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FOREWORD.

The subject of cranes has long related to a branch of engineering devoted to a practical application of a class of problems which afforded good mental training and exercise; for this reason the design of a 25-ton overhead electric travelling crane was chosen by the authors as a suitable subject for this work.

In preparing this volume, the writers have endeavored to approach not every detail in the design of an electric crane, but such that are of great importance, such as the design of the bridge and its chief mechanical details necessary for the drive, system of trolley travel, hoisting mechanism, driving mechanism for the trolley with necessary shafts and gearing, and the selection of appropriate type of motors for driving trolley, bridge and the hoisting.

Some references are made to books which are available to the student in this section, a list of which appears at the end of this volume.

We wish to express our sincere thanks to Professor E. W. Field of the Michigan Agricultural College, who has materially assisted in securing valuable data and crane catalogs, and who has given many helpful suggestions. We wish to express our appreciation to Mr. C. L. Smith of the Detroit Electric Crane Company, and Mr. J. L. Vail of the Crane Company, for their assistance in securing a number of valuable prints from which a list of some overall dimensions were obtained.

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REQUIREMENTS OF THE DESIGN OF THE STRUCTURAL DESIGN.

For

Type: Three-story.

Capacity: 20 tons.

Height: 20 feet.

Width: 20 feet.

Details:

Trolley, 20 ft. / in.

Dist., 20 ft. / in.

Trucks, 20 ft. / in. to be stored
within 10 feet.

Follows: 20 feet per unit.

End base of bridge: 2 ft. / in.

End base of trolley: 2 ft. / in.

End of trolley: 2 ft. / in.

ON THE Y-10.

From:

As a part from the following design, the structural design, the structural design.

1. The design of the design is based on structural design.

2. The design is based on the design of the design.

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$$I/y = 308,274/2,000 = 154.1$$

By trial a suitable section is found.

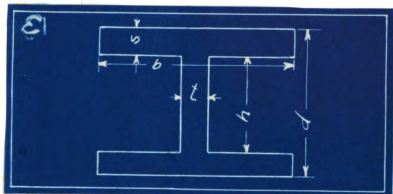


Fig. 2.

Section modulus, $S = I/y = bd^3/6 - b^3(h-t)/6$.

Values assumed, $S = 1$ in., $t = 1$ in., $b = 10$ in.,

$h = 22$ in., $d = 24$ in.

Substituting:

$$I/y = 10 \times (24)^3/6 - (22)^3 \times (10 - 1)/6 \times 24 = 154.7,$$

which indicates that the section is large enough when the values of the various parts are as assumed above.

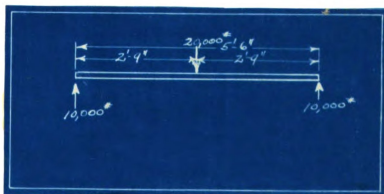


Fig. 3.

Top of page 1, line 10: "and is relevant."

1. The first step is to identify the problem or question that needs to be answered. This involves understanding the context and the specific requirements of the task.

$$U = \pi I/3; \quad 1/3 \approx 1/3 \approx 0, 2/3, 1/3 \approx \dots$$
[illegible]

10/11/1964, Sir Robert Robinson, 100, /1".

10. Total water 10, number of plants is 5 + 15 = 20.
11. 20/2 = 10.

[illegible]

1971

10-11-68

• • • • •

1. The first two items were 1. 2 1/2 x 3 1/2 x 1/2 in.
and 1. 1/2 x 1. 1/2 x 1/2 in. and were found for 100 lbs.
in the dump.

10, and 11. It is not clear, after first inspection, of
rivets remaining in.

12, 1971, 1972, none so rivet, if possible.
 1973, 1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650

Value of bolts in shear, each 1 in. = 7,611 lbs. $\frac{1}{4}$ in.
bolt area is found for one bolt 1 in. to find out the
value of one $\frac{1}{4}$ inch bolt in shear is 3,315 pounds. 1 in
bolt in shear is 11,261 lbs. Number of bolts required
will be.

THE UNIVERSITY OF CHICAGO

1. The first part of the report is a general introduction to the subject of the study.

2. The second part of the report is a detailed description of the methods used in the study.

3. The third part of the report is a discussion of the results of the study.

4. The fourth part of the report is a conclusion and a list of references.

5. The fifth part of the report is a list of appendices.

6. The sixth part of the report is a list of figures and tables.

7. The seventh part of the report is a list of footnotes.

8. The eighth part of the report is a list of abbreviations.

9. The ninth part of the report is a list of symbols.

10. The tenth part of the report is a list of acronyms.

— 2 —

TOP SECRET OF 1951 INFORMATION, FOR ALL

1. I am a member of the following organization: NAACP

[illegible]

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Robert A. Howard, Editor, 1913, W. B. Everts,
1914, 1915, 1916, 1917, 1918, 1919, 1920, 1921, 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1929, 1930, 1931, 1932, 1933, 1934, 1935, 1936, 1937, 1938, 1939, 1940, 1941, 1942, 1943, 1944, 1945, 1946, 1947, 1948, 1949, 1950, 1951, 1952, 1953, 1954, 1955, 1956, 1957, 1958, 1959, 1960, 1961, 1962, 1963, 1964, 1965, 1966, 1967, 1968, 1969, 1970, 1971, 1972, 1973, 1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592

10-11-68 10:00 AM

...the door of exit from
...the steel prison for slavery.

Form 123 ()

72

[illegible]

1. *Chlorophyll a* and *Chlorophyll b* were determined by the method of Lichtenthaler and Sponholz (1980).

7-17-90 Vol. 10-1 of 10-1-92.

to the death of person A, there is no law for holding
person A liable for the death of person B.

10-10-01-001-001-001

$$S = 1.0 \times 10^{-4} \text{ mole/l.} \times 1000 \text{ ml./l.} \times 1000 \text{ g./mole} = 0.1 \text{ g./l.}$$

1964-1965 (1966) 123-124 (11).

11-10-2010 11:10 AM

1. *Chlorophyll a* (Chl *a*)

According to the order of the rule passed on 26 April, the denominator of the ratio was calculated by use of the following formula ():

$$f(r) = \frac{1}{2} \left(1 + \frac{1}{2} \sqrt{1 - \frac{4}{(1 + 2r)^2}} \right)$$

7. The following is a list of the names of the persons who have been appointed to the various positions in the organization of the National Association of Manufacturers:

1944-1945, 1946-1947, 1948-1949, 1950-1951, 1952-1953, 1954-1955, 1956-1957, 1958-1959, 1960-1961, 1962-1963, 1964-1965, 1966-1967, 1968-1969, 1970-1971, 1972-1973, 1974-1975, 1976-1977, 1978-1979, 1980-1981, 1982-1983, 1984-1985, 1986-1987, 1988-1989, 1990-1991, 1992-1993, 1994-1995, 1996-1997, 1998-1999, 2000-2001, 2002-2003, 2004-2005, 2006-2007, 2008-2009, 2010-2011, 2012-2013, 2014-2015, 2016-2017, 2018-2019, 2020-2021, 2022-2023, 2024-2025, 2026-2027, 2028-2029, 2030-2031, 2032-2033, 2034-2035, 2036-2037, 2038-2039, 2040-2041, 2042-2043, 2044-2045, 2046-2047, 2048-2049, 2050-2051, 2052-2053, 2054-2055, 2056-2057, 2058-2059, 2060-2061, 2062-2063, 2064-2065, 2066-2067, 2068-2069, 2070-2071, 2072-2073, 2074-2075, 2076-2077, 2078-2079, 2080-2081, 2082-2083, 2084-2085, 2086-2087, 2088-2089, 2090-2091, 2092-2093, 2094-2095, 2096-2097, 2098-2099, 2100-2101, 2102-2103, 2104-2105, 2106-2107, 2108-2109, 2110-2111, 2112-2113, 2114-2115, 2116-2117, 2118-2119, 2120-2121, 2122-2123, 2124-2125, 2126-2127, 2128-2129, 2130-2131, 2132-2133, 2134-2135, 2136-2137, 2138-2139, 2140-2141, 2142-2143, 2144-2145, 2146-2147, 2148-2149, 2150-2151, 2152-2153, 2154-2155, 2156-2157, 2158-2159, 2160-2161, 2162-2163, 2164-2165, 2166-2167, 2168-2169, 2170-2171, 2172-2173, 2174-2175, 2176-2177, 2178-2179, 2180-2181, 2182-2183, 2184-2185, 2186-2187, 2188-2189, 2190-2191, 2192-2193, 2194-2195, 2196-2197, 2198-2199, 2200-2201, 2202-2203, 2204-2205, 2206-2207, 2208-2209, 2210-2211, 2212-2213, 2214-2215, 2216-2217, 2218-2219, 2220-2221, 2222-2223, 2224-2225, 2226-2227, 2228-2229, 2230-2231, 2232-2233, 2234-2235, 2236-2237, 2238-2239, 2240-2241, 2242-2243, 2244-2245, 2246-2247, 2248-2249, 2250-2251, 2252-2253, 2254-2255, 2256-2257, 2258-2259, 2260-2261, 2262-2263, 2264-2265, 2266-2267, 2268-2269, 2270-2271, 2272-2273, 2274-2275, 2276-2277, 2278-2279, 2280-2281, 2282-2283, 2284-2285, 2286-2287, 2288-2289, 2290-2291, 2292-2293, 2294-2295, 2296-2297, 2298-2299, 2300-2301, 2302-2303, 2304-2305, 2306-2307, 2308-2309, 2310-2311, 2312-2313, 2314-2315, 2316-2317, 2318-2319, 2320-2321, 2322-2323, 2324-2325, 2326-2327, 2328-2329, 2330-2331, 2332-2333, 2334-2335, 2336-2337, 2338-2339, 2340-2341, 2342-2343, 2344-2345, 2346-2347, 2348-2349, 2350-2351, 2352-2353, 2354-2355, 2356-2357, 2358-2359, 2360-2361, 2362-2363, 2364-2365, 2366-2367, 2368-2369, 2370-2371, 2372-2373, 2374-2375, 2376-2377, 2378-2379, 2380-2381, 2382-2383, 2384-2385, 2386-2387, 2388-2389, 2390-2391, 2392-2393, 2394-2395, 2396-2397, 2398-2399, 2400-2401, 2402-2403, 2404-2405, 2406-2407, 2408-2409, 2410-2411, 2412-2413, 2414-2415, 2416-2417, 2418-2419, 2420-2421, 2422-2423, 2424-2425, 2426-2427, 2428-2429, 2430-2431, 2432-2433, 2434-2435, 2436-2437, 2438-2439, 2440-2441, 2442-2443, 2444-2445, 2446-2447, 2448-2449, 2450-2451, 2452-2453, 2454-2455, 2456-2457, 2458-2459, 2460-2461, 2462-2463, 2464-2465, 2466-2467, 2468-2469, 2470-2471, 2472-2473, 2474-2475, 2476-2477, 2478-2479, 2480-2481, 2482-2483, 2484-2485, 2486-2487, 2488-2489, 2490-2491, 2492-2493, 2494-2495, 2496-2497, 2498-2499, 2500-2501, 2502-2503, 2504-2505, 2506-2507, 2508-2509, 2510-2511, 2512-2513, 2514-2515, 2516-2517, 2518-2519, 2520-2521, 2522-2523, 2524-2525, 2526-2527, 2528-2529, 2530-2531, 2532-2533, 2534-2535, 2536-2537, 2538-2539, 2540-2541, 2542-2543, 2544-2545, 2546-2547, 2548-2549, 2550-2551, 2552-2553, 2554-2555, 2556-2557, 2558-2559, 2560-2561, 2562-2563, 2564-2565, 2566-2567, 2568-2569, 2570-2571, 2572-2573, 2574-2575, 2576-2577, 2578-2579, 2580-2581, 2582-2583, 2584-2585, 2586-2587, 2588-2589, 2590-2591, 2592-2593, 2594-2595, 2596-2597, 2598-2599, 2600-2601, 2602-2603, 2604-2605, 2606-2607, 2608-2609, 2610-2611, 2612-2613, 2614-2615, 2616-2617, 2618-2619, 2620-2621, 2622-2623, 2624-2625, 2626-2627, 2628-2629, 2630-2631, 2632-2633, 2634-2635, 2636-2637, 2638-2639, 2640-2641, 2642-2643, 2644-2645, 2646-2647, 2648-2649, 2650-2651, 2652-2653, 2654-2655, 2656-2657, 2658-2659, 2660-2661, 2662-2663, 2664-2665, 2666-2667, 2668-2669, 2670-2671, 2672-2673, 2674-2675, 2676-2677, 2678-2679, 2680-2681, 2682-2683, 2684-2685, 2686-2687, 26

1. 24 410 1001.

7. *As a result of the above, the Commission has concluded that the*

...and the fact that the *Journal* is a journal of the American Psychological Association, the largest and most influential organization in the field of psychology, adds to the journal's prestige and makes it a must-read for all psychologists.

[illegible]

1. The first step in the process is to identify the problem or issue that needs to be addressed. This involves gathering information and understanding the context of the problem.

[illegible]

[illegible]

7. 1. 1971. 1971. 1971. 1971. 1971.

Post Office Box 100, Rio, N.M., U.S.A.

1. The first group of people who are not in the majority are the people who are not in the majority.

1344

The data collected on the three forms of the survey is as follows, which is probably far more accurate than the last survey was.

100-441002-1

[illegible]

The length of the first is 1 foot, therefore the length of the rope must be 100 or else it can burn all day.

$$2 \times 35 = 70 \text{ feet.}$$

Number of turns of rope on each side of the drum,

$$70 \times 12/26 \times 3.1416 = 10.2, \text{ use } 10 \text{ turns.}$$

Thickness of drum under grooves, see Figure 3.

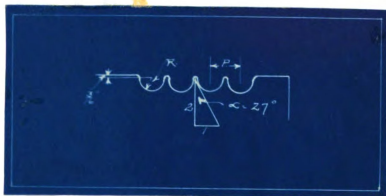


Fig. 4.

$$t = r/12 + 1/8 = 1.82 \text{ inches, use } 1 \frac{7}{8} \text{ inches.}$$

Groove:

$$\begin{aligned} R &= \text{radius of the rope} + 1/32 \text{ inch} \\ &= 3/8 + 1/32 = 13/32 \text{ inches.} \end{aligned}$$

Fitch of groove:

$$\begin{aligned} F &= 1 \frac{1}{8} \times \text{diameter of rope} + 5/16 \text{ inches} \\ &= 1 \frac{1}{8} \times 3/4 + 5/16 = 1 \frac{5}{16} \text{ inches.} \end{aligned}$$

Length of the drum:

$$\text{Space allowed for winding two ropes } 2(12 \times 1 \frac{5}{16}) = 17.75$$

"	"	between ropes on drum	6.00
"	"	on one end of the drum	6.00
"	"	on other end of the drum	6.00

$$\text{Total length of the drum} \quad \underline{\quad 42.75 \text{ in.} \quad}$$

Area for the drum: Marshall p. 207. Formula (1).

$$A = \frac{3}{8} \times 12.0785 \times 3 \times 1 \times 2$$

Force on gear at outer rim = F_1

$$F_1 = 11,400 \times 1.17 = 13,338 \text{ lbs. (max.)}$$

$$F_2 = \text{force on gear at inner rim} = 11,400 \text{ lbs.}$$

Force on tooth (1).

$$F = \frac{F_1 \sqrt{1.25} + F_2 \sqrt{.75}}{2} = \frac{13,338 \sqrt{1.25} + 11,400 \sqrt{.75}}{2} = 12,470$$

Force on tooth of tooth.

$$F = \text{allowable rolling stress of material}$$

$$F = \text{tooth face width (in.)}$$

$$p = \text{circular pitch (in.)}$$

$$n = f/b$$

Substitution in (*).

$$12,470 = \frac{11,400 \times 1.17}{2.5} \times \frac{12.5}{1.5} \times \frac{12.5}{1.5} \times \left(\frac{1}{2.5} - \frac{1}{2.5} \right) \times \frac{1}{2.5}$$

$$= 2.1.$$

$$\text{Face width} = 2.1 \times 12.5 = 26.25, \text{ use } 26.$$

$$\text{Pitch diameter of gear} = 12.5 \times 2 = 25 \text{ in.}$$

$$\text{Pitch diameter of pinion} = 12.5 \times 2 = 25 \text{ in.}$$

Force on tooth 12.

$$F_1 = 11,400 \times 1.17 = 13,338 \text{ lbs. (max.)}$$

$$F_2 = 11,400 \times 1.17 = 13,338 \text{ lbs. (max.)}$$

Use F_1 in design.

DESIGNATION.

15 teeth on pinion and 12 teeth on gear.

Force on shaft from motor is 11,400 lbs. (max.) in order to get the speed.

$$\text{Face width} = 2.1 \times 12.5 = 26.25, \text{ use } 26.$$

Allowable rolling stress of steel is 100,000 psi at this speed of 12,500 rpm.

1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 26

[illegible]

1949 (17).

$$1.1 \times 10^{-7} \times 1.1 \times 10^{-7} = 1.21 \times 10^{-14}$$

Stitch = .1 1/2 x 1 1/2 in. or 2.0 in. or 2.5 inches.

Height of door at top = 7'6" + 3.5 inches.

" " " Division = 100.5 = 6.7 199 99.

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1991

71.000 + 2/3 = 71.333 1/3

$$I = 1/2 \pi y = 1.4 \times 10^6, \quad II = 1.7 \times 10^6, \quad III = 1.7 \times 10^6.$$

1. *Chlorophyll a* and *Chlorophyll b* were determined by the method of Lichtenthal and Whistler (1973).

[illegible]

6 x 1.16 x 10.12 = 7.5 ft. per sq. inch of

1997

Long Island Sound 7,000 lbs.

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Journal of Management Studies, 19(6), 701-718.

$$221 \times 16.66/2 = 1,841 \text{ inch lbs.} \quad \text{Fig. 5.}$$

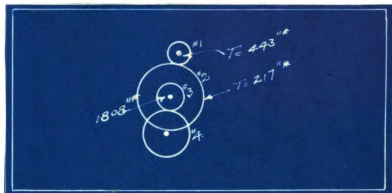


Fig. 5.

Use 6 as diam. pitch, with 22 teeth on the pinion, therefore the pitch diameter is $22/6$ which is 3.66 inches.

$$1,841 \times 2/3.66 = 1,005 \text{ lbs. on each tooth.}$$

$$W = \text{aply, where } s = 7,000; \quad y = .093;$$

$$1,005 = 7,000 \times 3.1416 \times f \times .093/6$$

$$f = 1,005 \times 6 \times 1,000/7,000 \times 3.1416 \times 93 = 2.94$$

inches, use 3 inches.

Speed of pinion is,

$$760/5 = 152 \text{ ft. per min.}$$

Diam. pitch is 6.

$$\text{Pitch diam. of pinion} = 22/6 = 3 \frac{2}{3} \text{ inches.}$$

$$\text{" " " gear} = 3.66 \times 3 = 11 \text{ inches.}$$

Face for pinion and gear is 3 inches wide.

DATA FOR HOISTING MECHANISM.

$$\text{Force acting on teeth on main drive gear} = 15,275 \text{ lbs.}$$

$$\text{Load on drum} = 20,000 \text{ lbs.}$$

Taking moments about bearing "B", see Figure 6,

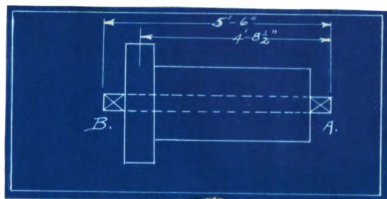


Fig. 6.

Vertical Reaction = 10,000 lbs.

Reaction due to both forces is,

$$15,275 \times 56.5/66 = 13,075 \text{ lbs.}$$

The resultant of these two forces, 13,075 lbs. and 10,000 lbs., from graphical solution resultant = 16,500 lbs., figuring that the pressure line is 15° involute. See Fig. 7.

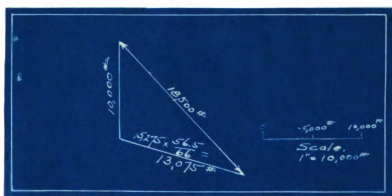


Fig. 7.

Calculations for shaft bending only;

$$M_B = 16,500 \times 9.625 = 178,060 \text{ inch pounds}$$

Formula (5),

$$\text{Defl. of shaft } d = \frac{M}{10.2 \times 10^6 / f_B}$$

Where $F_B = 12,000$, From Kent p. 1021.

$$d = \sqrt[3]{10.2 \times 178,060 / 12,000} = 5.525 \text{ inches, use}$$

commercial size 5 1/2 inches.

Bearing surface for 5 1/2 inch shaft.

Use babbit bearing, 400 lbs. per sq. in.

Projected area for bearing = $12,500 / 400 = 31.25$ sq. in.

Length of bearing = $31.25 / 5.5 = 5.6$ inches.

Shaft No. 2. see figure (5).

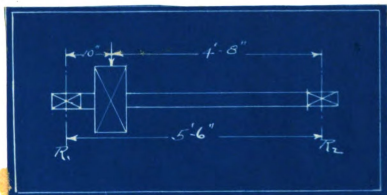


Fig. 8.

Force acting at pitch line is 15,275 lbs.

Reaction R_2 is

$$15,275 \times 56/66 = 12,950 \text{ lbs.}$$

$$R = 12,950 \times 10 = 129,500 \text{ inch pounds.}$$

Calculations for bending and twisting, formula (6).

$$M_{BR} = 0.35 R_B + 0.65 \sqrt{10^6 + R_T^2}$$

$$\begin{aligned} M_{BR} &= 0.35 \times 129,500 + 0.65 \sqrt{(129,500)^2 + (70,000)^2} \\ &= 143,000 \text{ inch pounds.} \end{aligned}$$

Substituting in formula (5).

$$d = \sqrt[3]{10.2 \times 143,000 / 12,000}$$

$h = 1.75$ inches, $r = 0.5$ inches in diameter.
The hole is circular, $r = 1.0$ inch, $h = 1.75$ inch.

Apply the load in the center of the hole in the direction
of the hole h_1 and h_2 .

$$11.75 \times 1.75 = 20.56 \text{ inch}^2.$$

Distance of bearing is

$$11.75 \times 1.75 = 20.56 \text{ inch}^2.$$

Unit No. 1.

The hole is not in the center of the hole, $r = 1.0$ inch, $h = 1.75$ inch.
Distance of bearing is

$$11.75 \times 1.75 = 20.56 \text{ inch}^2.$$

There is very little hole in the center of the hole, $r = 1.0$ inch, $h = 1.75$ inch.
Distance of bearing is $1.75 \times 1.75 = 3.06$, which is h_1 .

Distance of bearing is formula (1),

$$h_1 = (1.75 \times 1.75) + 3.06 \sqrt{(1.75 \times 1.75) + (1.75 \times 1.75)} \\ = 10.94 \text{ inch}^2.$$

Distance of bearing is formula (2),

$$h_2 = \frac{1}{2} \sqrt{11.75 \times 1.75 + 1.75 \times 1.75} \\ = 1.0 \text{ inch}^2, \text{ distance of bearing.}$$

Distance of bearing is

1.75 inch, $r = 1.0$ inch, $h = 1.75$ inch, h_1 and h_2 are as follows:

$h_1 = 11.75 \times 1.75 = 20.56$ inch², $h_2 = 1.0 \times 1.75 = 1.75$ inch² in the center of the hole.

Projector, $r = 1.0$ inch, $h = 1.75$ inch, h_1 and h_2 are as follows:

$$h_1 = 11.75 \times 1.75 = 20.56 \text{ inch}^2, \text{ distance of bearing; for}$$

a and b, see figure 9.

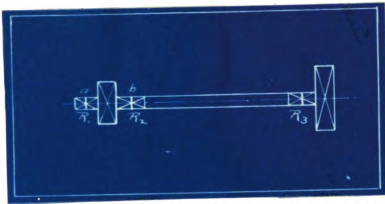


Fig. 9.

Now figuring from rotor shaft to next shaft, twisting moment on the shaft is 19,260 inch pounds.

$T = 63,000 \times 5/500 = 4,410$ inch pounds on the shaft, therefore on the pitch line of the pinion it would be,

$$4,410 \times 2/5.5 = 1,605 \text{ lbs.}$$

Then the reaction near the large gear is,

$$19,260 \times 30.25/32.5 = 17,950 \text{ lbs.}$$

Use bronze bearing allowing bearing pressure 800 lbs. to the sq. in., thus giving the length of the bearing,

$$17,950/3 \times 800 = 7.5 \text{ inches.}$$

As the frame was built 10 inches wide we deemed it advisable to make the bearings the same width, which gave us safe bearing area as no bearing exceeds that width.

Shaft of driving wheels.

Twisting moment on shaft is

$$443 \times 15 \times (.92)^2 = 5,534 \text{ lbs. acting on two wheels.}$$

$$5534 / 2 = 2,767 \text{ lbs. acting on each wheel.} = M_T.$$

As 10 inches was assumed as the distance from center of shaft bearing to center of shaft bearing the bending moment,

$$M_1 = WL/8 = 13,825 \times 10/8 = 16,781 \text{ inch lbs.}$$

Substituting in formula (6) the equivalent bending moment is,

$$M_{eq} = (0.55 \times 16,781) + .55 / \sqrt{(2767)^2 + (16,781)^2} \\ = 16,925 \text{ inch pounds.}$$

Substituting in formula (5), for diameter of shaft,

$$d = \sqrt[3]{10.8 \times 16,925 / 9,000} = 1.63 \text{ in., use } 1 \text{ in.}$$

Interpolate shaft.

Torsion moment on the shaft is 1,833 inch pounds;

Assume that the bending moment, which is not present, is equal to the torsion moment, or that the bending moment is equal to the torsion moment, 1,833 inch pounds.

Substituting in formula (5), for diameter of shaft,

$$d = \sqrt[3]{10.8 \times 1,833 / 9,000} = 1.27 \text{ in., use } 1.5 \text{ in.}$$

CHILL YOUNG L.

The trolley wheel was designed according to proportions found in Heus, page 67.

Diameter assumed was 12 inches, with tread $1\frac{1}{4}$ inches, and a constant of 200 lbs. per sq. in., then substituted in the formula,

$$W = c. b. T.$$

W = total load wheel will stand.

b = tread in inches.

c = constant, between 500 and 900 lbs. per sq. in.

$W = 500 \times 1\frac{1}{4} \times 12 = 16,250 \text{ lbs., this is safe as the wheel load is figured at } 17,500 \text{ lbs.}$

SHEAVE.

From investigation we found it advisable to use 21 inch
lower sheave. In order to determine the size of the shaft
it was necessary to find the maximum moment which is,

$$P \times a = \text{max. moment.}$$

$$M_p = 20,000 \times 2 \frac{1}{2} = 50,000 \text{ inch pounds.}$$

$$fx = 30,000$$

$$z = 50,000/10,000 = 5$$

$$= 5.1415 \times d^3 / 32, \quad \text{Cornish, page 153.}$$

$$= 3.71 \text{ inches, use 4 inches.}$$

The sheave wheels are to rove on the shaft, and the shaft
to be fastened. The bearing is to be steel on bronze, allow
1,100 lbs. per sq. in.

$(20,000/1,100)/4 = 4.55 \text{ sq. in., which is sufficient.}$
none was used.

Calculations for shear, crushing above hole for shaft.

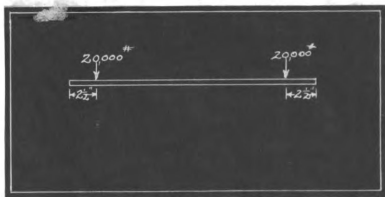


Fig. 10.

$$a = 20,000/10,000 = 2 \text{ sq. in.}$$

$$t = 3 / 5 = .6 \text{ inches, thickness of the plate}$$

necessary but I think not usual.

Next for the length of shaft at lower end of plate.

$$\text{Lower Arm} = 2 \frac{1}{2} = 9/2 = 4 \frac{1}{2} \text{ inches.}$$

$$20,000 \times 2 \frac{1}{2} / 32 = 12,500 \text{ inch lbs.} = \text{lb.}$$

$$s = 44,375 / 12,500 = 3.54 \text{ inches}$$

$$s = 3.54 = d^{1/2}$$

$$d^2 = 3.54 \times 2 / 3.1416$$

$d = 1.54$ inches, so it is safe to reduce the shaft to $1 \frac{1}{2}$ inches in diameter through the plate.

III. C. IVX.

The inner sleeve is 1 inch in diameter at the shaft the same diameter as for the inner sleeve. The sleeve is to move on the shaft, and the shaft is to be fastened with a bronze bushing. Refer to sheet number 5.

For inner support see sheet number 5.

IVX.

The section of the lock was calculated from formula, from Table, page 1114, formula (7).

$$s/F = 1 / (1 + \gamma P_1 / R^2), \text{ where}$$

P = load.

R = area of section.

γ = square of the radius of curvature.

F = allowable fiber stress in lbs. per sq. in.,

22,500 lbs. per sq. in., for structural steel.

From Table, Kent page 1114, for long or short column:
 $d = 1 \frac{1}{2}$, also: s/F or $P = 1.777$, $\gamma = 7.5$, $d = 1.1$.

$$R = (1 + \gamma/F) = (7.5 + 1.777) \times 1.1^2 = 11.9$$

$$12 = \frac{127.1 (15.12 + 17.77 + 1.21)}{18 (15.29 + 7.76 + 1.71)} = 2.1$$

$$v_1 = (1.3 + 1.2 \times 5) / (1.3 + 1.1 \times 3) = 2.08$$

$$v_0 = 2.08 + 3 = 5.08$$

$$v/c = 11.5 / (1 + 1.17 \times 5.08/2.1) = 1.91. \text{ which}$$

indicates that the above section is all right.

Look at short; $r = 1.1$ inches Yokes.

For calculating d_1 and d_2 .

$$P = (-121/4) (d_1^2 - d_2^2) f_1. \text{ Formula (3)}$$

$f_1 = 1,000$ lbs., pressure on the anchor, then

$$17,64 (d_1^2 - d_2^2) 1,000 = 1,000$$

$(d_1^2 - d_2^2) = 11.11$, assume d_2 equal to $3 \frac{1}{2}$ inches.

$$d_1^2 = (3 \frac{1}{2})^2 + 11.11,$$

$$d_1 = 4.75, \text{ use } 5 \text{ inches.}$$

For $b_1 b_2$ from b_1 on $2 \frac{1}{2}$ inches, not fitting in the formula,

$$H/4 = (1 \times b_1 b_2^2 / 4) f_1. \text{ } H = 11.1 \text{ lbs.}$$

$$f_1 = 10,000.$$

$$(b_1 b_2^2 / 4) = 10,000 \div 11,100 = 14.17 \frac{1}{4}.$$

$$b_1 b_2 = 10,000 \div 11.175 \times 2/10,000 = 19.137$$

$$2.5 b_1^2 = 19.137.$$

$$b_1 = 1.7 \text{ inches, use } 2 \text{ inches.}$$

For stress on the bolt; 7,500 lbs. per sq. in., allowed in shear for bolts.

$10,000/7,500 = 1.34$ sq. in. area of bottom of thread, and standard 1 inch bolt, area at bottom of thread 5.817 in.

Then at least 4 other anchor bolts $= 4 \times 1 \frac{1}{2}$ inches.

Side rail center to center of girder = $3 \frac{1}{2}$ inches.

WHEEL SPACING.

The wheel spacing is approximately equal to the ~~radius~~ wheel base, i. e., 13,700 mm. The center will be of the box type with side plates $\frac{1}{2}$ inch thick. 1 foot apart at the middle and 1 1/2 inches at the ends.

The unit wheel load is,

$13,700 \div 1 \times \frac{1}{4} \times 12 = 4,110$ lbs. per sq. in., which is safe.

Assume the trolley wheel base is 66 inches. Maximum wheel load will cover 1 sq. ft. and be 4110 lbs. $\div 4$. The center of span. See figure 11.

Formula (1) for maximum moment,

$$M = \left(\frac{W}{100(1 - \frac{a}{2l})^2} + \frac{wl}{2} + \text{weight of motor} \times \frac{l}{4} \right) \times a$$

where a = wheel spacing.

W = weight of live load in pounds.

l = length of the girder span in inches.

w = weight of the girder in pounds.

The bridge is to be a set of two or one of the Kennedy type, then a will be $\frac{1}{2}$ of the total live load.

Assume weight of trolley 13,700 lbs.

Wheel load (27 tons) 55,200 "

Total load acting on girder 98,700 "

Assume weight of girder 50 lbs. per sq. ft.,

Assume weight of motor 100 pounds.

Then substituting in formula (1),

$$M = \frac{98,700}{100(1 - \frac{66}{2 \times 137})^2} + \frac{50 \times 137 \times 12}{2} + \frac{100 \times 137}{4} \times 66$$

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$U = 2,934,000$ fiber stress.

Approximation of fiber stress allowed $10,000$ lbs. per sq. in. fiber stress.

$M =$ large area under load $\times$ fiber stress $\times r$, where r is the distance from c of fl. web.

$$d = 36 - 1 = 35 \text{ inches.}$$

$$A = 1,934,000 / 10,000 \times 35 = 13.74 \text{ sq. in.}$$

Young's calculation is that $1/4$ of the web section is assumed as resisting bending.

$$1/8 \times 72 \text{ web} \times 1/4 \times 16 = 1/4 \times 16 = 2.25 \text{ sq. in.}$$

and the fiber stress limit on fiber stress $10,000$ lbs. per square inch.

| | |
|--|-----------------|
| $1/8$ web area | 2.25 sq. in. |
| 1 cover plate $22 \times 3/16$ | 6.93 " " |
| 2 angles $4 \times 4 \times 1/4$ " " " " | <u>5.72</u> " " |
| Total area | 14.90 " " |

The above is for $10,000$ lbs. per sq. in. fiber stress, but the maximum stress will slightly exceed this so as we assumed the compressive stress to be $9,000$ lbs. per sq. in.

With the above total section take the following as the final at this stage.

$$d = 1.577 \times 2.2 = 3.47 \text{ inches.}$$

$$A = 1,934,000 / 10,000 \times 3.47 = 11.74 \text{ sq. in.}$$

Based on $10,000$ lbs. per sq. in. fiber stress.

$$17.41 \times 1.11 = 1.93 \text{ sq. in. based on } 9,000 \text{ lbs.}$$

per sq. in., fiber stress.

Flange area is,

| | | |
|----------------------------------|------|-----|
| 1/2" x 1/2" x 1/2" x 1/2" x 1/2" | 6.75 | in. |
| 2 x 1/2" x 1/2" x 1/2" x 1/2" | 6.75 | " " |
| 2 x 1/2" x 1/2" x 1/2" x 1/2" | 6.75 | " " |
| 2 x 1/2" x 1/2" x 1/2" x 1/2" | 6.75 | " " |
| 2 x 1/2" x 1/2" x 1/2" x 1/2" | 6.75 | " " |

Weight = 1.00 lb.

Weight of this section = 1.00 lb. = 16.01 oz.

Weight = 1.00 lb.

| | Area. | Weight. |
|--------------------------|----------------|---------|
| 1" x 1/2" plate | 6.75 x 1.17 = | 1.00 |
| Upper angles 1/2" x 1/2" | 6.75 x 1.17 = | 1.00 |
| 2" thick plate | 12.00 x 1.17 = | 1.00 |
| Lower angles 1/2" x 1/2" | 6.75 x 1.17 = | 1.00 |
| 1" x 1/2" plate | 6.75 x 1.17 = | 1.00 |
| | 31.17 sq. in. | 7.00 |

Weight for rivet holes, 11.17 lb. = 178.72 oz.

| | |
|---------------------------------|------|
| 2 x (11/16 x 11/16) = 1 x 11/16 | .75 |
| 2 x (11/16 x 11/16) = 1 x 11/16 | .75 |
| Total rivet | 1.50 |
| Weight = 1.17 x 1.17 = 1.00 | |

| | Area. | Weight. |
|-------------|---------------|---------|
| Section | 31.17 | 7.00 |
| Rivet holes | 1.50 | .75 |
| Total | 32.67 sq. in. | 7.75 |

Center of gravity is,

$$x = 719.014 / 32.67 = 22.00 \text{ in.}$$

2" HT OF 15" DIA.

Upper flange plate:

$$bd^3 / 12 \quad (\text{negligible})$$

$$Ah^2 = 6.75(17.55 - .1875)^2 = 2,000.57$$

Flange angles:

$$2 \text{ angles at } 4.51$$

$$= 5.72$$

$$Ah^2 = 5.72(17.55 - 1.515)^2 = 1,466.15$$

Web plates:

$$bd^3 / 12 = 2 \times .25 \times 18^3 / 12 = 2,376.45$$

$$Ah^2 = .5 \times 2 \times 1.514^2 = 68.91$$

Lower flange angles:

$$2 \text{ angles at } 3.18$$

$$= 5.72$$

$$Ah^2 = 5.72 \times 19.7^2 = 2,219.87$$

Lower flange plate:

$$bd^3 / 12 \quad (\text{negligible})$$

$$Ah^2 = 5.675 \times 21^2 = 2,480.625$$

$$I = 10,962.115$$

Live loads (neglecting Ah^2 values only).

Lower flange only in tension,

$$4 \times .675 \times 20.51^2 = 1,100.2$$

Net I is,

$10,962.115 - 1,100.2 = 9,861.91$, web stiffeners not so considered in the allowance for rivets.

The extreme fiber strain in compression then will be,

$$f = p_1 I / M; \quad p_1 = Y e / I$$

$$p_1 = 5,902.46 \times 17.55 / 9,861.91 = 1,072 \text{ lbs. each}$$

check for design.

Max tension,

$$P_5 = 4,900,000 \times 21.357 / 7,771.1 = 12,870 \text{ lbs.}$$

which checks for tension.

GRAPHICAL FORM.

Total load on the trolley 51,700 pounds distributed over four wheels.

Load on each wheel is,

$$51,700 / 4 = 12,925 \text{ lbs.}$$

Refer to sheet number 7, (load at in back cover).

Figure 1, wheel 1 inch = 16,000 lbs., $W = 16,000 \text{ lbs.}$

Figure 2, the scale of linear dimension is 1 inch = 10 ft.

Figure 3, the scale is 1 inch = 16,000 x 2 = 32,000 ft. lbs.

In the lower part of Figure 1, the bending moment due to the uniform load of the girder is 500 lbs. per lin. ft.

$$500 \times 50 = 25,000 \text{ inch pounds for center girder.}$$

Little ordinate is in

$$1 / 16,000.$$

$$W = 25,000 / 16,000 \times 1000 = 15,625$$

$$W = 15,625 / 12,925 = 1.21 \text{ ft.}$$

Scale off to the scale, 1 inch = 10 feet.

Moments corrected by 15 %.

$$4/10 \text{ span} = 3,333,333 \times 1.05 = 3,500,000$$

$$3/10 \text{ " } = 2,777,777 \times 1.06 = 2,944,444$$

$$2/10 \text{ " } = 2,222,222 \times 1.02 = 2,266,666$$

$$1/10 \text{ " } = 1,111,111 \times 1.01 = 1,122,222$$

Depth of web:

$$4/10 \text{ span} = 3,500,000 / 2,10 \times 15.17 = 25.9 \text{ in. min.}$$

$$3/10 \text{ web} = 1,945,714/9,000 \times 14.37 = 30.5 \text{ inches.}$$

$$2/10 \text{ " } = 2,335,354/9,000 \times 14.37 = 37.1 \text{ "}$$

$$1/10 \text{ " } = 1,459,164/9,000 \times 14.37 = 11.5 \text{ "}$$

1/10 of the web was deducted for shear alone.

Flange area is,

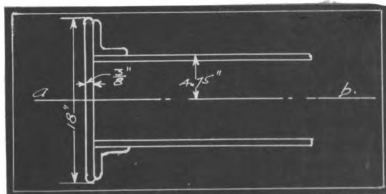
| | |
|------------------------|-----------------|
| Angles 6"x 4"x 3/16" | 5.72 sq. in. |
| Plate 14" x 3/16" | 6.75 " " |
| 3/5 of 1/10" web plate | <u>1.00 " "</u> |
| Area | 13.47 " " |

Before the section is finally adopted, it should be examined for the lateral bending that may come upon it due to suddenly stopping the fully loaded crane, if the brake operating upon the bridge shaft can exert a retarding force sufficient to stop the crane in 10 feet.

Weight in pounds:

| | |
|-----------|---------------|
| Bridge | 50,000 |
| Trrolley | 15,750 |
| Motor | 1,200 |
| Live Load | <u>60,000</u> |
| Total | 127,000 |

The moment of inertia of the upper flange must now be found. Refer to Figure 12.



Inertia about A (ft. lb.).

$$\begin{aligned} W_1^2 / 2 &= .75 \times 10^3 / 2 &= 113.25 \\ 2 \text{ wheels } W_2^2 / 2 &= 10^3 / 2 &= 100.00 \\ W_3^2 &= 1.7^2 \times 10^3 &= 21.07 \\ 2 \text{ girder } W_4^2 &= 10 \times 1/2 \times 10^3 &= \underline{175.00} \\ \text{Total} & &= 310.32 \end{aligned}$$

Inertia energy of the wheels,

$$W_1^2 / 2 = (.75 \times 10^3 / 2) (10/60)^2 = 11.46 \text{ ft. lbs.}$$

Inertia energy of the trolley and live load,

$$W_2^2 / 2 = (10^3 / 2) (10/60)^2 = 21.07 \text{ ft. lbs.}$$

Total retarding force for one girder wheel,

$$11.46 / 2 \times 10 = 57.3 \text{ lbs.}$$

Total retarding force for one girder, trolley and load,

$$21.07 / 2 \times 10 = 105.35 \text{ lbs.}$$

$$F = \frac{W_1 V}{L} + \frac{W_2 V}{L}$$

$$= 500 \times 10 \times 1/60 + 1000 \times 10 \times 1/60 =$$

$$= 166.67 \text{ inch pounds.}$$

$$F = p I / a; \quad p = F a / I;$$

$$p = 166.67 \times 9/16 = 9.375 \text{ lbs., this must be}$$

added to pressure of bolts.

The fiber stress in the upper flange will be,

$$10,000 + 9,375 = 19,375 \text{ lbs., for the worst conditions}$$

possible it will be safe.

$$F = 166.67 \text{ inch pounds } \times 12 = 2,000.$$

The end reaction is given only for conditions in the table. The reactions are given for the 10 ft. span of steel member 7. From the above and column 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 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.

accounting for both dead and live loads.

S_1 = load (lb/ft) due to weight of floor 1 with moment that steel beam is distributed over 30 inches length. (See page 1, 2)

$$S_1 = W/L \text{ lb./ft.}$$

V = vertical shear in rivets.

P = vertical distance between 2 beam rivets in the upper and lower flanges.

S_2 = shear of flange 1 per inch of span.

If S = the shear stress upon rivets per one inch of span then,

$$S = \sqrt{S_1^2 + S_2^2} \quad \text{and the rivet spacing is,}$$

s = rivet value / S , where v is the value of rivets secured horizontally.

Trolley steel concentration is,

$$(11,000 + 13,700)/4 = 12,325 \text{ pounds.}$$

$5/16$ in. is:

$$S_1 = 12,325 / 30 = 410.8, \text{ and } 37.$$

$$S_2 = 13,700 / 37 = 370.$$

$$S = \sqrt{410^2 + 370^2} = 551.$$

Using $5/16$ inch rivets would make area of rivets,

$$1,000 / 551 = 1.8 \text{ inches.}$$

The limit is 3 inches (according to practice, not more than 16 times the thickness of plate) so shear stress is over 7,500 lbs. per sq. in.

$1/16$ in. is:

$$S_1 = 12,325 / 31 = 397; \quad S_2 = 37.$$

$$d = \sqrt{(1.5)^2 + (.3)^2} = 1.59.$$

$$1.59 / 1.7 = .93 \text{ inch pitch, use } 1 \text{ in. pitch.}$$

2/30 in.:

$$V_2 = 10,000 / 1.7 = 5882; \quad \sigma_2 = 171.$$

$$d = \sqrt{(1.7)^2 + (.3)^2} = 1.73.$$

$$1.73 / 1.73 = 1 \text{ inch pitch, use } 1 \frac{1}{2} \text{ inch pitch.}$$

USE RIVET 2/30.

Area = 1 square inch / Rivet stress in tension.

$$1 = 10,000 / 10,000 = 1.0 \text{ sq. in.}$$

All shear rivets for rivets, .115 in. in.

$$2.17 + .115 = 2.28;$$

$$2.28 / 2 = 1.14 \text{ sq. in. for tension. (use 1.11)}$$

Use 1.11 sq. in. / 1.11 sq. in. = 1 in.

$$d = 1/10 (12,000 - 1), \text{ for } 10 (1), \text{ for } 10.$$

$$d = 1199 \text{ for } 10 (1), \text{ for } 10 (1), \text{ for } 10 (1)$$

in. in.

$$1 = 1199 \text{ for } 10 (1),$$

$$1 = 1199 \text{ for } 10 (1),$$

distributed in 10 (1),

$$d = (1/10) (12,000 - 1) / 10 = 1199 \text{ for } 10 (1),$$

distributed in 10 (1),

The value of 1/10 is used for 10 (1) for 1/10 inch pitch

pitch, using a bearing value of 1, for 10 (1) for 10 (1), is

$$1.15 \times 10,000 = 11,500 \text{ for } 10 (1),$$

value of rivets is,

$$11,500 / 1,175 = 9,800 \text{ for } 10 (1),$$

$$11,500 / 1,175 = 9,800 \text{ for } 10 (1)$$

END STIFFENERS.

End stiffeners to be same as web stiffeners.

Distance apart is equal to depth of the section at end.

Rivet spacing is the same as for the web stiffener.

REACTIONS.

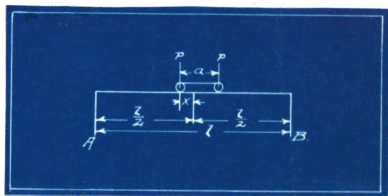


Fig. 13.

$$A = P (1 + 2z/l - a/l)$$

$$B = P (1 - 2z/l + a/l)$$

Substituting;

$$A = 12,425 (1 + 2 \times 1.275/50 - 5.5/50) = 12,637 \text{ lbs.}$$

$$B = 13,425 (1 - 2 \times 1.375/50 + 5.5/50) = 14,163 \text{ "}$$

Reaction due to dead load,

$$15,000 / 2 = 7,500 \text{ lbs.}$$

Total reactions;

$$A = 12,637 + 7,500 = 20,137 \text{ lbs.}$$

$$B = 14,163 + 7,500 = 21,663 \text{ " (Hess p. 11)}$$

BRIDGE TRUSS.

See figure 14.

$$R = Pa + wl^2/2$$

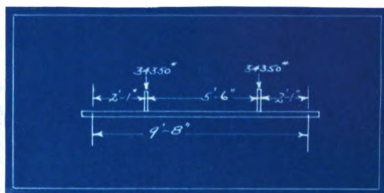


Fig. 14.

$$W = 34,350 \times 2 \frac{1}{2} \times 12 + 35 \times 10 \times 10 \times 12/3 \\ = 865,900 \text{ inch pounds.}$$

$$W = 9 \text{ I/c;}$$

$$I/c = 865,900 / 10,000 = 8.66$$

From Cambria, page 163, select 2 channels, 15 inch,
40 pounds.

Maximum wheel load, the following weights were assumed.

$$\text{Weight of trolley} \quad 13,700 \# = W_T$$

$$\text{Load} \quad 40,000 \# = L$$

$$\text{Weight of Bridge} \quad 30,000 \# = W_B$$

Maximum wheel load is,

$$W_B / 4 + (W_T + L) / 2$$

Substituting;

$$30,000/4 + (13,700 + 40,000)/2 = 34,350 \text{ lbs.}$$

SPLIT SECTION.

Use 1/2 inch plate on the inside of the girder and 3/8
inch on the outside. Shear at split section from shear

diagram is 22,800 lbs.

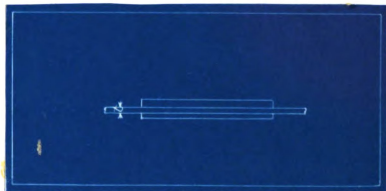


Fig. 15.

t = thickness of plate.

P = compression load.

p = pitch of the rivets in one row, using $5/8$ inch rivets.

Shear on rivets:

$$P = 1/4 \times 3.1416 \times (5/8)^2 \times 20,000 = 6,136 \text{ lbs. per rivet.}$$

Number of rivets;

$$22,800 / 6,136 = 3.6 \text{ rivets, use 4 rivets.}$$

Compression on rivets;

$$P = 2 \times 1/4 \times 5/8 \times 20,000 = 6,250 \text{ lbs.}$$

Number of rivets;

$$22,800 / 6,250 = \text{approx. } 3.6, \text{ use 4 rivets.}$$

Tension in plate;

$$P = 1/4 (4 - 5/8) 12,000 = 9,750 \text{ lbs.}$$

BRIDGE MOTOR POWER AND DRIVE.

Force per ft. motor for bridge drive.

$$F. P. = \frac{(W_1 + W_2 + L)(f + \mu r) + B \times 1.5}{B \times 31,000}$$

Substituting, force per ft.

$$3.5 \frac{(10,000 + 17,700 + 11,000)(.25 + .20 + .2) + 3 \times 20}{31 \times 31,000}$$

$$F. P. = 12.9$$

Select a gear 1 - motor, 2000 R. P. motor, 10-12 ft.

2000 R. P. motor.

Force per ft. driving shaft, 12 inches.

The bridge wheel is 12 ft. diameter.

$$F. P. \times \text{circumference} = \text{work in ft. per minute}$$

circumference of wheel is 37.7 ft.

Substituting:

$$12.9 / 31 \times 3.1416 = 12.7, \text{ use } 12.7 \text{ R. P.}$$

Substituting, motor to driving shaft.

$$12.7 / 30 = 11.7, \text{ use } 11 : 1.$$

$$1 - 11:1; 1 - 1:1:$$

The gear must be designed for the torque due to the bridge or the torque due to the driving motor. Whichever is the larger.

For the driving motor, the torque is.

$$T = 61,000 \times 12.9 / \pi$$

$$= 61,000 \times 20 / 3.14 = 2,300 \text{ ft. lbs.}$$

Kinetic energy in crane (weight and full load and full speed).

$$WV^2/g = (17,700 \times (112/60)^2) / 3.2 = 12,500 \text{ ft. lbs.}$$

The force exerted on the cable when it is suddenly
retained by stopped at the crane is about 10 feet.

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