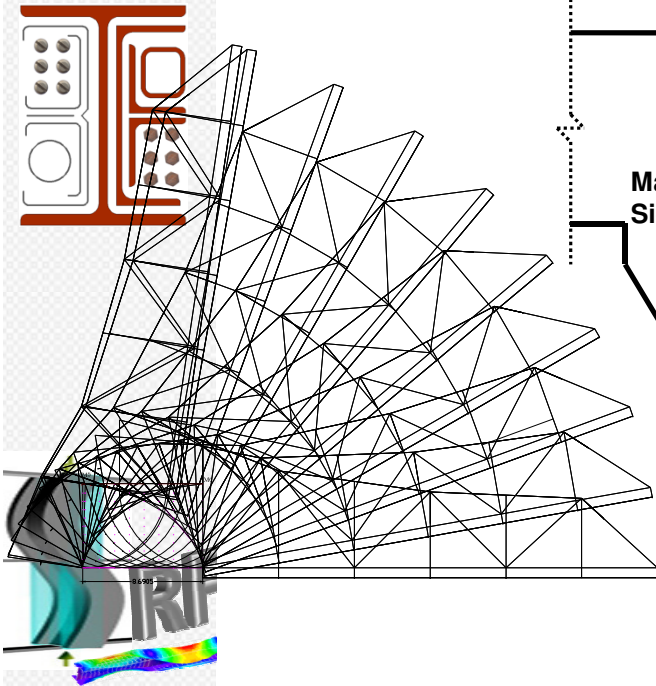
PEPSCON 2013



FEA & Design of Pamban Railway Bridge



*What are
the
challenges?
&
Why SERC?*



DETAILS OF RE-GIRDERING

| YEAR | BRIDGE CONSTRUCTION STARTED | | SB WORK COMPLETED | | OPEN FOR TRAFFIC | |
|------|-----------------------------|--|-------------------|--|------------------|--|
| 1910 | SPAN 1-40 | | PSC GIRDER | | | |
| 1960 | 19-113 | | CYCLONE WASHED | | | |
| 1964 | 115-146 | | 1-6 | | | |
| 1965 | 19-113 | | SAME GIRDER | | RE GIRDER | |
| 1965 | 115-146 | | | | | |

| NR | SPAN | YEAR | TOTAL | NR | SPAN | YEAR | TOTAL |
|----|--------------|------|-------|----|--------|------|-------|
| 1 | 7-19 | 1960 | 13 | 12 | 63-66 | 1997 | 4 |
| 2 | 2-6 | 1961 | 5 | 13 | 61-65 | 1997 | 5 |
| 3 | 33-39, 67-70 | 1967 | 11 | 14 | 50-52 | 1998 | 3 |
| 4 | 66-71 | 1968 | 6 | 15 | 57-59 | 1998 | 3 |
| 5 | 132-146 | 1988 | 15 | 16 | 72-79 | 1998 | 8 |
| 6 | 126-131 | 1990 | 6 | 17 | 86 | 1998 | 1 |
| 7 | 60 | 1999 | 1 | 18 | 97-111 | 1998 | 15 |
| | | | | | | 2005 | 2 |
| | | | | | | 2005 | 13 |
| | | | | | | 2005 | 6 |
| | | | | | | 2005 | 2 |

NOTE:
2-6, 35-39, 66-70, 135, 137, 138, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.

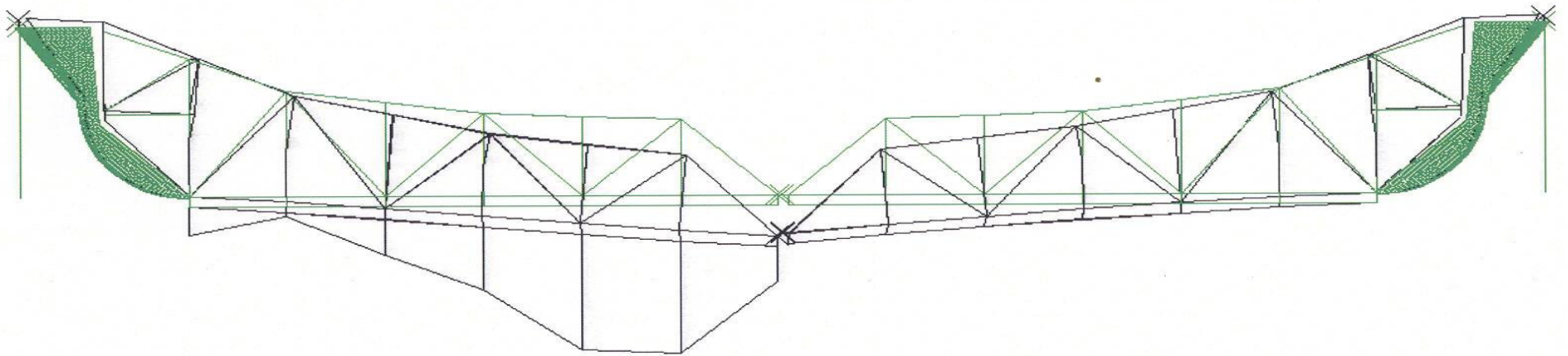
Built in 1911-1913

Total length about 2km, Scherzer span 87.5m;

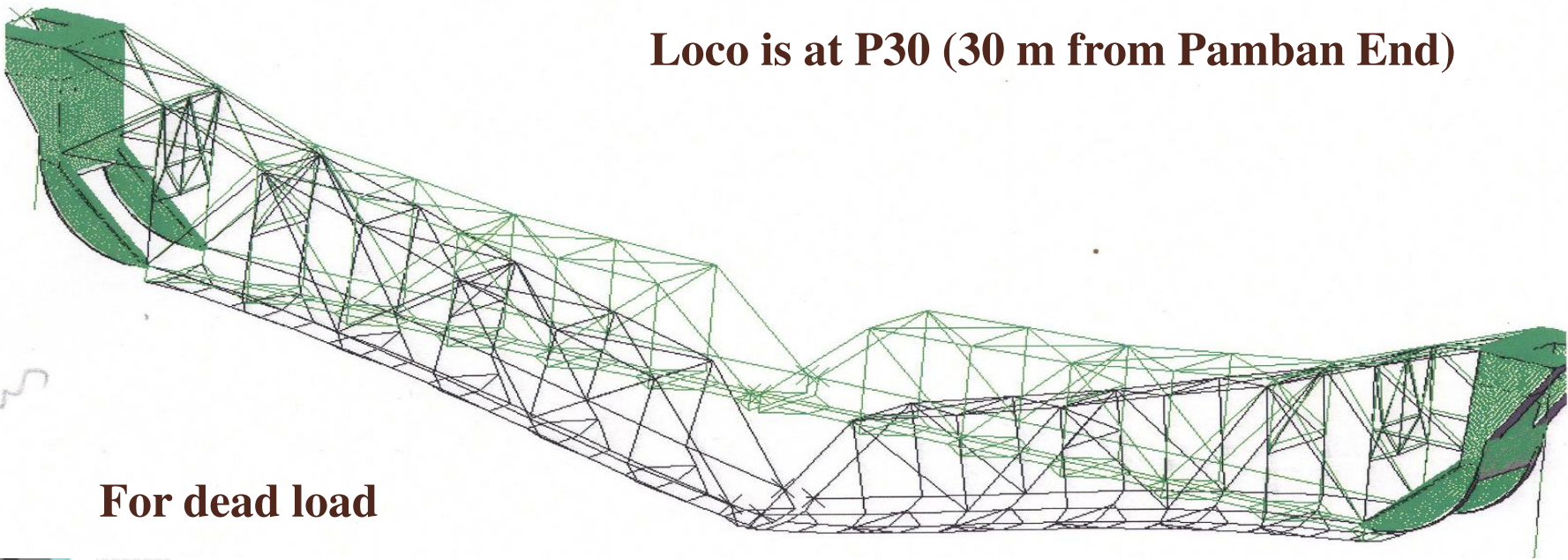
Bridge successfully converted for broad gauge based on recommendations of CSIR-SERC



FEA & Design of Pamban Railway Bridge



Loco is at P30 (30 m from Pamban End)

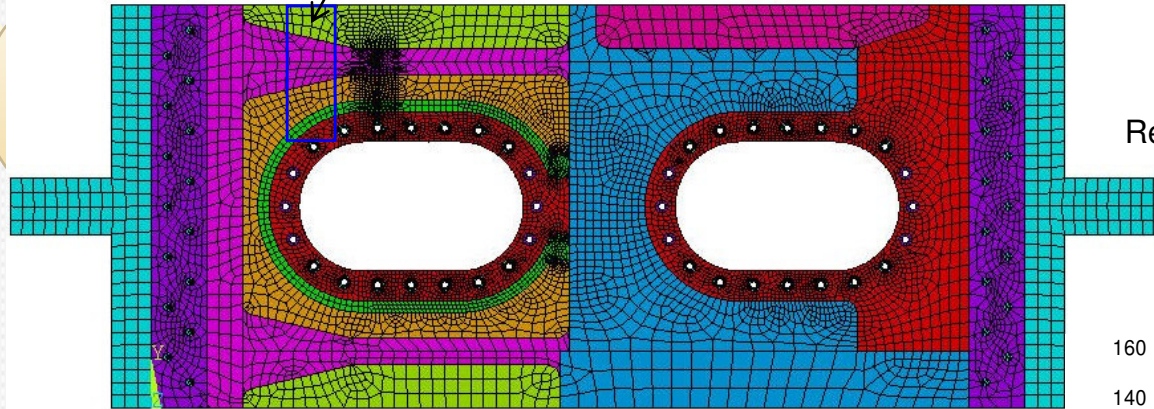


For dead load



Damage Tolerant Evaluation of Wing Bottom Skin Panel

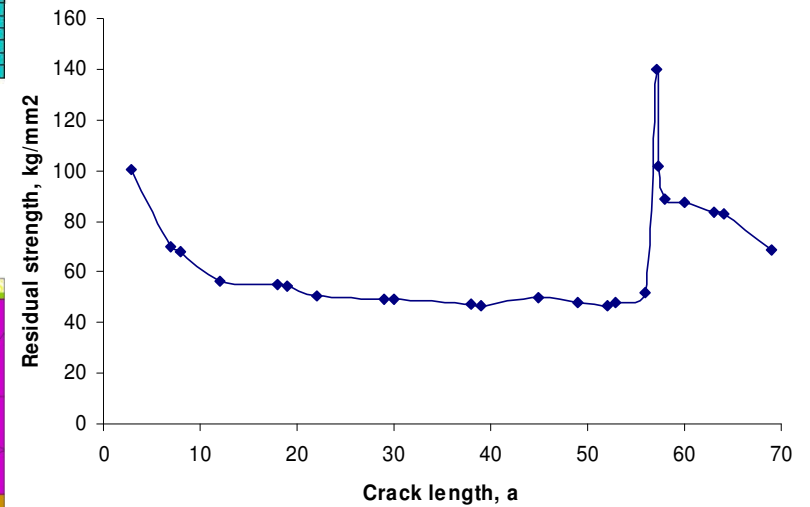
Refined area for crack growth analysis



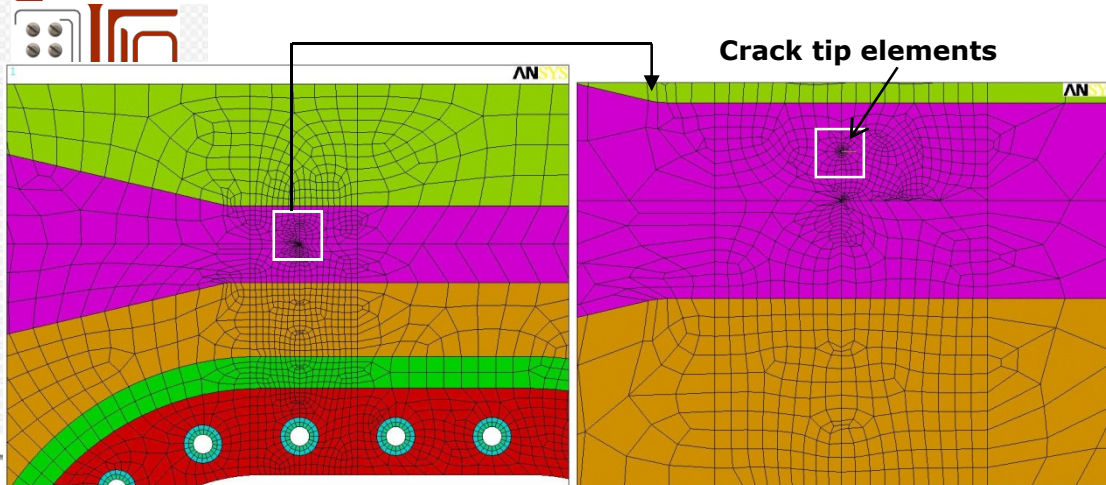
No. of elements 9707; No. of nodes 30274;
 Plate/Shell elements 9363; No. of Eqns. 181572;
 Stiffener Shell elements 344;

SARAS Aircraft

Refined FE Model for SIF Computation



Plot of Crack Length vs Residual Strength

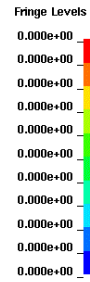
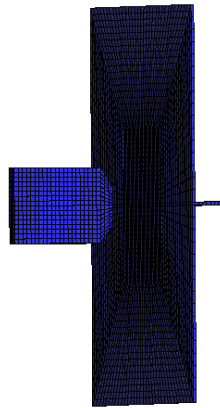


FE idealisation with crack tip elements

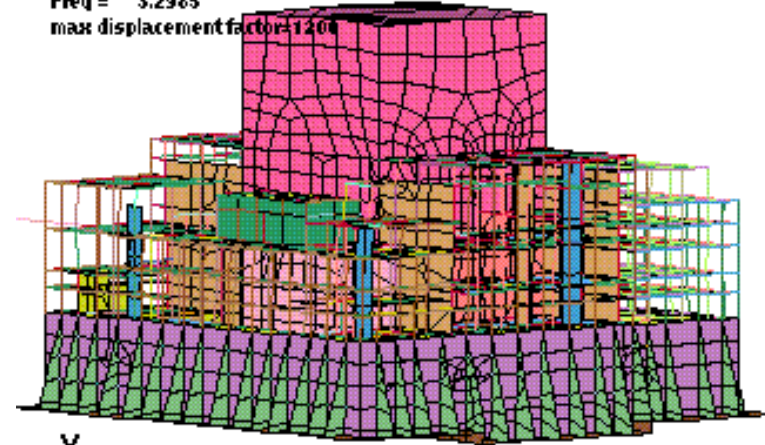
Zoomed view indicating crack tip elements

Computational Simulations

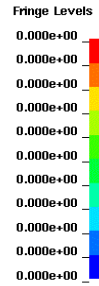
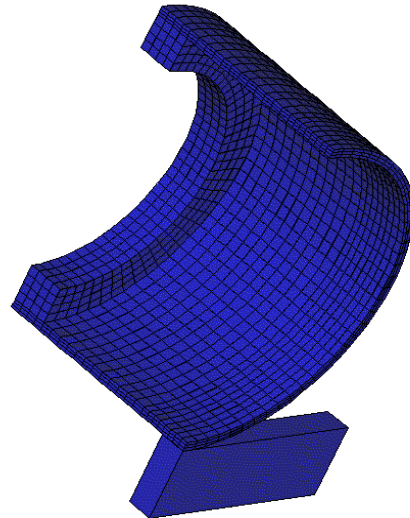
FINEART IMPACT ANALYSIS
 Time = 0
 Contours of Effective Stress (v-m)
 min=0, at elem# 10704
 max=0, at elem# 10704



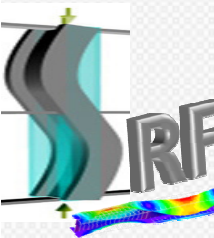
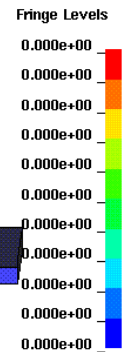
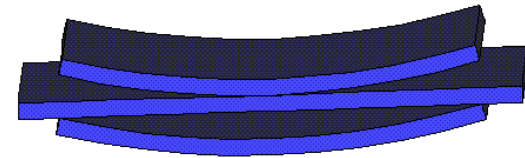
LS-DYNA eigenvalues at time 2.00000E-0
 Freq = 3.2985
 max displacement factor=1204



sample 2.inp1 00640 766 31
 Time = 0
 Contours of V-stress
 min=0, at elem# 1
 max=0, at elem# 1



Time = 0
 Contours of V-stress
 min=0, at elem# 1
 max=0, at elem# 1





Seismic Performance Studies and Construction of 10 Storied Building in 48 Hours in Mohali



Emerging Trends

- ❁ **Utilisation of Steel/Concrete ratio is around 0.3 in India**
- ❁ **Whereas the ratio is close to or greater than 1.0 in the Western Countries**
- ❁ **National initiative to push the Steel utilisation**



Emerging Technology



**Technology for
Mass Housing**

**One such move towards the
National initiative**

**Technology needs to be
assessed for performance**





Mandatory Requirements

Performance of the steel framed structure needs to be assessed for

- **Seismic loads**
- **Wind loads**

As per relevant BIS Codes of practice



Formulation of Problem

M/s Synergy Thrislington approached CSIR-SERC for Seismic Performance Evaluation of Cold Rolled Steel Framed Structures

- ♣ Shake table experimental studies with different spectra**
- ♣ Analytical studies**



Scope & Objectives

- ♣ **Analysis of the G+7 CRC framed structure for the seismic load as per IS code**
- ♣ **To evaluate the seismic performance of model of a G+7 framed structure for a ground motion compatible to Zone V Spectrum as per IS:1893-2002**
- ♣ **Study of the damage pattern and suggestion for improvement**



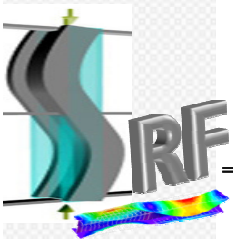
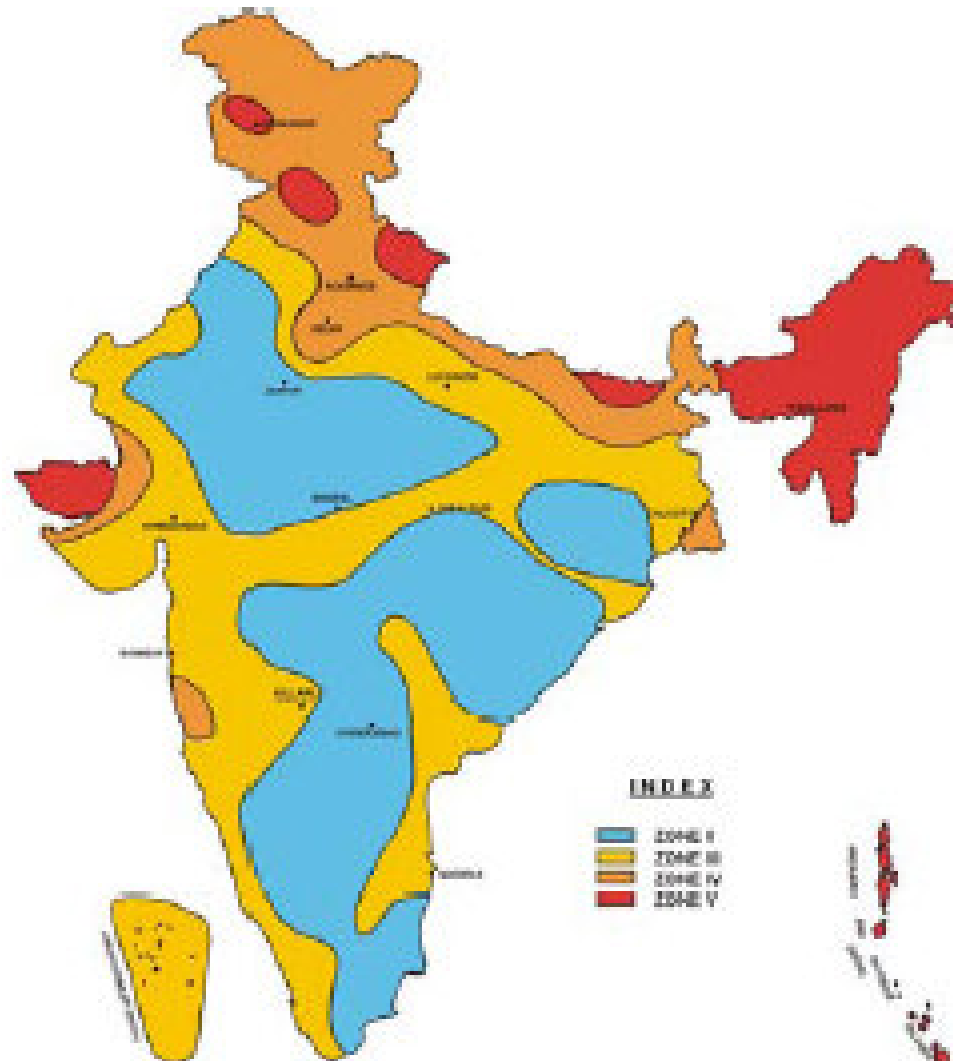
ASTaR Lab.

State-of-the-art 4mx4m tri-axial shake table with 6 DoF

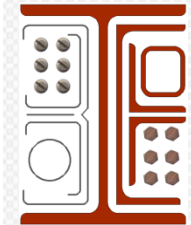
- ♣ **4 horizontal and 4 vertical actuators of capacity 250kN each**
- ♣ **Acceleration up to 1.0g**

Used in the present investigation for seismic performance evaluation for testing upto Zone V and beyond

Seismic Zone Map of India [IS:1893-2002]



Scaled Model of G+7 Framed Structure on the Shake Table



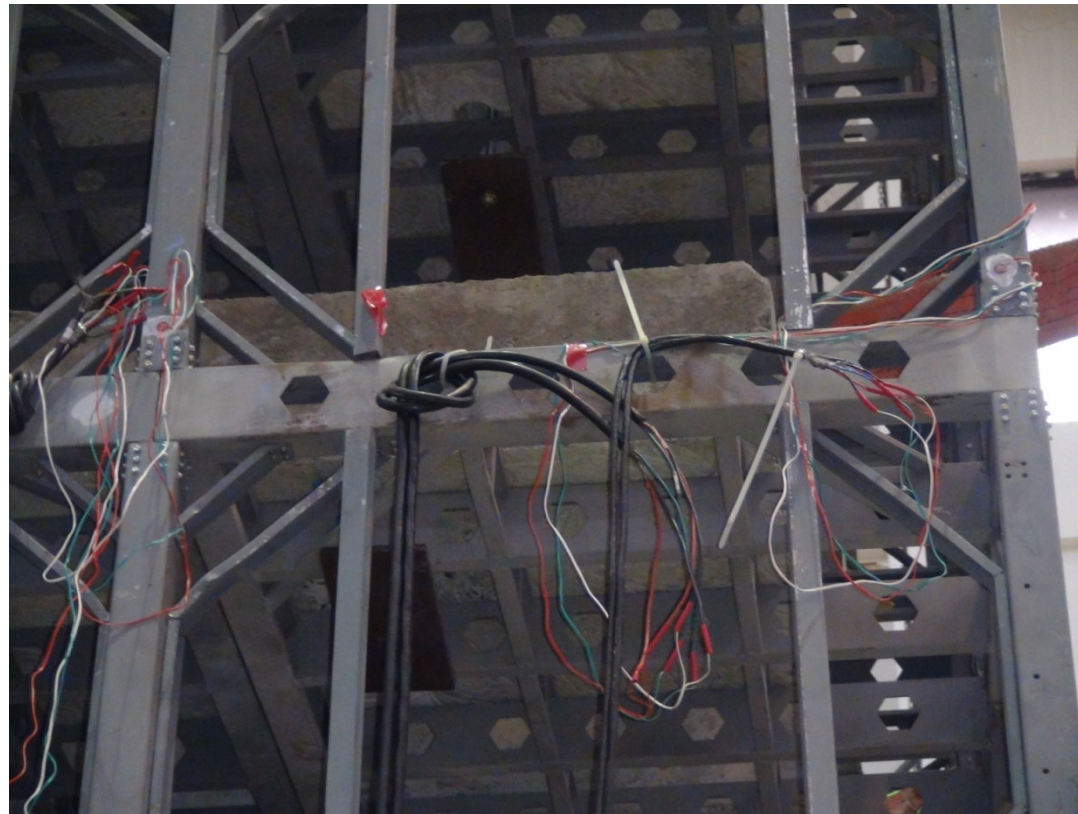
Simulation of Dead and Imposed on the Model



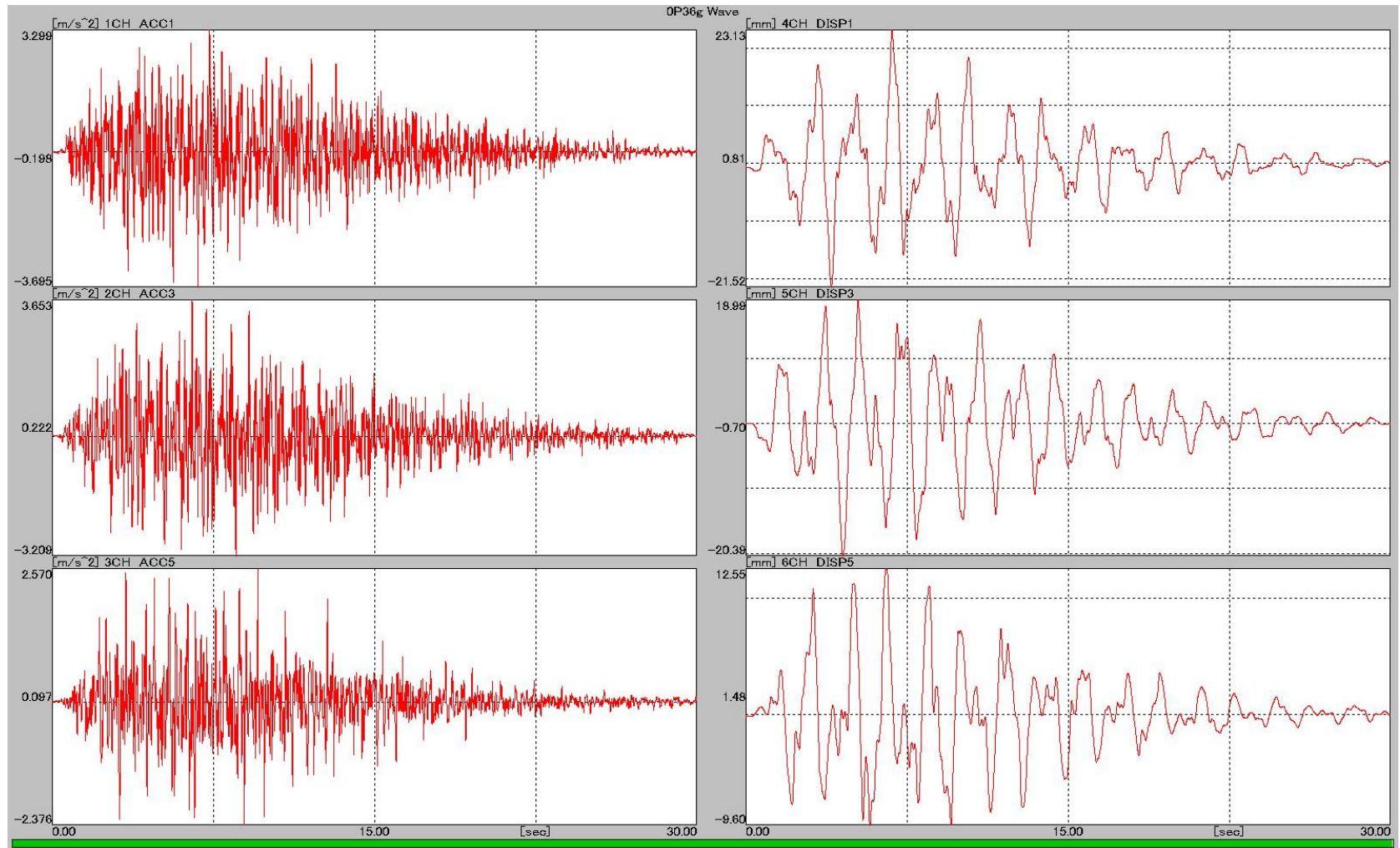
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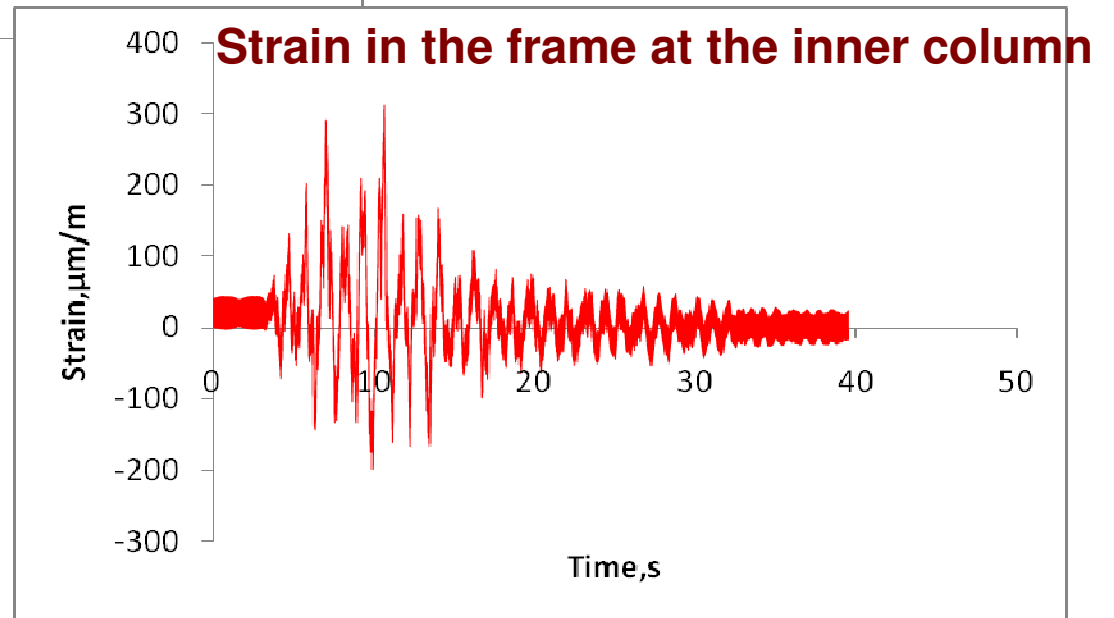
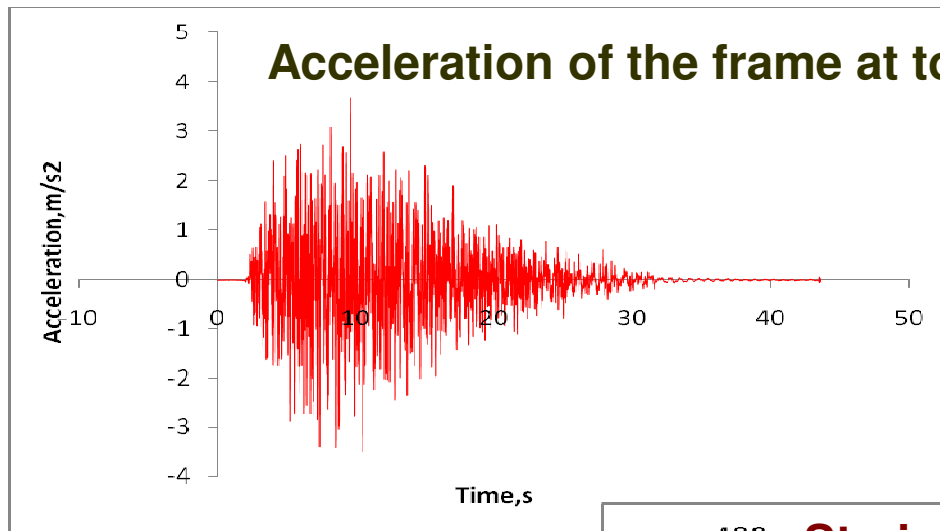
Instrumentations on the Model



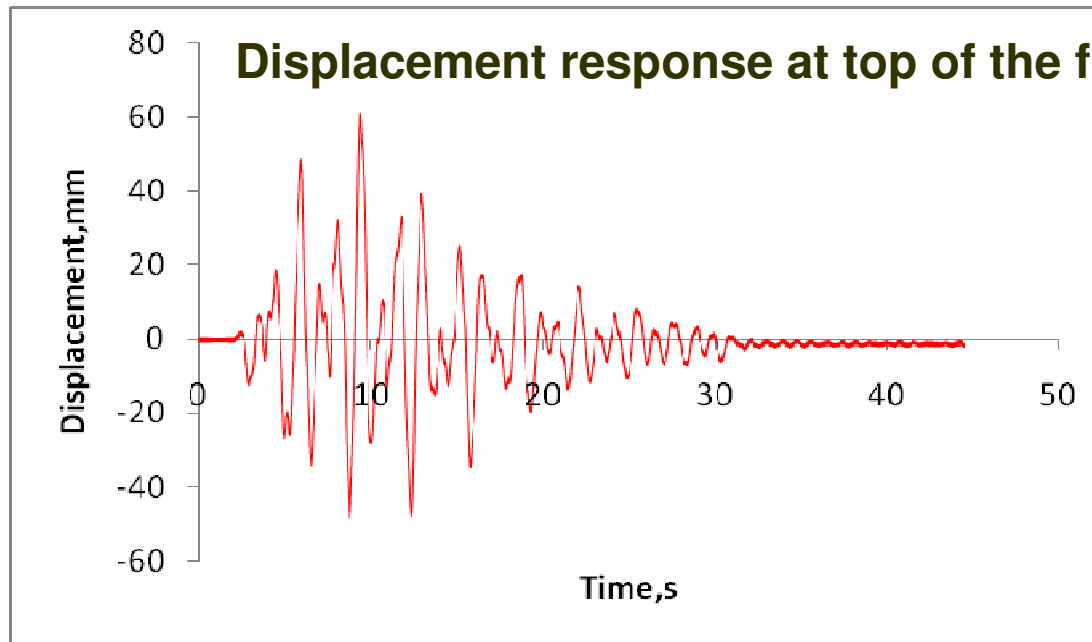
Input Time History for 0.36g



Plot of Responses for 0.36g

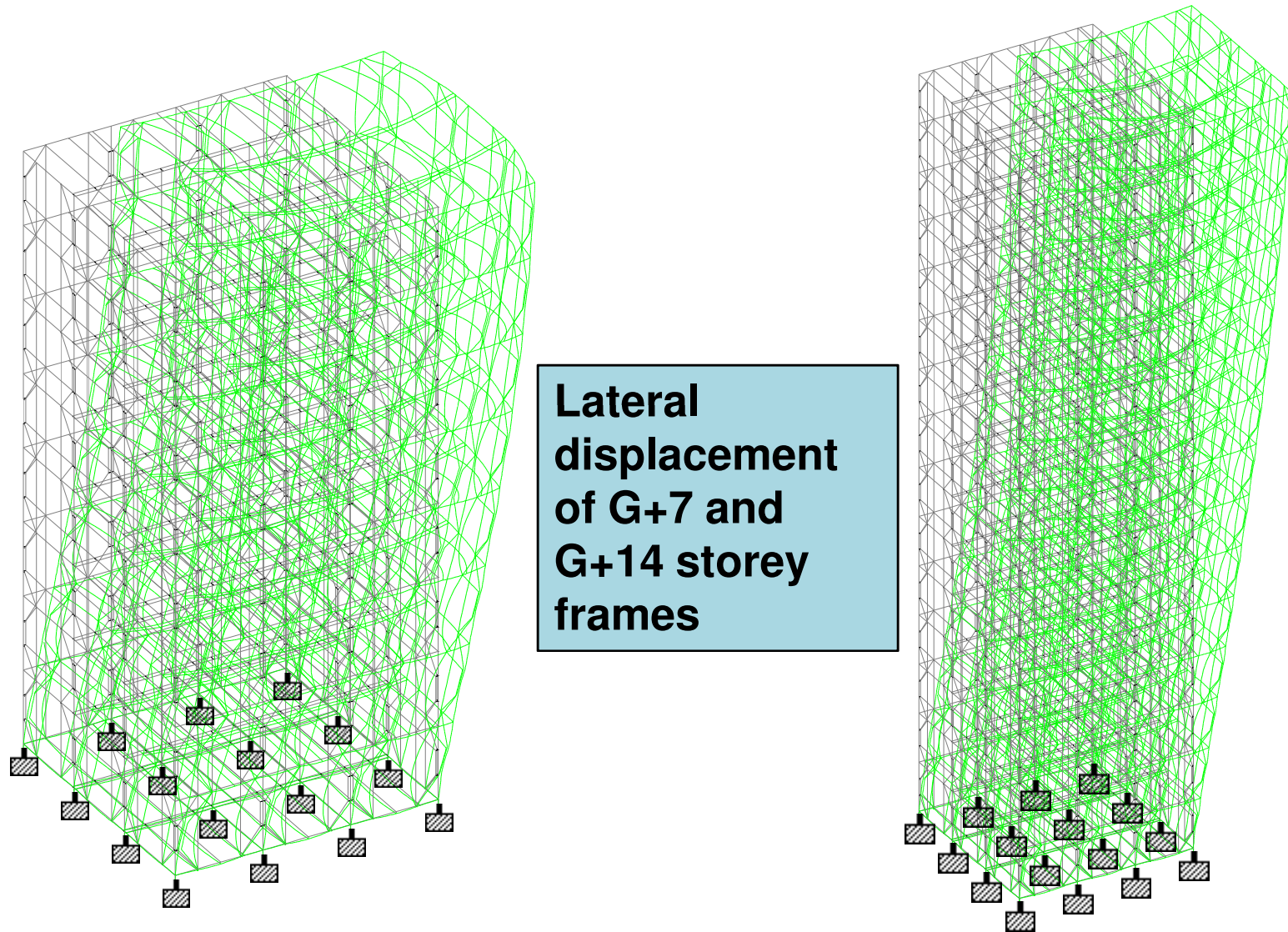


Plot of Responses for 0.36g



| Zone | Maximum Displacement, mm | Maximum Acceleration, m/s ² |
|-------------|--------------------------|--|
| II (0.08g) | 14.24 | 1.5 |
| III (0.16g) | 30.94 | 2.59 |
| IV (0.24g) | 29.55 | 2.45 |
| V (0.36g) | 61.26 | 3.68 |
| 0.48g | 80.10 | 7.14 |

Analytical Simulations - Seismic Response Spectrum Analysis (Zone V)

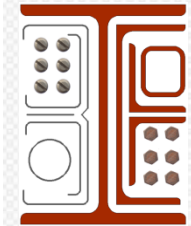




Video on Shake Table Studies





- ⚙ **Highlights of the shake table experimental studies**
- ⚙ **Spectra applied progressively by increasing earthquake motions quantified by peak ground accelerations corresponding to Zones II, III, IV & V as per IS:1893-2002**

Video on Shake Table Studies





Launch of the Building at Mohali

-  **Punjab Deputy Chief Minister Honorable Sukhbir Singh Badal had laid the foundation stone at Mohali, 10 km from Chandigarh**
-  **Construction of the 10-storied building, located in an industrial area in the city of Mohali, began on 29th Nov. 2012, Thursday afternoon at 4.30 pm local time**
-  **Target in assembling 200 tonne building having an area of over 25,000 square meters**
-  **Three cranes and over 200 workers, including technicians, worked “round the clock”**



Salient Construction Details at Site

- ⊗ **All the components of the building were manufactured in the factory and pre-fitted with floors**
- ⊗ **Concrete has been used only in the foundations and three inch deck floorings in the nut and bolt structure**
- ⊗ **More than 80 %of the work is done in the factory**
- ⊗ **Ultrafast technology of construction with less than 20% of work at the site**
- ⊗ **Minimal emission of flying dust and less pollution of water at the site**
- ⊗ **Facade of the building is double skinned PUF panel that ensures thermal insulation**
- ⊗ **Other essentials including provisions for water supply, wiring, sanitation and air conditioning ducts**

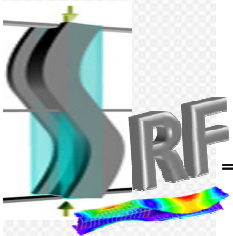
Photos on Construction Details



Photos on Construction Details



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Photos on Construction Details



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Photos on Construction Details



Photos on Construction Details



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Photos on Construction Details



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Photos on Construction Details



PEPSCON 2013



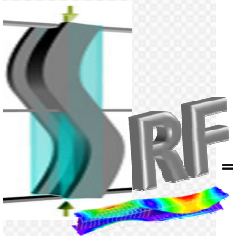
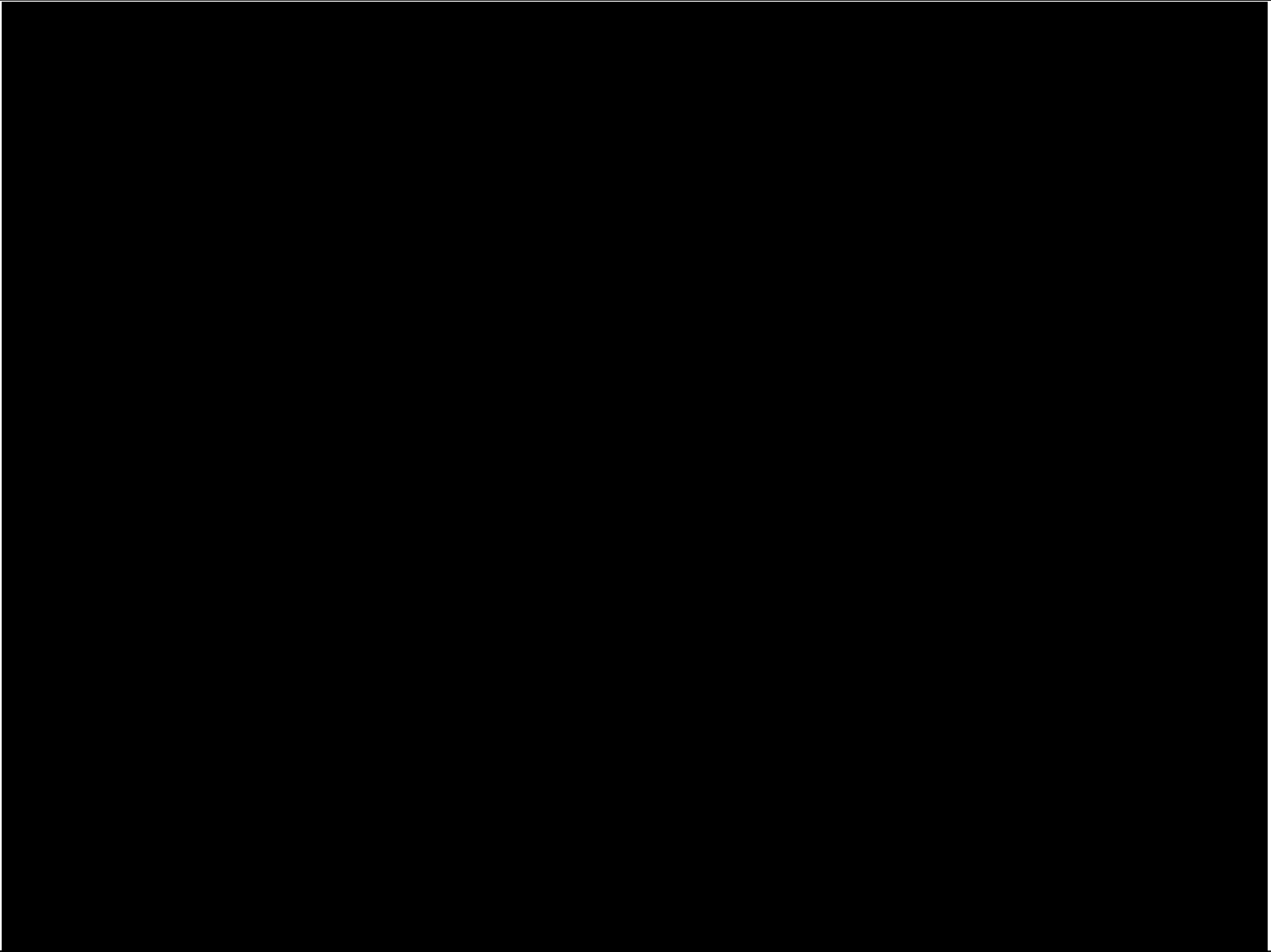
Photos on Construction Details



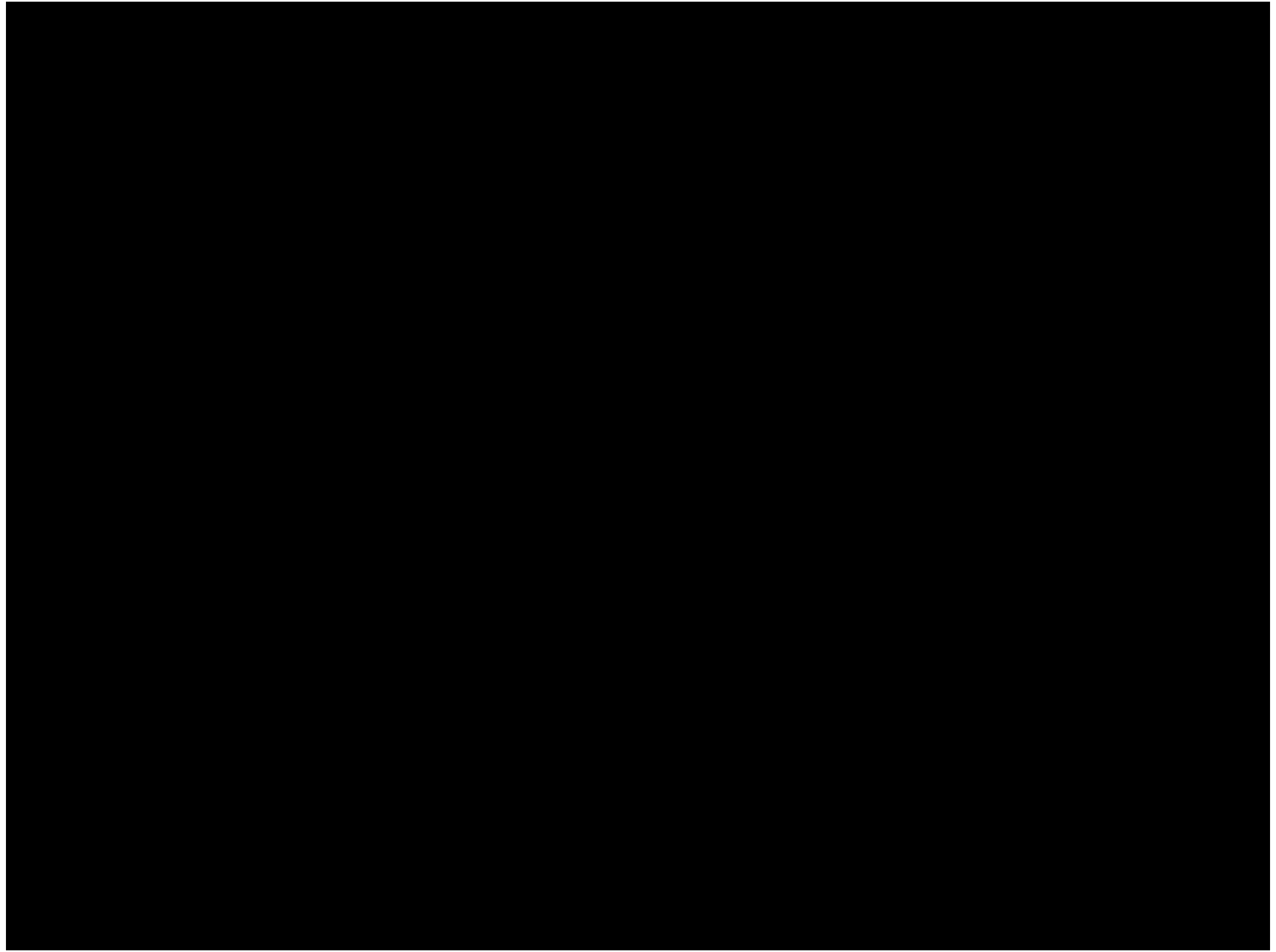
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Video on Launch and Start of the Project



Video at 24hrs after Launch



Completed Building



- ♣ First building of its kind in the country – Limca book of records
- ♣ Completed on 1st Dec, Saturday at 4.30 pm
- ♣ Better, energy efficient construction technology that will enable builders and owners to generate revenue within days, instead of waiting for months

**Well Coordinated
Team Effort**

Tough challenges ...



Thank You

...thrilling opportunities

