TRENDS IN SUBMARINE CABLE SYSTEM FAULTS

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On behalf of the *Submarine Cable Improvement Group* (www.scig.net)

Abstract: This paper is written on behalf of the Submarine Cable Improvement Group (www.scig.net). Data from undersea system faults continues to be collected by several organizations. The analysis herein highlights recent system faults and provides a continuation of previous studies which were presented in 2004, 2001, and 1997. Global trends are reported, with focus on data from the last six years.

1 FAULT DATA SOURCES AND METHODOLOGY

As others within the submarine cable industry, several members of the SCIG maintain fault databases. In this analysis, data from Tyco Telecommunications and Alcatel-Lucent Submarine Networks are used to focus on the last three years, or since the last similar data was published. The analysis studied data from the two sources separately, and presented them side by side in the first two figures. Trends focused on the last six years, from 2001 to 2006, as opposed to the last study[1] which compared data as far back as the late 1980's.

The data has been separated into three general categories: External aggression, Component, and Other. Within the external aggression categories, data was subdivided between fishing, anchors, abrasion, geological, dredges, crushing and others. A great effort has been expended to properly allocate the faults to the right category. However, similar to most field data collection efforts, some interpretation was required. In instances where faults could not be binned, these were assigned the special category of other. Overall conclusions within the study are not affected by these interpretations.

The analysis that follows is presented in two sections. First, the total number of faults throughout the world, as reported in the two databases, is presented from an absolute point of view. Second, the data is normalized using the total number of systems and their associated lengths. Length-normalized fault rates are presented in faults per 1000 km, as the sum of number of faults divided by the total length of cable. Focusing on the last six years made the graphs easier to read. The data was further separated into two depth ranges – cable in less than 1000 meter water depth and cable in water depths greater than 1000 meter.

2 ABSOLUTE FAULT ANALYSIS

Faults are grouped into three major categories – External Aggression, System Component and Other/Unknown. Figure 1 shows the data, presented by data source, and clearly indicates the similarities with previous studies[i,ii,iii,4], where external aggression type faults represent the dominant category, accounting for over 70% of all faults for the 2004-2006 period. They range between 72% and 86% whereas component-based failures are in the range of 2% to 11%, and Other/Unknown range between 2% and 27%, depending on which database is considered.

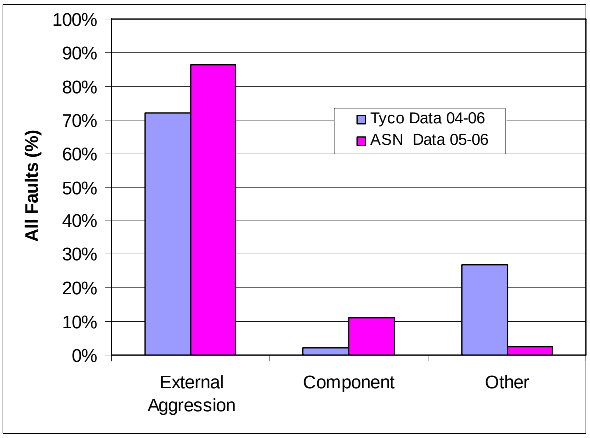

Figure 1. Overall Causes of Fiber Optic Cable Failure

External aggression faults are separated into sub-categories in Figure 2, which include either 'human activity', such as fishing, anchors and dredging, or 'natural aggression' such as earth movement and chafe/abrasion. These are also presented by data source.

Faults attributed to human activity are greater than 80% in both databases. Greater than three out of every four external aggression faults is attributable to human activity, either from fishing or from dropping and/or dragging anchors. Fishing remains the major cause of human activity faults, making up about 60% of all external aggression faults.

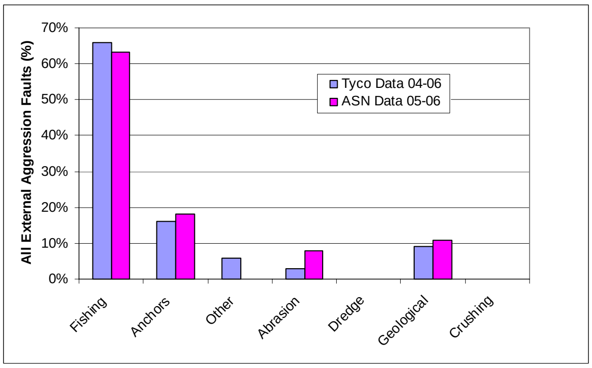

Figure 2. External Aggression Faults for all Water Depths

Abrasion failures average less than 5% between the two data sources, while Geological failures average about 10%, and no Crushing faults were reported. This could be the result of higher magnitude geological activities on the ocean bottom resulting in cable tension failures rather than crushing and/or chafing failures that result from a lower magnitude activity, with relatively minor earth movement.

The above two Figures have established that the two databases provide equivalent trends for all External Aggression faults. Thus, the rest of the data analysis is conducted using one data source for expediency.

All external aggression faults with respect to depth are presented in Figure 3a.

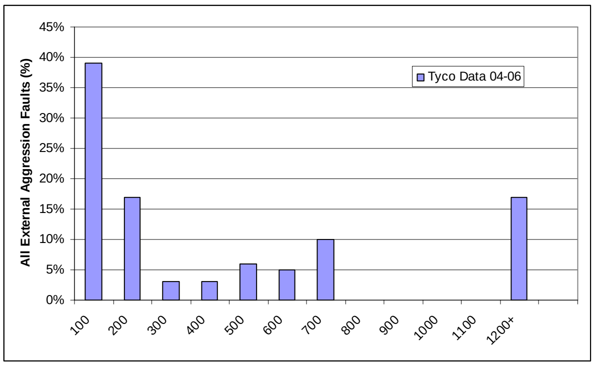

Figure 3a. Depth Distribution of all External Aggression Faults

The majority of the faults still occur in water depths of 200 meters or less, with about 40% of faults occurring in less than 100 meters. For the time period of this analysis, i.e. 2004 to 2006, the rest of the shallow water faults occur in the 300 to 700 meter range. This data is compared to that of previous studies[1], as presented in Figure 3b, where the period of 2001 to 2003 showed a greater fault activity in the 700m to 1000m water depths. The present data is reminiscent of the 1986 to 1995 data. It could be an indication of a fishing trend that has reverted back to fishing in water contours shallower than 700m. Deep water External Aggression faults are still hovering around the 15%.

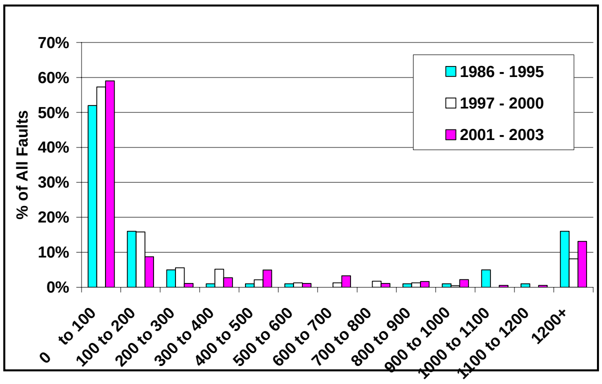

Figure 3b. Depth Distribution of all External Aggression Fiber Optic Faults[1]

These same phenomena are also seen in Figure 4 which focuses on fishing faults only, and shows the distribution of fishing-based faults with respect to water depth.

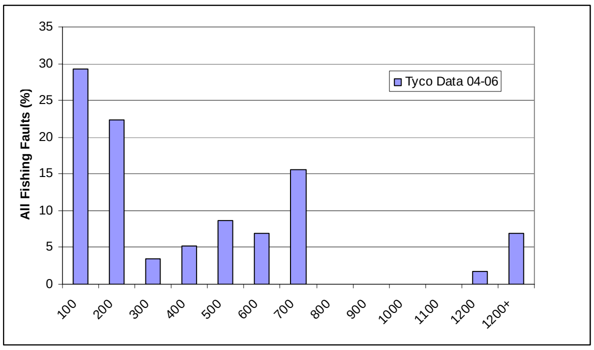

Figure 4. Water Depth Distribution of Fishing Faults

3 LENGTH NORMALISED DATA

If one is to use fault data for planning additional undersea systems, their routes and maintenance services, then a useful reference unit could be obtained from further analysis of the data. Such reference unit, normally called “Faults per 1000km”, is obtained by dividing the number of faults by the total length of cables deployed. This reference unit is only useful in a global sense, since it could be misleading if one uses it locally where fishing, and/or geological trends are significantly different.

The trends presented in this section focused on the last six years, from 2001 until 2006, as opposed to those which compared data as far back as the late 1980’s[1,2].

Length-normalized fault rates per year, in shallow and deep waters, are presented in Figure 5. These indicate less than 0.35 faults per year per 1000 km for shallow water, and less than 0.15 faults per year per 1000 km for deep water. It is believed that with the greater number of systems deployed over the last 15 years, these figures are extremely low and present the limit of what could be achievable in undersea cable protection.

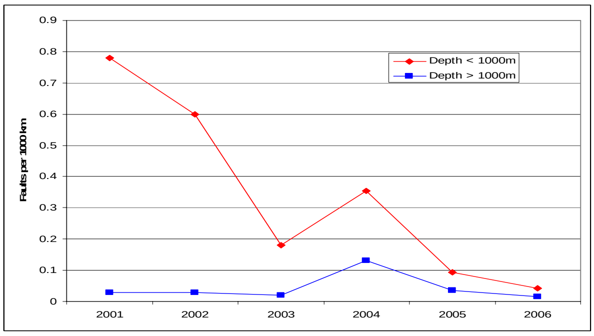

Figure 5. Length-Normalized Overall Fault Rates for Depths < 1000m and Depths > 1000m

The rest of the analysis concentrates on faults in shallow water, i.e. less than 1000m. Annual fault rates for all external aggression causes are presented in Figure 6, where the average rate is about 0.1 faults per year per 1000km over the last 6 years. Such rate, although fluctuates from year to year, seems to have leveled off at an average of 0.1 per year.

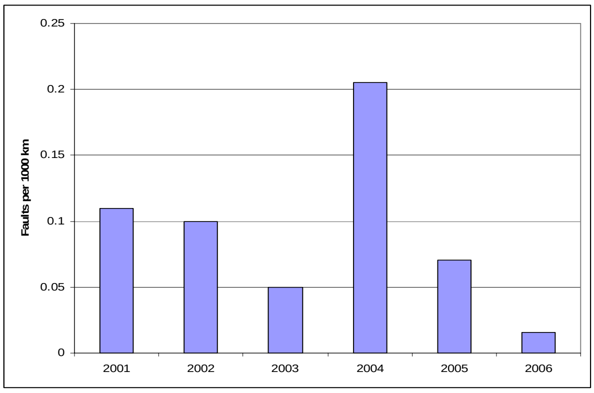

Figure 6. Length-Normalized External Aggression Faults in less than 1000m Water Depth

Figure 7 presents fishing faults only. Although 2004 data is higher than surrounding years, one cannot draw specific conclusions from a global data set, as over a period of 3 years the average is a little over 0.06 faults per year per 1000km. This continues to be an extremely low rate, most likely due to systematic cable burial and cable awareness throughout the world.

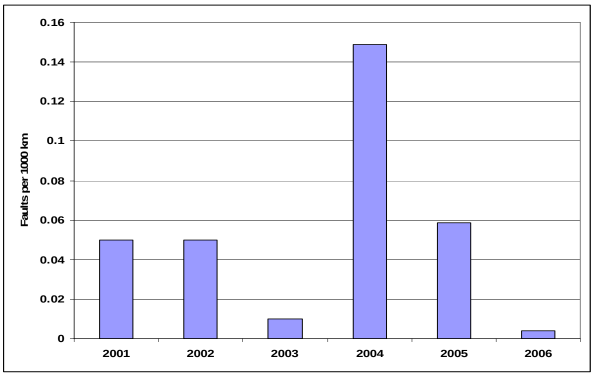

Figure 7. Length-Normalized Fishing Faults in less than 1000m Water Depth

Figure 8 shows the absolute number of deep water faults (deeper than 1000m) per year. This rate is slightly less than 2 faults per year over the last six years. This data does not provide any indication of global deep water fishing expansion.

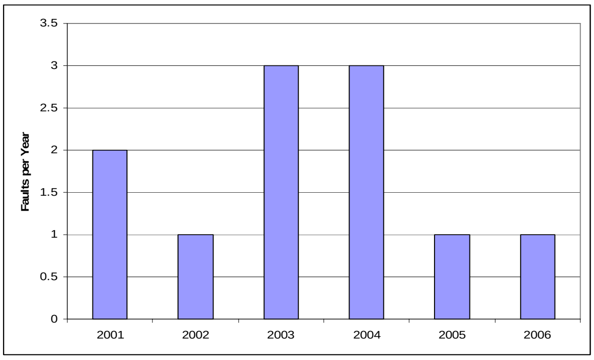

Figure 8. Absolute Fishing Faults in greater than 1000m Water Depth

The second largest category of external aggression faults, in less than 100m water depth, is that of anchor faults. Figure 9 shows an average of less than 0.02 faults per year over the last six years. These faults continue to occur within busy harbors and anchoring areas which are hard to protect.

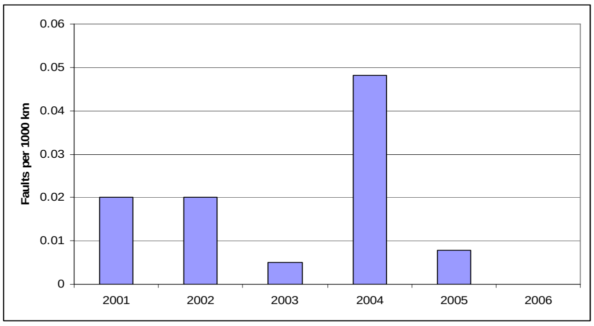

Figure 9. Length-Normalized Anchor Faults in less than 1000m Water Depth

4 CONCLUSIONS

This paper presents a global analysis of undersea system fault data over the last six years. It is clear that external aggression remains the primary cause of faults, and fishing faults constitute the majority of those. Most faults continue to occur in less than 200m water depth. These conclusions provide general and global trends. However, regional rates do vary significantly. Normalized fault rates, for the length of cable deployed, show annual external aggression fault trends are extremely low.

5 ACKNOWLEDGEMENTS

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6 REFERENCES

[i] Kordahi M, and Shapiro S, 'Worldwide Trends in Submarine Cable System Faults', SubOptic'04, May '04, Monte Carlo, Monaco.

[2] Featherstone J, Cronin A, Kordahi M, and Shapiro S, 'Recent trends in Submarine cable faults', SubOptic'01, May 01, Kyoto, Japan.

[3] Shapiro S, Murray J, Gleason R, Barnes S, Eales B and Woodward P, 'Threats to Submarine Cable', SubOptic'97, May '97, San Francisco, USA.

[4] Frantz R, Bubel G, and Wagner E, 'Recent Trends in Submarine Cable Failures', ICPC, Marlow, April 1996.